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Integrating Design Thinking within the R2D2 Instructional Design Model: A Pedagogical Framework for Conceptual Design Process in Design Education

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ABSTRACT

Design Thinking is widely adopted in design education to foster creativity and innovation; however, its pedagogical implementation often lacks instructional clarity and consistent approaches to learning design and assessment. Design Thinking is frequently presented as a sequence of stages, which can obscure the underlying learning demands and provide limited guidance for educators. At the same time, instructional design models offer structure but are rarely aligned with the iterative and exploratory nature of design learning. This article proposes an integrated pedagogical framework that aligns Design Thinking with the 'Read, Reflect, Display, Do' (R2D2) instructional design model. Using a conceptual framework development approach, Design Thinking phases are analysed in terms of their dominant cognitive and social learning demands, while R2D2 is interpreted as flexible instructional engagement modes rather than a linear sequence. The framework specifies phase-to-mode alignments, associated learning activities, observable learning artefacts, and indicative educator and learner roles. By making reflection, representation, and action explicit, the framework supports more coherent pedagogy, inclusive participation, and transparent assessment of creativity and innovation in conceptual design education.

Keywords: design thinking pedagogy, instructional design, pedagogical framework, conceptual design education.

INTRODUCTION

Conceptual design process is a core component of design education, as it shapes how students explore problems, generate ideas, and translate abstract concepts into tangible design solutions. However, research shows that students often struggle with core activities such as idea generation and problem framing, highlighting the pedagogical challenges in teaching this process effectively (Ferreira & Christiaans, 2012; Pan et al., 2010; Xiao & Jiang, 2022). Educators are expected to foster creativity and innovation while also providing sufficient structure to guide novice learners through complex and often ambiguous design processes (Feng et al., 2025; Samaniego et al., 2024). In many design programs, this balance is difficult to achieve, resulting in learning experiences that are either overly prescriptive or insufficiently scaffolded (Fitriyah et al., 2025; Oo et al., 2024).

In response to these challenges, Design Thinking has gained substantial attention as a pedagogical approach in higher education, particularly in design-related disciplines. Design Thinking emphasizes human-centred problem solving, iterative exploration, and reflective practice, which closely correspond to key goals commonly associated with the conceptual design process in design education (Thuan & Antunes, 2024). Empirical studies have shown that Design Thinking-based learning can enhance students' creative confidence, problem-solving ability, (Alt et al., 2023) and engagement (Liu et al., 2023). Despite its growing popularity, Design Thinking in higher education is often operationalised as a collection of activities or project-based interventions, with limited instructional design coherence and weak articulation of pedagogical structure (Alvarado, 2025; Fitriyah et al., 2025). As a result, its educational effectiveness can vary widely depending on educator experience, course structure, and institutional context.

At the same time, instructional design models provide theoretically grounded guidance for structuring learning experiences, activities, and assessment (Abuhassna et al., 2024). However, empirical research indicates many widely used instructional design models are structured around systematic sequences and predefined stages, which can make them relatively slow and less adaptive to dynamic learning demands (Shé et al., 2022)(Abuhassna et al., 2024). Additionally, studies of instructional designers demonstrate that traditional models often under-conceptualise creativity as a core design principle, further constraining their suitability for highly creative learning environments (Cuesta-Hincapie, 2025). This tension has led researchers to call for instructional design models that support flexibility, learner agency, and creativity, moving beyond rigid phase-based structures toward approaches that align with constructivist learning principles.

One such approach is the Read, Reflect, Display, Do (R2D2) instructional design model, originally proposed to support diverse learners in online and constructivist learning environments (Bonk & Zhang, 2007). R2D2 emphasizes recursive learning cycles, reflection, visualisation, and active engagement, rather than fixed instructional sequences. These characteristics suggest strong theoretical compatibility with the iterative and reflective nature of Design Thinking. Nevertheless, while R2D2 has been applied in general higher education and online learning contexts to support learner diversity and engagement (Bonk & Zhang, 2007), it has received limited attention in design education literature. In particular its potential role in structuring conceptual design process and supporting creative pedagogy remains underexplored when compared with more commonly adopted frameworks such as Design thinking.

