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Cultivating Design Thinking in Higher Education: A Systematic Review of Pedagogical Approaches

Membudayakan Pemikiran Reka Bentuk dalam Pendidikan Tinggi: Satu Kajian Sistematik terhadap Pendekatan Pedagogi

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ABSTRACT - This systematic literature review (SLR) aims to find out how Design Thinking (DT) is developed in higher educational settings and what pedagogical methods and scaffolding ways have been implemented, as well as identify current academic debates and research lacunae. According to the PRISMA guidelines, there were 27 high-quality eligible empirical studies from the WOS, Scopus and ERIC in 2021–2025. Based on deep analysis the data suggests a major shift in how DT is being taught. What we found is that educators are moving away from simple, rigid models like the Stanford five-stage model toward more complex learning ecosystems. These paradigms are in the form of digital shifts using online whiteboards, learning by doing through maker practice and interdisciplinary integration among various faculties. The most successful programmes use a mix of scaffolds, such as microtools to shape cognitive habits; visual trails to track thinking trajectories; and gamified simulators that force students to physically experience user pain points. However, our look at the evidence also reveals some serious challenges. Most current DT assessment frameworks fail to capture real growth because they lack ecological validity and lean too heavily on student self-reports, which creates a significant gap in measuring implicit skills like empathy or resilience. Further, it has yet to be tested empirically that critical thinking is a prerequisite of DT. Instead, students often experience uncertainty anxiety when the messy reality of DT conflicts with their structured school days. The study suggests that breaking away from innovation theatre demands that schools cultivate blended learning ecosystems and develop benchmarking based on actual performance. Finally, the way we teach should evolve from step-by-step instruction to the pushing of students toward real-world pressures through hands-on making and the complicated social-ethical tensions found among diverse stakeholders.

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INTRODUCTION

Higher education is currently undergoing a massive shift, moving away from the old model of teaching isolated subjects to focus instead on the cross-disciplinary skills needed to tackle "wicked problems". Within this changing landscape, Design Thinking (DT) has moved from the sidelines to the centre stage of educational strategy. By weaving together empathy, creative flair, and logical analysis, DT is no longer just an elective skill; it has become an essential toolkit for anyone trying to navigate the "Brittle, Anxious, Non-linear, and Incomprehensible" (BANI) world we live in today (Selvalakshmi et al., 2022; Wren et al., 2025). However, while the talk around DT grows louder in higher education, the actual body of research remains remarkably scattered. We see plenty of individual case studies, but we still lack a transparent, systematic way to pull these different teaching models together. Most importantly, scholars have not yet used a systematic review to pin down which specific instructional scaffolds actually help students move past just copying a process to truly owning the mindset.

This gap between theory and classroom practice puts teachers in a tight position, trying to distinguish between methods that create actual talent and the kind that merely gives rise to “innovation theatre”(Ardila Echeverry et al., 2025; O'Toole & Kelestyn, 2021). Since we lack standardised, objective ways to measure success, most evaluations still fall back on student self-reports or basic academic grades. Unfortunately, these metrics miss the mark when it comes to tracking growth in quiet, implicit skills like resilience, creative confidence, or the ability to handle ambiguity (Lubna et al., 2024; Patel et al., 2024; Zupan & Nabergoj, 2025). This leads to a major roadblock: the trial-and-error logic at the heart of DT constantly conflicts with a traditional school culture that values "right answers" over exploration (Hews et al., 2023; Manna et al., 2022; Taimur et al., 2022).

To tackle these issues, our study follows PRISMA protocols to review 27 high-quality empirical cases from 2021 to 2025, pulling evidence from Scopus, Web of Science (WOS), and ERIC. The review addresses three research questions: RQ1, What pedagogical methods are used to cultivate DT in higher education? RQ2, Which instructional scaffolds effectively promote mindset internalisation? RQ3, What are the limitations and research gaps in current teaching methods for DT? By bringing this evidence together, we hope to bridge the knowledge gap and reveal how DT is evolving from a simple business tool into a more critical, embodied practice. Our ultimate goal is to offer evidence-based insights that help educators look beyond formalism and fill the current "assessment vacuum".

