

# Integrating Design Thinking and ICT to Foster Creative Problem-Solving Skills in EFL Classrooms

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**Abstract.** The increased demand for twenty-first-century skills has shifted English as a Foreign Language (EFL) education from linguistic accuracy towards learners' creative problem-solving, collaboration, and innovation. Despite the positive effects of Design Thinking (DT) and Information and Communication Technology (ICT) on teaching and learning, existing research is still disjointed and rarely explains the systematic integration of both approaches in developing creative problem-solving skills in EFL classrooms. This study aims to synthesize the current evidence of Design Thinking and ICT integration, identify the current research trends and gaps, and propose an integrated pedagogical framework that supports authentic problem-based language learning. A Systematic Literature Review (SLR) was conducted following a rigorous procedure of search, screening, eligibility, and thematic synthesis. A total of 32 peer-reviewed studies published mainly between 2020 and 2025 were identified from key academic databases through predetermined inclusion and exclusion criteria. The results indicate that ICT serves as a cognitive and collaborative scaffold across the five iterative phases of DT, including empathize, define, ideate, prototype, and test, by enabling learner interaction, multimodal communication, reflective feedback, and iterative knowledge construction. The review also shows that the integrated application of DT and ICT always improves learners' fluency, flexibility, originality, elaboration, learner agency, and multimodal literacy while engendering meaningful interaction with authentic communicative problems. Nevertheless, the majority of existing studies are context-specific, short-term, and do not provide a comprehensive pedagogical framework that explicitly aligns ICT tools with each DT phase in EFL instruction. This review offers a new integrated DT and ICT framework that provides practical pedagogical implications for teachers and curriculum designers while extending the theoretical understanding of technology-supported creative problem-solving in contemporary EFL education.

**Keywords:** Design Thinking, ICT integration, EFL, creative problem-solving

## INTRODUCTION

The digital transformation of language classrooms worldwide has forced the 21st-century English as a Foreign Language (EFL) education to shift from linguistic accuracy toward the development of creativity, critical thinking and problem-solving. Information and Communication Technology (ICT) has been a part of the EFL instruction process in a profound way, as Sabiri [1] puts it, and it has transformed the way that learners gain access to resources, communicate with their peers, and interact with authentic language input. However, its integration and transformative potential remain constrained by structural and pedagogical limitations [2], [3], [4]. This technological shift is taking place alongside a broader pedagogical shift. Design Thinking (DT) is essentially a cycle of empathizing, defining, ideating, prototyping and testing – messy and iterative in nature, rather than linear. It has become popular in language classrooms as a way to move learners from passive reception toward real-life problems which they have to tackle rather than exercises that look like problems [5]. The evidence backing this is no longer just anecdotal. Across a number of studies now meta-analytic and thematic alike DT-based interventions show up consistently linked to gains in creativity and problem-solving, and this holds across fairly different educational settings [6], [7]. That consistency is part of why DT keeps getting cited as a serious framework for building higher-order thinking in language education today.

Investigating the systematic integration of DT and ICT is urgent for both theoretical and practical reasons. Despite growing enthusiasm for ICT in EFL instruction, its implementation remains fragmented and frequently constrained by structural and contextual barriers that prevent many teachers from moving beyond supplementary technology use, particularly in Southeast Asian teaching settings [8], [3]. Meanwhile, DT has been shown to support more sustainable, technology-enhanced teaching practices and

stronger pedagogical competencies among educators, particularly when technology is embedded intentionally within each stage of the design process rather than treated as a peripheral add-on [9], [10]. Theoretically, such integration extends current knowledge on technology-mediated pedagogy in language learning by elucidating the interaction between digital resources and a systematic, iterative process of instructional design. Practically, the integration provides teachers and curriculum designers with a concrete, transferable basis for the intentional integration of ICT in creative, problem-based EFL teaching instead of random use of technology.

Previous studies provide only partial and fragmented support for such integration. Research has shown that DT use in language and technology disciplines classrooms improves learners' creativity, innovation, and problem-solving skills, but in an isolated discipline-based context instead of a systematic integrated EFL context [5], [11]. Moreover, an emerging yet nascent convergence between Technological Pedagogical Content Knowledge (TPACK) based technology integration and DT in educational institutions is also found in a systematic review by Rahman et al., [12]. At the same time, innovations supported by ICT such as AI-assisted learning models have shown the great potential to scaffold communicative and problem-solving tasks in language classrooms, illustrating the potential of ICT to support authentic engagement even if not explicitly cast within a structured DT process [13], [14], [15]. These studies highlight the pedagogical value of DT and ICT as separate approaches but are short-term and context-specific. They seldom provide a comprehensive framework that explicitly links ICT tools to each phase of the DT process in EFL instruction. This limitation leaves researchers and practitioners without clear evidence-based guidelines for systematic implementation, which is the motivation and the shape of the present review.