Current literature therefore reveals a clear gap. On one hand, Design Thinking research rarely engages deeply with instructional design theory, leading to pedagogical implementations that lack coherence and replicability (Fitriyah et al., 2025). On the other hand, instructional design studies seldom address the specific cognitive and creative demands of conceptual design process learning. There is limited work that explicitly integrates Design Thinking with a structured yet flexible instructional design model capable of supporting creativity and innovation in design education.

In response to this gap, this paper proposes an integrated pedagogical framework that embeds Design Thinking within the R2D2 instructional design model. The study aims to conceptually align the phases of Design Thinking with the recursive stages of R2D2, thereby offering a theoretically grounded and pedagogically actionable approach to conceptual design process in design education. By bridging creative process theory and instructional design, the proposed framework seeks to contribute to ongoing discussions on how design education can better support creativity, innovation, and meaningful learning in higher education.

LITERATURE REVIEW

Design Thinking in Design and Higher Education

Design Thinking has been increasingly adopted in higher education as a pedagogical approach aimed at fostering creativity, problem-solving, and learner engagement. Originating from professional design practice, it has been reframed in educational contexts as a process that emphasizes empathy, iterative exploration, and reflective learning (Baker & Moukhliss, 2020). In design education, Design Thinking is often positioned as particularly suitable for conceptual design tasks, where problems are ill-defined and multiple solutions are possible. Table 1 summarises recent empirical studies examining the positive implementation of Design Thinking within design education, highlighting consistent evidence of its impact on creativity, engagement, ideation, and problem framing core components of the conceptual design process.

Table 1- Recent Empirical Studies on Design Thinking in Design Education

Author(s) & Year	**Context**	**Key Empirical Findings**	**Relevance to Conceptual Design Process**
Alt (2023)	Higher education (design-related courses)	Significant improvement in creative confidence, perceived creativity, and innovative behaviour	Supports DT as a means to strengthen students' confidence and openness during early conceptual design stages
Liu et al. (2023)	University-level design thinking course	Increased creative confidence, learning engagement, and participation in problem-solving tasks	Demonstrates DT's role in sustaining engagement during problem exploration and ideation
Lin & Chang (2024)	Design-related higher education (hands-on DT tasks)	DT-based learning enhanced creative output and cognitive engagement during ideation tasks	Provides cognitive evidence supporting DT's alignment with ideation and conceptual exploration
Huang et al. (2024)	Design education (ideation-focused tasks)	Improved idea originality, divergent thinking, and design ideation performance	Directly supports DT effectiveness in conceptual idea generation
Romero-Caballero et al. (2025)	Higher education (design & innovation courses)	Improved problem framing, collaborative learning, and student engagement	Shows DT's effectiveness in managing complex, ill-defined design challenges
Oo et al. (2024)	Art & design education	Enhanced collaboration, creative thinking, and idea development quality	Empirical support for DT-like practices in collaborative conceptual design tasks
Thuan & Antunes (2024)	Design education	Strengthened reflective practice, iterative thinking, and user-centred reasoning	Reinforces DT's relevance to reflective and iterative conceptual design processes

However, recent systematic reviews Table 1 raise important concerns. Despite its growing popularity, the pedagogical implementation of Design Thinking in educational settings remains uneven and insufficiently theorised. Across a decade of research, studies report substantial variability in how Design Thinking is enacted in practice, often focusing on activities, workshops, or projects without clearly articulating the instructional logic that underpins them (Fitriyah et al., 2025). Alignment between learning objectives, scaffolding mechanisms, reflective learning processes, and assessment practices is also frequently weak or underreported (Alvarado, 2025; Rojas et al., 2025). Reviews in Table 2 focusing on specific domains, such as STEM and K-12 education, similarly highlight the absence of unified pedagogical models and the prevalence of context-dependent implementations, which complicates comparison, replication, and transfer across settings (Li & Zhan, 2022; Lin et al., 2025). Collectively, these reviews indicate that while Design Thinking is widely used, its pedagogical foundations remain only partially theorised, reinforcing the need for clearer instructional structuring without undermining its iterative and learner-centred nature.