METHODS AND MATERIALS

This review strictly followed the systematic literature review guidelines of the PRISMA 2020 statement. The review process followed four stages: identification, screening, eligibility, data abstraction and analysis. These four phases of PRISMA were conducted independently by two researchers and then cross-checked with each other to resolve any disagreement.

2.1 Identification

To ensure the relevance of the literature that aligned with the aim of the research and was comprehensively and systematically identified, 2 databases that are deemed reputable (Web of Science (WOS) Core Collection and Scopus) and ERIC, one of the leading specialised databases for educational research, were searched. The search strategy revolved around three major concepts: “Design Thinking”, “Higher Education”, and “Teaching Method”. To further ensure the exhaustiveness and accuracy of the identification phase, prior to the search, search terms and synonyms employed in previous related studies were reviewed and incorporated into the search. The syntax was adjusted to strictly follow the various rules prescribed by each database (Table 1). To ensure data relevance and timeliness, search filters were applied directly to the databases to restrict the results of the search to “articles” in English published in the past 5 years. This refined strategy led to 257 records (Scopus n = 91; WOS n = 69; ERIC n = 97).

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Table 1. Boolean retrieval terms

SCOPUS: (Title= "design thinking")AND(Title/abstract/key words= "Higher Education" OR "Tertiary Education" OR "University" OR "College" OR "Undergraduate*" OR "Graduate*" OR "Academic Setting" OR "Campus" OR "Curriculum" OR "Pedagogy")AND(Title/abstract/key words= "cultivation" OR "pedagogy" OR "teaching method" OR "curriculum design" OR "skill development" OR "capability development" OR "competency development")AND (Title/abstract/key words= "method*" OR "approach*" OR "strateg*" OR "pedagog*" OR "intervention*" OR "practice*"OR "skill*" OR "competenc*" OR" abilit*" OR "capacit*" OR "literacy")
WOS: (Title="design thinking")AND(Topic="Higher Education" OR "Tertiary Education" OR "University" OR "College" OR "Undergraduate*" OR "Graduate*" OR "Academic Setting" OR "Campus" OR "Curriculum" OR "Pedagogy")AND(Topic= "cultivation" OR "pedagogy" OR "teaching method" OR "curriculum design" OR "skill development" OR "capability development" OR "competency development")AND(Topic= "method*" OR "approach*" OR "strateg*" OR "pedagog*" OR "intervention*" OR "practice*" OR "skill*" OR "competenc*" OR " abilit*" OR "capacit*" OR "literacy")
ERIC: ("design thinking")AND ("Higher Education" OR University OR College OR Undergraduate* OR Graduate*) AND (pedagog* OR "teaching method*" OR curriculum OR "skill development" OR competenc*) AND (method* OR approach* OR strateg* OR practice*)

2.2 Screening

Once the initial search yielded 257 records, we removed 43 duplicates, which left a total of 214 unique entries to be screened based on their titles and abstracts. Subsequently, the titles and abstracts of these records were screened against specific inclusion and exclusion criteria were: (1) the target population was explicitly identified as university students; (2) the research content focused on pedagogical methods for DT; (3) the content was explicitly relevant to the three formulated research questions; Exclusion criteria : (1) articles published prior to 2021; (2) non-English articles; (3) books; (4) conference proceedings; (5) magazines; (6) "in press" articles; (7) review articles; (8) news articles; (9) K-12 education; (10) articles where the title and abstract indicated no relevance to DT pedagogy. After screening and verification by two researchers, 28 articles were deemed potentially eligible and advanced to the next stage of evaluation.

2.3 Eligibility

After screening, the quality of the 28 remaining articles were independently assessed by two reviewers and reviewed with The Mixed Methods Appraisal Tool (MMAT) 2018 to finally decide on their eligibility through full-text reviewing. It was found that one study was not included because it did not have any relevant empirical evidence. Overall methodological quality of the remaining studies was relatively high, most meeting all minimum MMAT criteria. A total of 27 articles completely fulfilled all criteria and were included in the final synthesis. The process of selecting literature is illustrated visually in the PRISMA flow diagram (Figure 1).