The investigation is guided by three review questions. First, how does ICT serve as a cognitive and collaborative scaffold in five iterative phases of DT, i.e. empathize, define, ideate, prototype, and test, in EFL classrooms? 2) What are the current research trends and gaps in the existing research on the integration of DT and ICT for promoting creative problem solving in EFL learning? Third, what integrated pedagogical framework can be suggested to explicitly link ICT tools to each Design Thinking phase so as to support creative problem-solving in EFL instruction? The study builds on the conceptualization of DT by Tim Brown [16] as a human-centered and iterative methodology for innovation and problem solving. DT is understood as a process of creative problem solving that is based on structured, empathy-driven inquiry and not a flash of isolated inspiration. On the basis of this, Razzouk and Shute [17] describe the defining cognitive processes of DT, making clear the specific cognitive and creative demands that each phase places on learners. Furthermore, TPACK framework [18] offers a supportive theoretical lens to perceive ICT as a pedagogically embedded tool, rather than a supplementary resource; situating the use of technology within the larger interaction of content, pedagogy and context. Thus, the current study aims to provide a Systematic Literature Review to synthesize the existing empirical evidence on the integration of DT and ICT in EFL classrooms, identify current research trends and gaps in this area, and propose an integrated pedagogical framework that explicitly aligns ICT tools with each phase of the DT process. The study explores how this incorporation supports authentic, problem-based language learning and extends the theoretical understanding of technology-supported creative problem-solving. It also offers practical guidance for teachers and curriculum designers who wish to foster these skills in contemporary EFL education.

## **MATERIALS AND METHODS**

### **Study Area**

This study was conducted within the framework of EFL education, where DT and ICT were combined to improve students' creative problem-solving skills. Rather than exploring a specific geographical context, this systematic literature review (SLR) was conducted within a conceptual study area by synthesizing evidence from different EFL contexts. This approach is consistent with the aim of SLRs to systematically synthesize evidence and identify research patterns and provide insights comprehensively through transparent and reproducible procedures [19]. Similar review studies have also adopted a conceptual scope for exploring pedagogical innovations across multiple educational contexts rather than a specific setting [20], [13]. The review included empirical studies from secondary schools, higher education, and teacher education programs in different countries. The range of studies has provided a more comprehensive understanding of the integration of DT and ICT in EFL teaching to foster creative problem-solving skills. Previous reviews have demonstrated the utility of pooling evidence from different contexts in identifying pedagogical approaches, technological trends, implementation difficulties and gaps in research, which can inform future EFL pedagogy and technology-enhanced learning [21], [22]. Accordingly, the delimitation of the study area was based on the convergence of DT, ICT integration, creative problem-solving, and EFL education, instead of geographical or institutional parameters. This delimitation was in line with the study

goal of consolidating existing evidence on technology-enhanced instructional practices, while providing theoretical and practical implications to EFL instruction and acquisition [19], [20], [8].

## **Procedures**

### **Research Design**

The SLR approach was utilized in the present study to analyze the empirical evidence regarding the combination of DT with ICT in order to develop creative problem-solving abilities in EFL classes. The use of the systematic literature review approach allows a clear, systematic, and replicable procedure for identification, appraisal, and synthesis of research studies, which reduces the risk of selection bias compared to narrative literature reviews [19]. The systematic literature review followed the PRISMA 2020 guidelines for the identification, screening, eligibility, and inclusion of research studies [19]. The PRISMA has been shown to be effective for synthesizing evidence and enabling replication of reviews across educational contexts through reviews in education [20], [22]. The review protocol included pre-specified search strategy and eligibility criteria, study selection and data extraction. A priori protocol registration reduces researcher bias and increases the validity of synthesized findings through the use of standardized evaluation criteria [13]. Moreover, it enables the comparison of different educational contexts, the identification of pedagogical patterns and the development of evidence-based recommendations for future research and instructional practice [21], [8]. Therefore, the methodological approach is a sound basis for the synthesis of evidence on DT, ICT integration and creative problem-solving in EFL education and directly supports the three guiding research questions of this review [4]. Therefore, the methodological approach provides a solid foundation for the synthesis of evidence on DT, ICT integration, and creative problem-solving in EFL education, directly supporting this review's three guiding research questions [4].

### **Literature Search Strategy**

A literature search was performed to find empirical studies that used DT and ICT to improve creative problem-solving skills in EFL settings. The search strategy comprised the identification of databases, key words, Boolean operators, the time frame of publication and inclusion criteria [19]. A predefined search strategy improves the process of searching for evidence by promoting transparency, reproducibility, and completeness, and reduces publication and selection bias [13], [8]. The search was performed across Scopus, WoS, ERIC, and Science Direct databases indexing peer-reviewed papers in education, applied linguistics, and educational technology. Other relevant papers were located using Google Scholar [20], [22]. Peer-reviewed journal articles only, in English, published between 2020 and 2025, were considered. Boolean operator-based keyword combinations were used to increase the accuracy of searching. The main search string was as follows: ("Design Thinking" AND "ICT" OR "Information and Communication Technology") AND ("Creative Problem-Solving" OR "Creative Thinking") AND ("EFL" OR "English Language Teaching" OR "English as a Foreign Language"). Minor changes in the syntax were made to adapt the search string for the indexing needs of each database while keeping its meaning unchanged [19]. The collected references were exported to the reference manager and duplicates removed; the rest were screened and assessed for eligibility [21], [4]. The methodological role of explicit search procedures is complemented by thematic-synthesis guidance [23]. Related evidence syntheses and studies also document ICT integration in English-language education and inquiry-oriented critical-thinking contexts [22], [24], [25], [26].