Table 1 Systematic Reviews and Thematic Syntheses on Design Thinking Pedagogy and Implementation

Reference	**Education Context**	**Main Focus**	**Pedagogical Concerns Identified**
Fitriyah (2025)	All education levels	DT research trends, methodologies	Variability of implementation; weak articulation of learning objectives, scaffolding, assessment; limited instructional coherence and replicability
Lin et al. (2025)	K-12 education	Design Thinking research in K-12	Absence of unified pedagogical models; diverse interpretations of Design Thinking phases; limited large-scale empirical validation; inconsistent instructional and assessment practices
Alvarado et al. (2025)	Higher education	DT as active teaching methodology	Lack of explicit instructional design integration; inconsistent application of DT principles; limited pedagogical framing
Rojas et al. (2025)	STEM education	DT implementation patterns	Contextual differences in implementation; influence of pedagogy on student outcomes; methodological diversity
Mardiah (2023)	General education	DT implementation trends	Trends, challenges, future research directions including pedagogical inconsistencies.
Li & Zhan (2022)	K-12 education (primarily STEM-curricula)	Design Thinking integrated learning (DTIL) in K-12 contexts	Non-unified Design Thinking models; strong context dependence; wide variation in instructional designs; inconsistent assessment approaches; limited empirical evidence on learning effectiveness

In light of these concerns table 2, shows the growing need for instructional design approaches that can provide clearer pedagogical structure for Design Thinking without constraining its exploratory and iterative nature. Several approaches have already attempted to structure design-oriented learning. Traditional instructional design models such as ADDIE provide structured, phase-based planning, but were largely developed for well-structured domains and can be difficult to reconcile with the non-linear, exploratory character of conceptual design learning (Abuhassna et al., 2024). Design-Based Learning has been shown to scaffold iterative project work and authentic problem-solving, particularly in engineering-related design contexts, although its implementation remains highly contextual and variably articulated (Gómez Puente et al., 2013). Challenge-Based Learning (CBL) likewise builds on real-world challenges and collaborative inquiry, but systematic reviews in higher education report diverse teaching practices rather than a unified pedagogical model (Leijon et al., 2022)(Galdames-Calderón et al., 2024).

Within design education itself, research highlights that conceptual design learning depends on cycles of reflection, external representation, critique, and iteration; yet studio traditions often rely on implicit practices and unevenly structured learning processes (Razzouk & Shute, 2012; Wrigley & Mosely, 2022). Collectively, these approaches demonstrate that Design Thinking does not operate in a pedagogical vacuum, but they do not explicitly organise modes of learner engagement such as information exploration, reflection, external representation, and iterative making in ways that directly correspond to the learning demands of Design Thinking in conceptual design contexts. This creates space for an integration that foregrounds engagement modes more explicitly.

Instructional Design Models and Creative Learning

Instructional design models play a central role in structuring learning experiences by aligning objectives, activities, and assessment. However, traditional instructional design approaches have largely been developed for

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well-structured domains, where learning outcomes are clearly defined and progression is linear (Abuhassna et al., 2024). Conceptual design learning is exploratory, iterative, and often non-linear, requiring flexibility and opportunities for reflection rather than rigid sequencing.

Recent studies in higher education highlight this mismatch by stating linearity and prescriptive instructional structures limits opportunities for experimentation and risk-taking which are essential for creative exploration (Oo et al., 2024; Romero Caballero et al., 2025) These critiques point to the need for instructional design models that support recursive, divergent representations of knowledge, and learner choice.

At the same time, abandoning instructional design altogether is not a viable solution. Without pedagogical structure, creative learning environments risk becoming fragmented and inequitable, particularly for novice learners who lack prior design experience. This tension suggests that creative education requires instructional design models that are structured yet flexible, offering guidance without constraining creative exploration.

The R2D2 Instructional Design Model

The Read, Reflect, Display, Do (R2D2) instructional design model (figure 1) was proposed to address learner diversity and to support constructivist learning environments (Bonk & Zhang, 2008). Unlike linear instructional design models, R2D2 is organized around recursive learning modes rather than fixed stages. Each mode 'reading, reflecting, displaying, and doing', represents a different way of engaging with content and knowledge construction.