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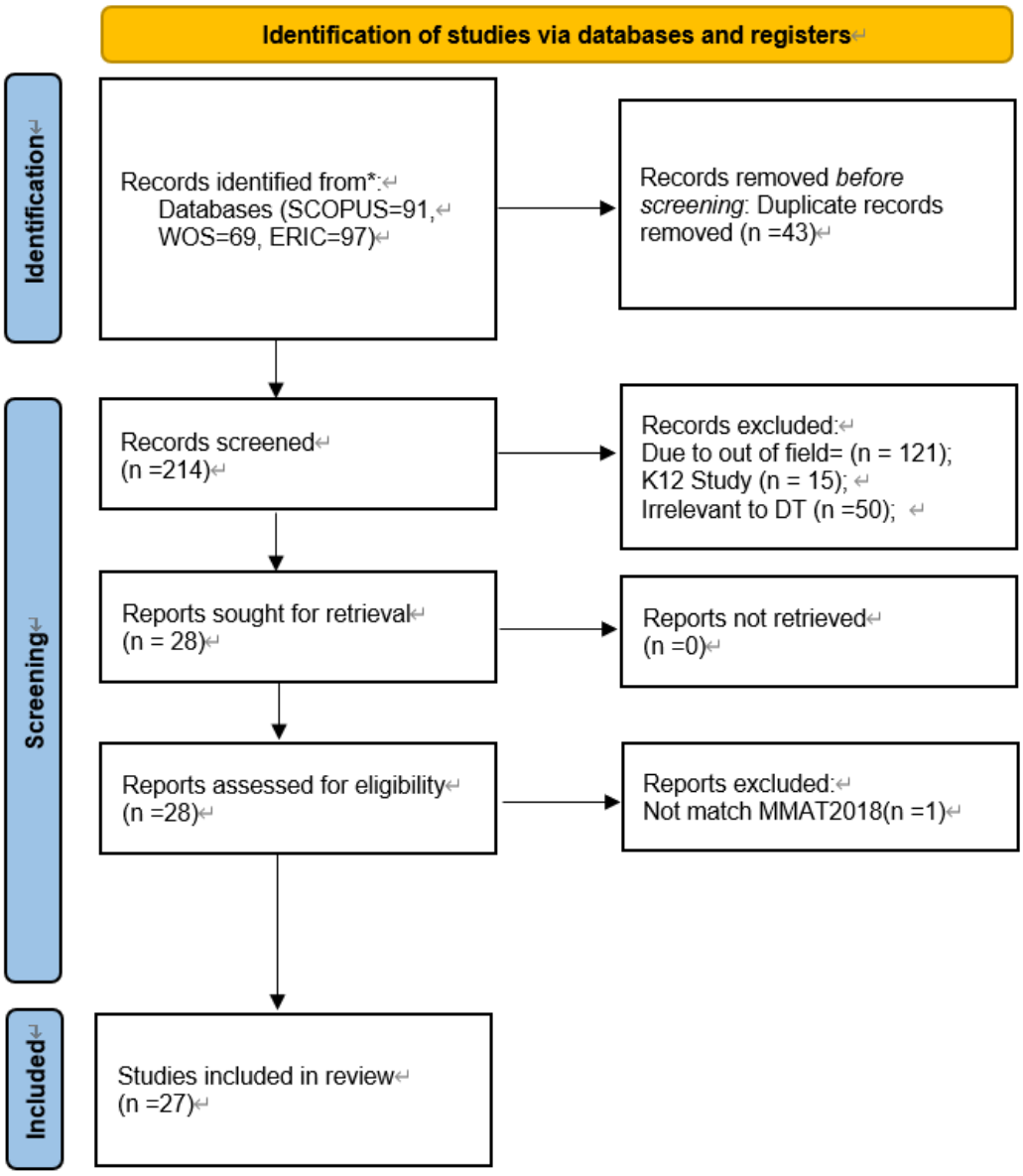

Figure 1. Flow diagram of PRISMA 2020

2.4 Data Abstraction and Analysis

The aim of this phase was to extract important evidence from the 27 studies finally included and then to neatly synthesise this evidence in order to answer three key research questions. Extracted Data: We used a pre-determined standardised data extraction form to extract relevant information from each paper. The following data fields were included: author(s), year, research problems, research objectives, research questions, methodological approach, research design, hypotheses, theory and framework, instrument used to collect data, sampling method, sample size, key findings, disciplinary perspective, conclusions, and limitations. Data Analysis: Based on these extracted datasets, we critically analysed and synthesised evidence to comprehensively address three research questions.