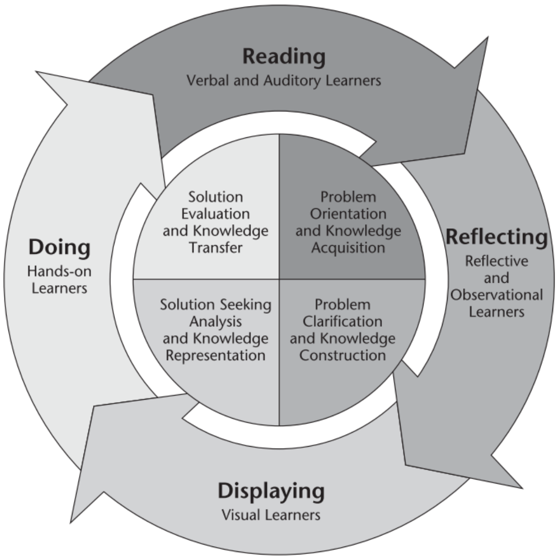

Figure 1 Phases of R2D2 Instructional Design Model (Bonk & Zhang, 2008) - Empowering Online Learning: 100+ Activities for Reading, Reflecting, Displaying, and Doing. San Francisco, CA: Jossey-Bass.

R2D2's emphasis upon reflection, visualization, engagement and active participation, suggests its potential relevance for experiential and design-oriented learning contexts (Haifa & Bin Mubayrik, 2022)(Olivares Garita et al., 2019). Despite these pedagogical strengths, existing studies demonstrate applications of R2D2 largely concentrated upon online learning and general higher-education contexts with comparatively little work examining its potential within design education (Bonk & Zhang, 2008; Haifa & Bin Mubayrik, 2022; Olivares Garita et al., 2019).

Research Gap and Rationale for Integration

The reviewed literature suggests that the alignment between Design Thinking pedagogy and instructional design theory remains partial and variably articulated, rather than entirely absent. Systematic reviews highlight variability in how learning objectives, scaffolding mechanism, reflective processes and assessment practices are theoretically grounded and explicitly designed (Alvarado, 2025; Fitriyah et al., 2025; Rojas et al., 2025).

While emerging approaches such as Design-Based Learning, Challenge-Based Learning and Design-Based Research have begun to structure design-oriented pedagogy in meaningful ways (Easterday et al., 2014; Gómez Puente et al., 2013), there remains limited work that systematically aligns Design Thinking with an instructional design model that explicitly foregrounds recursive reflection, multimodal representation, and learner diversity features that are central to conceptual design education. In particular, the integration of Design Thinking within the R2D2 framework has not yet been conceptually articulated in design education scholarship.

Addressing this gap is essential for advancing design pedagogy beyond isolated teaching strategies toward more coherent and theoretically grounded learning designs. An integrated R2D2-Design Thinking framework has the potential to provide educators with a structured yet flexible approach that supports creativity, innovation, and meaningful learning in design education.

METHODOLOGY

This study adopts a conceptual framework development approach grounded in theory construction and conceptual synthesis, following established procedures for design and development research and qualitative theory building in education (Jabareen, 2009; Richey & Klein, 2014). Conceptual framework development is appropriate when empirical findings are fragmented and when the research objective is to integrate and reorganise existing theoretical constructs into a coherent, pedagogically actionable structure rather than to test a causal relationship.

Rather than evaluating instructional outcomes empirically, the present study aims to clarify pedagogical logic, reduce ambiguity in Design Thinking implementation and provide a theoretically defensible framework that can guide instructional design and future empirical validation in conceptual design education.

Framework Development Procedure

The development of the integrated Design Thinking-R2D2 framework followed a five stage analytical process, adapted from (Jabareen, 2009) conceptual framework methodology and instructional design research practices (Richey & Klein, 2014).

Stage 1: Identification of Core Constructs

Two primary construct sets were identified from the literature:

(1) Design Thinking pedagogy, conceptualised through commonly adopted phases in educational contexts (empathize, define, ideate, prototype, test), and

(2) R2D2 instructional design model, operationalised through its four instructional engagement modes (Read, Reflect, Display, Do).

Design Thinking was treated not as a prescriptive method but as a set of learning demands embedded within conceptual design activities, responding directly to critiques that Design Thinking phases are often used descriptively without pedagogical clarification (Baker & Moukhliss, 2020; Fitriyah et al., 2025)

Stage 2: Analysis of Learning Demands

Each Design Thinking phase was analysed to identify its dominant cognitive, social, and representational learning demands, drawing on design cognition literature and empirical studies in design education. These demands included, for example, perspective-taking, problem framing, divergent ideation, representational reasoning, iterative making, and evaluative judgment.

This analytical step reframed Design Thinking from a sequence of activities into a learning demand architecture, making explicit the underlying processes required for conceptual design learning.

Stage 3: Interpretation of R2D2 as Instructional Modes

The R2D2 model was interpreted as a non-linear set of instructional engagement modes rather than a fixed instructional sequence. Each mode was conceptualised as supporting different forms of knowledge construction:

- Read (information acquisition and interpretation),
- Reflect (sense-making, evaluation, and metacognition),
- Display (external representation and visual reasoning), and
- Do (learning through action and iteration).

This interpretation preserves R2D2's constructivist foundations while enabling alignment with the iterative nature of conceptual design learning.

Stage 4: Relational Mapping and Coherence Validation

Design Thinking learning demands were then mapped to R2D2 instructional modes through iterative relational analysis. The mapping was refined using three coherence criteria:

- **Construct coherence:** alignment at the level of learning theory (e.g., whether reflective modes meaningfully support problem framing and evaluative reasoning).
- **Pedagogical coherence**: feasibility of translating mapped relationships into teachable activities with observable outputs.
- **Assessment coherence:** alignment between expected learning artefacts and commonly used assessment approaches in design education, particularly artefact and process-based evaluation of creativity and innovation.

Mappings that failed to meet one or more coherence criteria were revised or rejected.

Stage 5: Synthesis and Framework Articulation

The final stage involved synthesising validated mappings into an integrated pedagogical framework. The framework specifies:

- aligned Design Thinking learning demands and R2D2 instructional modes,
- representative learning activities,
- observable learning artefacts, and
- indicative educator and learner roles.

The resulting framework is intended to function as a pedagogical design tool rather than a prescriptive teaching method, supporting flexibility, learner diversity, and iterative learning while improving instructional clarity and assessment transparency.

Methodological Positioning and Limitations

As a conceptual study, this work does not claim empirical effectiveness or causal impact on creativity or innovation outcomes. Instead, it provides a theoretically grounded and replicable instructional framework that responds directly to persistent critiques of ambiguity and inconsistency in Design Thinking pedagogy. The framework (figure 2) is intended to support future design-based research and empirical evaluation in authentic

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design education settings.