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RESULTS AND DISCUSSION

3.1 Pedagogical Approaches for Cultivating DT in Higher Education

Higher education approaches evolve in a unique way from "Model-based Foundations" to "Interdisciplinary Integration" to "Digital Transformation" and lastly, "Critical Reconstruction". Pedagogical activities have gone beyond instrumental instruction, moving towards complete teaching ecosystems that are increasingly complex, situated, and socially responsible. The findings can be synthesized into five main categories, as provided in Table 2.

Table 2. Summary of DT education pedagogical approaches

Category	Key Approaches	Pedagogical Focus	Key References
Foundational Models	Stanford five-Stage model; Double Diamond	Standardized process guidance; Convergent & divergent thinking.	Cai et al. (2025); Liu (2024); Zupan & Nabergoj (2025)
Hybrid Composites	DT + Project-Based Learning (PBL); Flipped Classroom	Contextualizing DT in real-world problem solving; Pre-class empathy mapping.	Kim & Ryu (2023); Lubna et al. (2024); Zhang et al. (2025)
Embodied & Gamified	Game Modding; LEGO Serious Play; Role-playing	Shifting from cognitive understanding to somatic/affective perception.	Hews et al. (2023); Selçuk et al. (2022); Shultz Colby (2023)
Digital Ecosystems	Online Whiteboards (Miro/Mural); E-brainstorming	Visualization of thinking processes; Collaborative cloud platforms.	Bustard et al. (2023); Taimur & Onuki (2022)
Critical Turn	Critical DT; Decolonized Learning	Addressing social justice, ethics, and power dynamics beyond commercial logic.	Lake et al. (2024); Patel et al. (2024); O'Toole & Kelestyn, (2021)

Classic models like Stanford five-stage model and Double Diamond models are still the essential procedural scaffolding(Cai et al., 2025; Liu, 2024; Zupan & Nabergoj, 2025; Ardila Echeverry et al., 2025; Wren et al., 2025) Educators are increasingly tailoring them to subject epistemologies(Selvalakshmi et al., 2022; Taimur & Onuki, 2022). To enrich the learning context, DT is rarely found as a standalone approach; instead, it is very often closely integrated with Project-Based Learning (PBL), flipped classrooms or experiential learning. Various researches argue that PBL gives legitimacy to solve "wicked problems", whereas DT contributes methodological scaffolding for problem-solving. This complementarity provides a sturdy synergy in engineering, marketing and sustainable education(Kim & Ryu, 2023; Lubna et al., 2024; Taimur et al., 2022).Specifically, creative scholars have incorporated DT into flipped classrooms in massive medical education by using pre-class “empathy maps” to collect learners' pain points and conducting in-class prototyping and tests to enhance pedagogical efficiency effectively(Zhang et al., 2025). Gamification and embodied pedagogy are also recognised as trendsetting trends in recent years. Applications are diverse, from LEGO and role-play to creating "safe-to-fail" zones in legal education (Hews et al., 2023),using game modding as a constructive device (Selçuk et al., 2022).With gamification and embodied cognition, the priority in pedagogic shifts from cognitive understanding to somatic perception and affective empathy. This embodiment is particularly crucial for the pedagogy of social justice and ethical sensitivity orientation (Shultz Colby, 2023).

Digital Transformation: From Physical Workshops to Online Collaborative

In the post-pandemic era with the emergence of an educational ecosystem, a grand body of research relating to digital transformative pedagogy has come into existence. Platforms like Miro, MURAL and Zoom and online word-cloud utilities have become central pedagogical infrastructures (Bustard et al., 2023; Taimur & Onuki, 2022). Studies show that the digitisation does not replace physical place but adds new dimensions for competence building. For example, e-brainstorming used word cloud visualisation to encourage creative ideation (Aldalalah, 2022). or building digital autonomous learning environments based on big data technologies (Sriwisathiyakun, 2023).

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But a key objection in this field is the lack of “presence”. Indeed, comparative studies show synchronous online sessions are more efficient, yet face-to-face interaction still has an added value which is hard to replace in "empathy" and "physical prototyping"(Kim & Ryu, 2023).Hence,the present pedagogical horizons are moving to "Hybrid Spaces". It is a mode of digital process management that preserves essential offline fieldwork and physical make moments, thus achieving higher technology ideology with enhanced humanistic experience(Taimur et al., 2022).

The Critical and Ethical Turn: Pedagogical Reframing Beyond Commercial Logic

Current scholarly literature confirms in fact that DT pedagogy is preparing for a significant "critical turn". Academics have begun to interrogate the disproportionate emphasis on commercial innovation and rapid iteration that currently characterizes DT pedagogy. Instead, the attention is turning to what DT may have to offer at the societal level in terms of dealing with social disparities, decolonisation and ethics. For example, one study has proposed “Critical DT” as the hybrid critical and futures thinking process with the use of problem starters (Patel et al., 2024). Moreover, researchers critically examine “innovation theatre” in favour of what they call a “fluid, responsive”, and reflective improvisation. In this strategy, DT serves as an emancipatory action for decolonisation and negating hegemonic power relations (Lake et al., 2024; O'Toole & Kelestyn, 2021).

This is perhaps the most conceptually profound development echoed in this review. It says that DT pedagogy at this level of learning is no longer satisfied with producing ‘competent tool users’ but seeks to prepare ‘change agents’ with social responsibility and critical consciousness. This paradigm shift demands that educators function as “more than facilitators” and become instigators of critical dialogue, ever-vigilant to ensure ethical areas for communication within schools.

In conclusion, the pedagogical approaches to DT in higher education have developed into a mixed ecology and are guided by a critical educational philosophy. This ecosystem can be represented in an anatomical metaphor: the Stanford five-stage model as a skeleton, PBL and gamified pedagogy as musculature, and digital tools as a nervous system. And to do this, future instructional design will need to find a shifting equilibrium between standardised procedural pedagogy and deep experiences that are improvisational, embodied, and critical.

3.2 Instructional Scaffolding Mechanisms for Mindset Internalization

The findings of the review indicate that the effective scaffolding for internalizing DT (external doing to internal being) must be seen in terms of a composite system rather than single procedural tool. These mechanisms can be hallmarked into three dimensions: cognitive structuring, visualization & digitization and embodiment & gamification symbols. A summary of the analysis is presented in Table 3.

Table 3. Categorization of instructional scaffolds for mindset internalization

Scaffolding Domain	Key Mechanisms / Tools	Function for Internalization	Key References
Cognitive Structuring	Question Starters ("What if?"); Empathy Maps; Fill-in-the-blank protocols	Breaks macro-processes into micro-steps; Reduces entry barriers; "Makes thinking visible."	Bustard et al. (2023); Patel et al. (2024); Shahrasbi et al. (2021); Zhang et al. (2025)
Visualization & Digitization	Online Whiteboards (Miro/MURAL); Zoom Playback; Word Clouds	"Objectification" of thought processes; Metacognitive monitoring; Providing a "spectator perspective."	Aldalalah (2022); Kim & Ryu (2023); Taimur et al. (2022)
Embodiment & Gamification	Game Modding; LEGO Serious Play; Physical Theatre; Making (DTM)	Shifting from cognitive understanding to somatic perception; Using bodies as "sensors."	Hews et al. (2023); Selçuk et al. (2022); Tham (2021); Wren et al. (2025)

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Cognitive Structuring Scaffolds: From Linear Processes to Micro-Guidance Tools

Cognitive scaffolding structures Although DT stresses non-linearity, there is still a need for structured procedural models to help novices move through the ambiguity (Bustard et al., 2023; Cai et al., 2025). And the key to internalisation is breaking down the macro-process behind it into micro-level tools. E.g., "What if?" – "Question Starters" translate abstract critical thinking to concrete reflection (Patel et al., 2024), and "Empathy Maps" and fill-in-the-blank protocols reduce barriers to entry by focusing on user pains (Shahrasbi et al., 2021; Zhang et al., 2025). The real value comes from “making thinking visible” and having students process information in particular ways until it becomes inherent. Visualisation and Digitalisation Scaffolds: The "Objectification" and "Retrospection" of Thinking Processes.