Explicit Theoretical Propositions/ Design Principles

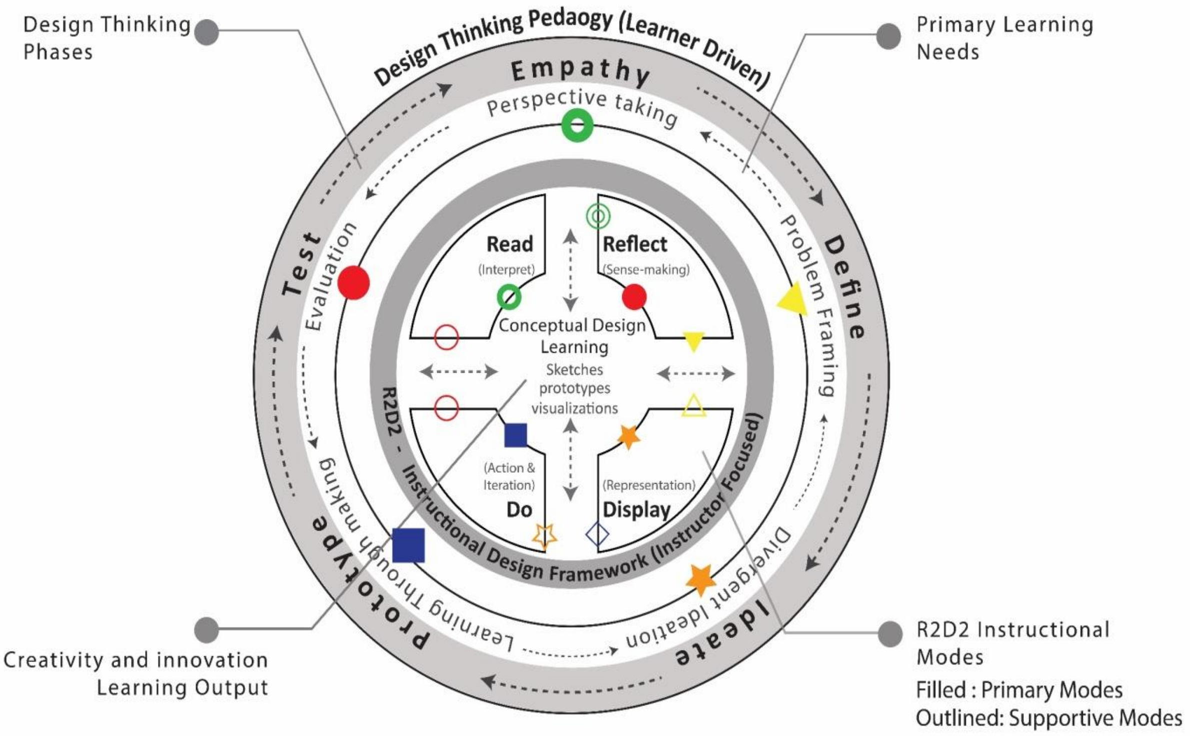

Figure 2 - Integrated Design Thinking-R2D2 pedagogical framework for conceptual design learning

Figure 2 Integrated Design Thinking–R2D2 pedagogical framework for conceptual design learning

Figure 2 presents the integrated Design Thinking–R2D2 pedagogical framework that structures conceptual design learning through the alignment of learning demands and instructional modes. Rather than viewing Design Thinking as a fixed procedural sequence, the framework conceptualises each phase ‘empathise, define, ideate, prototype, and test’ as representing dominant cognitive, social, and representational learning demands. These include understanding users and contexts, framing and reframing problems, generating and reasoning about alternatives, iteratively constructing solutions, and interpreting feedback.

These learning demands are supported through the R2D2 instructional design model, which is interpreted as a set of four non-linear learning engagement modes: Read (information exploration and meaning-making), Reflect (interpretation, evaluation, and metacognition), Display (external representation, visual reasoning, and communication), and Do (learning through action, iteration, and making). The mapping illustrated in Figure 2 therefore operates as a responsive instructional scaffold: rather than pushing learners through predetermined steps, it enables educators to activate appropriate instructional modes in response to evolving demands of conceptual design work. The circular and iterative structure of the diagram emphasises that movement across both Design Thinking phases and R2D2 modes is recursive and dynamic, allowing learners to cycle repeatedly between understanding, ideation, representation, and iteration as their design ideas develop.

Following this conceptual explanation, Table 3 translates the framework into a pedagogically actionable structure. It specifies, for each mapped element, exemplary learning activities, observable artefacts, indicative educator roles, learner responsibilities, and assessment implications. In doing so, Table 3 operationalises the conceptual integration shown in Figure 2 and demonstrates how the framework can be implemented in authentic studio-based and blended learning environments.

Table 2- Mapping Design Thinking Learning Demands to R2D2 Instructional Modes

Design Thinking Phase	Primary Learning Needs	Primary R2D2 Mode(s)	Supportive R2D2 Mode(s)	Representative Learning Activities	Observable Learning Artefacts / Outputs
Empathize	Perspective taking; interpretation of user context; sense-making; bias awareness	**Read**	**Reflect**	User research review; observation analysis; persona interpretation; reflective journaling	User profiles; empathy maps; annotated observations; reflective notes
Define	Problem framing; synthesis; justification; critical reflection	**Reflect**	**Display**	Insight clustering; framing discussions; opportunity statement development	Problem statements; “How might we” questions; concept framing diagrams
Ideate	Divergent thinking; representational reasoning; idea comparison	**Display**	**Do**	Sketching; concept mapping; brainstorming with visual prompts; rapid enactment	Idea sketches; concept boards; morphological charts; scenario storyboards
Prototype	Learning through action; iteration; material reasoning	**Do**	**Display**	Rapid prototyping; mock-ups; material exploration; iterative refinement	Physical/digital prototypes; process documentation; iteration logs
Test	Evaluation; feedback interpretation; decision-making; iteration	**Reflect**	**Read / Do**	User feedback sessions; critique discussions; revision cycles	Evaluation notes; revised prototypes; testing insights; design rationale

Theoretical Propositions of the Design Thinking-R2D2 Framework

Based on the conceptual synthesis and coherence analysis, the integrated DT–R2D2 framework advances the following pedagogical propositions for conceptual design education:

Proposition 1:

Conceptual design learning is best supported when instructional design responds to learning demands rather than enforcing phase-based progression.