Digital tools are widely acknowledged in the literature as potent scaffolds to assist students during mindset internalisation. Online whiteboards like Miro and MURAL act less as collaborative spaces and more as visual containers for your mental process. Studies have shown that by visually recording the entire Design Thinking Process (DTP framework), students can easily visualise their own "cognitive trajectories" and conduct metacognitive reflection (Taimur et al., 2022; Taimur & Onuki, 2022).

Notably, "retrospective reflection" has been highlighted as an attribute of digital scaffolding. For example, research has shown that using the recording and playback features of Zoom allows students to revisit group discussions with a “third eye. By taking this “spectator perspective”, the internalisation of empathy and cooperative skills increases greatly (Kim & Ryu, 2023). In addition, since word clouds can act as visual stimuli, they have been found useful in enhancing e-brainstorming to help learners to focus on the main ideas derived from a mass of information (Aldalalah, 2022).

The ephemerality of DT is fundamentally modified by digital scaffolding. While the discussions penned in stickies will typically disappear once a session ends, digital archiving allows for “cognition review” to happen. This act of “metacognitive monitoring” serves as a key process towards the internalisation of mindset.

Embodiment Scaffolds: From "Cognitive Understanding" to "Somatic Perception"

The most recent trend that has emerged from this literature review is a focus on embodied or gamified learning using the embodiment and gamification scaffolds to move beyond purely cognitive boundaries for learning. This strategy allows students to embody DT in a somatic way, and it provides full, contextualised immersion. In particular, research positions games as "simulators," using "game modding"—the modification of semi-structured rules—to enable tinkering with systems thinking over time(Selçuk et al., 2022).At the same time, we are reframing our bodies themselves as “sensors” used to engage directly with unfolding environments; for example, in legal education, even LEGO construction and physical theatre have been introduced in innovative ways meant to disrupt professional ways of thinking that are increasingly recognised as having limited helpfulness if not actively obstructive (and thoroughly somaticised) results(Hews et al., 2023).The framework of "Design Thinking and Making" (DTM) is also suggested based on further evidence, which stresses that "hands-on making" itself acts as a cognitive scaffold. This view holds that translating ideas into physical forms with material needs to happen because the way in which resistant matter resists reshuffles thinking(Tham, 2021).Furthermore, methods such as "embodied dialogue" and "improvisation" are commonly used to teach empathy and openness(Hawkins et al., 2025; Wren et al., 2025).This general picture reflects a deep paradigm change in DT education from traditional Cartesian cognitivism to embodied cognition. Whereas canonical scaffolds focus on the mind, embodiment targets a whole soma.

Nevertheless, the literature also provides evidence of a hidden clash over "scaffolding fading". On one hand, some very structured scaffolds, like fill-in-the-blank protocols, can bring the novices to an advanced level remarkably fast(Shahrasbi et al., 2021). On the other hand, over-structuration can limit one's ability to explore truly "wicked problems". But scholars caution that if scaffolding is too rigid, students may be “acting” in a pageant of innovation rather than actually internalising the mindset(O'Toole & Kelestyn, 2021).

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Thus the core paradox of pedagogy to come is how to offer students the psychological safety of structured scaffolds while still maintaining enough ambiguity in environmental scaffolds that sufficiently creative internalisation will be triggered. The answer probably lies in creating a 'Dynamic Scaffolding System' that shifts from solution-based templates to stimulating inquiry as student ability develops.

3.3 Research gaps and Limitations in the DT teaching approach

Despite DT has proliferated across higher education institutions, literature indicates that its implementation continues to pose numerous and significant challenges. These problems represent a basic conflict between the' non-linearity and ambiguity" of DT, on the one hand, and the "linearity and certainty" characteristic of traditional higher education. The current obstacles can be distilled into four major subgroups as presented in Table 4.

Table 4. Implementation barriers and research gaps

Barrier Category	Specific Challenges	Pedagogical Impact	Key References
sychological Resistance	"Single correct answer" mindset; Discomfort with ambiguity; Perfectionism.	Induces anxiety and frustration; results in "passive learning inertia" and resistance to iterative failure.	Hews et al. (2023); O'Toole & Kelestyn (2021); Taimur et al. (2022); Vardakosta et al. (2023)
Structural & Institutional	Rigid linear schedules; Lecture-centric seating; Lack of maker spaces.	Causes "disciplinary friction"; DT implementation becomes superficial without spatial/temporal flexibility.	Bawaneh & Alnamshan (2023); Manna et al. (2022); Shahrasbi et al. (2021); Vivanco-Galván et al. (2024); Wren et al. (2025)
Technologica l Constraints	Missing face-to-face body language; Working in isolation rather than co-creating together.	Leads to a "dilution of empathy" and a severe deficit in physical fabrication and relational trust.	Kim & Ryu (2023); Taimur & Onuki (2022)
Assessment & Superficiality	Disconnect from real needs; Reliance on traditional standardized tests.	Creates an "assessment vacuum" unable to measure tacit competencies, fostering "innovation Theatre."	Ardila Echeverry et al. (2025); Patel et al. (2024); Zupan & Nabergoj (2025)

Firstly, one of the main difficulties mentioned in literature is students' resistance to this characteristic Ambiguity. Several studies show that students who are trained to believe in a "single correct answer," as is the case for law and STEM as well as traditional academics, express anxiety and resistance when they encounter non-linear processes of DT(Hews et al., 2023; O'Toole & Kelestyn, 2021). There is evidence in the literature that students describe the early stage of DT process as a "long and painful" stage, resulting in deep frustration before they can even achieve formative team trust(Taimur et al., 2022).Motivated by perfectionism and passive learning inertia, most students are challenged to truly co-create(Vardakosta et al., 2023). This uncovers an unsettling pedagogical paradox: students are not able to deal with the uncertainty that DT is supposed to teach. This highlights the need for psychological safety in early 'phases' to be built through ice-breaking procedures. That also points to an important gap in the research.

And then, the prevalence of the institutional inertia in higher education functions as a formidable systemic barrier that hinders rapid and conscientious adoption of DT education. This limitation is predominantly characterized by space and resource shortage. Fixed seating lecture-centric classrooms are traditional dominant, lack of specific hardware/software (lacking Mac computers or development tools), and a dearth of flexible maker spaces literally cut off the material base underlying prototyping and deep collaboration(Shahrasbi et al., 2021; Vivanco-Galván et al., 2024).There are equally great tensions between temporal dimensions. Universities' rigid linear semester systems and schedules are fundamentally at odds with the "cyclic iterative" logic inherent in DT.

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For example researches indicate that discrepancies feedback from different courses' schedules in cross-curriculum cooperative project caused the project to fail(Manna et al., 2022). Moreover, there's the same time constraint that short-term courses bring to bear, this pushes the process of questioning to remain 'superficial' and it is hard to get deep into immersion(Wren et al., 2025).And when DT is forcibly integrated into rigorously structured subjects such as mathematics or science, "disciplinary friction" is created. The universal procedural models of DT may not be compatible with the strict epistemological features of these disciplines and they are now and then criticized for overlooking the basics preparation(Bawaneh & Alnamshan, 2023; Vivanco-Galván et al., 2024). This is powerful evidence that DT cannot be installed as a "plugin" in the curriculum system. without corresponding changes in flexible academic scheduling and spatial transformation, DT education risks collapse into a stylized "sticky note carnival".

Thirdly, accelerated by digital transformation, the constraints of DT pedagogy via online have never been more evident. While digital tools have made us vastly more efficient at documentation, "deep empathy" and "phyical fabrication" still suffer egregiously from this problem. Digital "empathy dilution": Online DT methods do not have the digital equivalent of face to face body language and emotional expression (Kim & Ryu, 2023; Taimur & Onuki, 2022)which are key for developing relational trust. Virtual spaces kill the "play spirit", as co-production often becomes "individual work in separate online rooms" instead of the direct coproduction that physical prototyping demands.