Rather than treating Design Thinking as a linear or cyclical procedure, the framework conceptualises its phases as expressions of dominant learning demands. Instructional effectiveness is enhanced when educators select instructional modes (reading, reflecting, displaying, doing) in response to these demands, enabling iterative movement across understanding, ideation, representation, and evaluation.

Proposition 2:

Creativity in conceptual design emerges through deliberate alternation between external representation and reflective sense-making.

The framework highlights the pedagogical importance of the "Display" and "Reflect" modes in supporting creative cognition. External representations such as sketches, diagrams, and prototypes function not merely as outputs but as thinking tools that enable critique, comparison, and reframing. Reflection, when designed as an instructional activity rather than an implicit expectation, strengthens evaluative judgment and creative decision making.

Proposition 3:

Design Thinking pedagogy becomes instructionally scalable when embedded within a flexible instructional design architecture.

Embedding Design Thinking within the R2D2 instructional design model provides a scalable pedagogical architecture that can be adapted across studio-based, blended, and technology-enhanced learning environments without constraining iterative exploration.

Discussion: Pedagogical Implications of the Integrated Design Thinking–R2D2 Framework

Scope and Conditions of Use of the DT–R2D2 Framework

The DT–R2D2 framework is designed primarily for contexts where conceptual design learning requires iterative problem framing, ideation, representation, and prototyping. It is particularly suitable for studio-based and blended learning environments in higher education, where students are expected to engage in reflective practice, produce external representations of ideas, and iterate through multiple solution pathways. The framework assumes instructional settings where learners have opportunities to engage in guided critique, visual thinking, and iterative making, rather than highly prescriptive task completion.

The framework is most applicable for novice-to-intermediate design learners who benefit from explicit instructional structuring of reflection, representation, and action. Advanced professional designers may require more domain-specific or discipline-embedded adaptations. While the framework can be translated into online and technology-enhanced environments, successful use requires deliberate design of reflection prompts, representation tools, and feedback mechanisms. It is not intended for purely procedural or skills-training contexts where outcomes are fixed and creativity or problem framing are not central learning objectives.

Clarifying these boundary conditions ensures that the framework is not positioned as universally prescriptive, but as a flexible pedagogical architecture that supports conceptual design learning where iterative thinking, reflection, and multimodal engagement are pedagogically necessary

Structuring Conceptual Design Learning without Reducing Iteration

A recurring challenge in Design Thinking education is the tension between structure and openness. While Design Thinking is valued for its iterative and exploratory nature, educational implementations often oscillate between being overly prescriptive or insufficiently scaffolded. The proposed framework addresses this tension by treating Design Thinking phases as expressions of learning demands rather than as instructional steps, while positioning R2D2 as a flexible instructional structure that responds to these demands.

By aligning Design Thinking phases with R2D2 instructional modes, the framework offers educators a way to design learning experiences that are structured without being linear. Instructional decisions are guided by dominant learning demands, such as sense-making, representation, or action, rather than by rigid phase progression. This supports iterative movement between understanding, ideation, and evaluation, which is central to conceptual design learning.

Educator and Learner Roles

The framework also clarifies the distribution of agency between learners and educators. Design Thinking is positioned as learner-driven, emphasising student engagement with complex design problems and decision-making processes. In contrast, R2D2 functions as an instructor-scaffolded layer that structures engagement through reading, reflection, representation, and action.

This distinction is pedagogically important because it counters the assumption that Design Thinking naturally leads to effective learning without deliberate instructional design. By making the educator's role explicit, as a designer of learning modes rather than a director of outcomes, the framework supports more intentional facilitation, particularly in early design education contexts where students may lack prior experience.

Strengthening Reflection, Representation, and Inclusive Participation

The integration of R2D2 strengthens several pedagogical mechanisms that are often weakly implemented in Design Thinking courses. Reflection, for example, is frequently encouraged but rarely designed as an explicit instructional activity. The framework positions reflection as a continuous mode of engagement, supported through critique protocols, reflective prompts, and decision documentation, rather than as an implicit expectation.

Similarly, the framework reinforces the role of external representation in conceptual design learning. By explicitly foregrounding representation through the "Display" mode, the framework emphasises sketches, diagrams, prototypes, and other artefacts as central thinking tools. This reduces the risk of Design Thinking being enacted primarily through discussion or verbal reasoning, which can limit critical engagement and critique.

Importantly, the use of multiple instructional modes also supports learner diversity. Traditional Design Thinking pedagogy often advantages students who are confident communicators or who possess prior design experience. By offering multiple pathways for engagement and expression, the DT–R2D2 framework reduces reliance on a hidden curriculum and supports more equitable participation across diverse learner profiles.

Implications for Learning Outcomes and Assessment

The framework also has direct implications for how learning outcomes and assessment are conceptualised in Design Thinking education. While empirical studies suggest that Design Thinking can support creative confidence and innovative behaviour (Alt et al., 2023)(Liu et al., 2023), such outcomes are contingent on how learning is designed and assessed. Broad claims of creativity are difficult to operationalise and evaluate without clear pedagogical anchors.

By making expected learning artefacts explicit at different stages of the design process, such as problem framing statements, ideation portfolios, prototype iterations, and reflective testing insights; the framework supports more transparent and consistent assessment practices. These artefacts provide observable evidence of learning processes and decision-making, enabling assessment approaches that move beyond self-reported creativity or subjective impressions. In this way, the framework responds directly to critiques that Design Thinking research often lacks clear operationalisation of learning outcomes and relies on loosely defined indicators of creativity and innovation (Alvarado, 2025; Fitriyah et al., 2025).

Theoretical Implications of the DT–R2D2 Framework

Implications for Instructional Design Theory

The DT–R2D2 framework contributes to instructional design theory by illustrating how instructional structure can be conceived not as a prescriptive sequence but as a set of responsive engagement modes aligned with evolving learning demands. By positioning Design Thinking as a learner-driven creative process and R2D2 as an instructor-designed pedagogical scaffold, the framework challenges dominant assumptions that instructional design necessarily implies linear progression. Instead, it supports an understanding of instructional design as an adaptive architecture that enables iterative movement between understanding, ideation, representation, and evaluation. This re-conceptualisation strengthens arguments for flexible, constructivist instructional design models capable of supporting creative, ill-structured learning environments.

Implications for Creativity Research in Design Education

The framework also deepens theoretical understanding of how creativity develops in conceptual design learning. By highlighting the deliberate alternation between external representation ("Display") and reflective sense-making ("Reflect"), it reinforces the view that creativity is not solely a product of divergent thinking, but emerges through cycles of articulation, critique, reframing, and decision-making. In doing so, the framework positions sketches, diagrams, prototypes, and reflective artefacts not merely as outputs but as cognitive instruments that mediate creative reasoning. This contributes to broader discussions in creativity research that call for more explicit theorisation of how instructional structures shape creative processes rather than assuming creativity emerges naturally from open-ended activity.

Implications for Assessment Theory in Design Education

Finally, the DT–R2D2 framework offers theoretical implications for assessment in design education by conceptualising assessable artefacts as integral components of the learning process rather than post-hoc evidence of outcomes. By aligning observable artefacts with specific learning demands and instructional modes, the framework provides a basis for theorising assessment as an embedded, process-sensitive practice that can capture how students frame problems, iterate ideas, justify decisions, and reflect on testing outcomes. This perspective contributes to ongoing debates about how creativity and innovation can be meaningfully evaluated in design education, moving beyond self-reported perceptions toward authentic, artefact-based assessment grounded in clearly articulated pedagogical intentions.

Contribution to Design Education and Future Directions

Taken together, the DT–R2D2 framework contributes to design education by offering a pedagogically grounded approach to integrating creative processes with instructional design principles. Rather than proposing a new Design Thinking model, the framework reframes existing practices through an instructional lens that clarifies learning demands, supports diverse learners, and strengthens assessment coherence. While the framework is conceptual in nature, it provides a foundation for future empirical research examining its implementation in studio-based, technology-enhanced, learning environments. Future studies may explore how the framework influences creativity, innovation, engagement, and learning outcomes across different design education contexts.

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