Finally, the literature is unanimous on an "Superficiality of Implementation" characterising pedagogical application and a lack of any suitable statistical assessment instruments. This superficiality is initially reflected in process "disconnect" where students often disregard the field research data during ideation, producing solutions that are distanced from real needs. This essentially segregates DT—as a holistic approach—into an unconnected series of task lists (Ardila Echeverry et al., 2025). Existing applications are often blamed for not appreciating deeply enough the complex social predicaments that they handle(Patel et al., 2024; Taimur & Onuki, 2022).Conventional tests or multiple-choice questions are absolutely useless when trying to measure these tacit and holistic competencies developed through DT. At the same time, no common norm-referenced standardized tools tailored to this new paradigm have been developed and pedagogically efficacy is hard to objectively measure and support(Patel et al., 2024; Zupan & Nabergoj, 2025).

In summary, the examination of RQ3 uncovers a stark discconnect between the "promise of the ideal paradigm" and "obstruction of real-world context" that DT pedagogic implementation encounters in higher education. The point of focus here sharply turns into a single question: "How are we going to carve an 'Institutional Enclave' in the existing ossified academic evaluation systems, constricted physical spaces, and stubborn disciplinary inertia—one that truly allows for failure and ambiguity?" This implies that what all future reforms must go beyond the micro-pedagogical level and grow to a whole system reconstruction of curriculum framework, test mechanism but even some campus spatial planning.

3.4 Synthesis and Theoretical Implications

Based on this review the article emphasises that while DT pedagogy has evolved into a multi-dimensional ecosystem, incorporating Stanford five-stage model and PBL and digital scaffolds(Cai et al., 2025; Lubna et al., 2024; Vardakosta et al., 2023),it continues to be struggling from epistemological "structural friction." The contradiction between DT's "non- linear ambiguity" and institutes' "linear certainty" creates student anxiety (Hews et al., 2023; Taimur et al., 2022), which is compounded by an "assessment vacuum" that omits objective indicators of implicit competencies (Patel et al., 2024; Zupan & Nabergoj, 2025). Constrained by inflexible logistics, practice often degenerates into "Innovation Theatre" (Ardila Echeverry et al., 2025; Manna et al., 2022), and digital tools accelerate a "Digital Paradox" that empties out empathy(Kim & Ryu, 2023; Taimur & Onuki, 2022).

In response to this formalism the space has rebounded from a "Critical Turn" where it re-reads DT as an emancipatory practice up against power(Lake et al., 2024; Patel et al., 2024), and an 'Embodied Turn' enlisting serious games and fabrication to restore materialised intuition(Selçuk et al., 2022; Tham, 2021). Finally, the classic Stanford five-stage model is being replaced by a complex model that integrates embodiment and criticality. The time for "teaching the process" is over; good pedagogy must force students to "make, play, and struggle" with both real materiality and ethical quandaries.

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CONCLUSIONS

In conclusion, this systematic review emphasizes the core paradigm shift in higher education DT practice coming, in the transition of commercial instrumentalism towards critical and embodied paradigms. The study is able to theorize this as “structural friction” between linear certainty (institutional) and (non-linear) ambiguity in creative exploration. In a practical sense, this review demonstrates that “logistics is pedagogy”; it shows that without a school’s academic schedules and spatial organisation becoming subject to systemic change nowhere can the DT be internalised beyond mere formal superficiality. The primary contribution of this study will be an evidence-based road map for designing blended learning ecologies that develop individuals as students in the face of a complex and non-linear world.

The limitations of this review include a language limitation to articles published in English, possibly overlooking some studies published in other languages. Furthermore, the omission of grey literature may lead to some publication bias.

In future, the evolving line of focus on developing objective, performance-based measurement methodologies to assess how well and long DT mind-sets are internalised can become paramount for researchers. Furthermore, there are few longitudinal studies that establish how such pedagogical interventions affect a student’s professional influence in the future. Finally, deep mindset transformation will demand that universities create institutional micro-environments in which real ambiguity is allowed, and creative failure counted.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHORS CONTRIBUTION

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AVAILABILITY OF DATA AND MATERIALS

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