### **Eligibility Criteria**

The criteria for inclusion and exclusion were set prior to selecting the studies in order to ensure the relevance and quality of the synthesized data. Setting the criteria before the selection process helps prevent selection bias and increases the credibility of systematic literature reviews [19]. This also helps evaluate the studies uniformly and thus increases the validity and reliability of the synthesized findings [13], [8]. The inclusion criteria were as follows: studies (1) published as peer-reviewed journal articles; (2) written in English; (3) published within the period from 2020 to 2025; (4) dealing with EFL or English language teaching; (5) empirically investigating the use of DT, ICT, or creative problem-solving. Studies using quantitative, qualitative, and mixed-methods designs were considered complementary and relevant to pedagogical practices and educational outcomes [21], [22]. The following studies were excluded from the analysis: (1) studies published as conference proceedings, book chapters, dissertations, editorials, review papers, or not peer-reviewed; (2) studies not published in English; (3) studies unrelated to English language learning; (4) studies having no evidence base; (5) studies researching digital technology and DT without linking them to creative problem-solving in EFL education.

Table 1. Inclusion and Exclusion Criteria

| Criteria            | Inclusion                                      | Exclusion                                                                    |
|---------------------|------------------------------------------------|------------------------------------------------------------------------------|
| Publication type    | Peer-reviewed journal articles                 | Conference papers, book chapters, dissertations, editorials, review articles |
| Language            | English                                        | Non-English publications                                                     |
| Publication year    | 2020-2025                                      | Before 2020                                                                  |
| Educational context | EFL / English Language Teaching                | Non-EFL contexts                                                             |
| Research design     | Quantitative, qualitative, mixed methods       | Studies without empirical data                                               |
| Research focus      | Design Thinking, ICT, Creative Problem-Solving | Unrelated educational topics                                                 |

### Study Selection Process

The study selection process followed a systematic approach consisting of four stages described in the PRISMA 2020 Statement: identification, screening, eligibility, and inclusion [19]. Such an approach was used to maintain transparency in the evaluation of all studies collected in the process and to minimize selection bias in the course of this review [13], [8]. The eligibility criteria were applied at each step to preserve methodological consistency and to include only relevant articles in the review process. The first step consisted of identification of records using the electronic databases chosen for this purpose. Further records were identified by manually scanning reference lists and conducting complementary database searches to minimize the chance of missing relevant publications [21], [22]. All extracted citations were exported to reference management software, where duplicate records were identified and deleted prior to screening [21]. In the screening stage, the remaining studies were assessed based on their titles and abstracts against the previously defined inclusion and exclusion criteria; publications clearly unrelated to the integration of DT, ICT, creative problem-solving, or EFL education were excluded. In the eligibility stage, the full text was evaluated to determine whether each article met all the methodological and topical requirements outlined in this review [19]. Finally, only studies that fully met the eligibility criteria were included in the qualitative synthesis, providing the empirical evidence used to directly address RQ1 (ICT's scaffolding role across the DT phases), RQ2 (current research trends and gaps), and RQ3 (the proposed integrated pedagogical framework) [4].

### Data Analysis

The chosen studies were analyzed using the thematic synthesis technique described by Thomas and Harden [23]. This technique provides a structured and systematic way of integrating findings from several empirical studies. In the process of analysis, the following steps were applied: identification of findings from each study; inductive line-by-line coding to identify concepts related specifically to the five iterative phases of DT empathize, define, ideate, prototype, and test and to the ICT functions reported within each phase; clustering of related codes into descriptive themes reflecting how ICT tools were reported to scaffold each DT phase; and interpretation of the links between these descriptive themes to create higher-order analytical themes addressing the study's research questions. The technique allowed going beyond simply summarizing the findings of each single study by providing conceptual conclusions about how the use of DT together with ICT can foster creative thinking skills among EFL students. During the thematic synthesis process, there was continuous comparison across the studies to ensure that the emerging themes are credible, consistent, and trustworthy in relation to the evidence [23].

## RESULTS AND DISCUSSIONS

### Study Selection Process

As Figure 1 shows, the identification stage yielded 202 records from database searching and 50 records from registers. Prior to screening, 57 records were removed (37 duplicates, 10 records marked ineligible by automation tools, and 10 removed for other reasons), leaving 195 records for title and abstract screening. Of these, 50 records were excluded at the screening stage. Reports were then sought for retrieval ( $n = 51$ ), of which 30 could not be retrieved. The remaining reports were assessed for eligibility ( $n = 64$ ), and 32 were excluded for not being written in English ( $n = 12$ ) or not being related to the topic ( $n = 20$ ). This process resulted in a final set of 32 new studies included in the review.

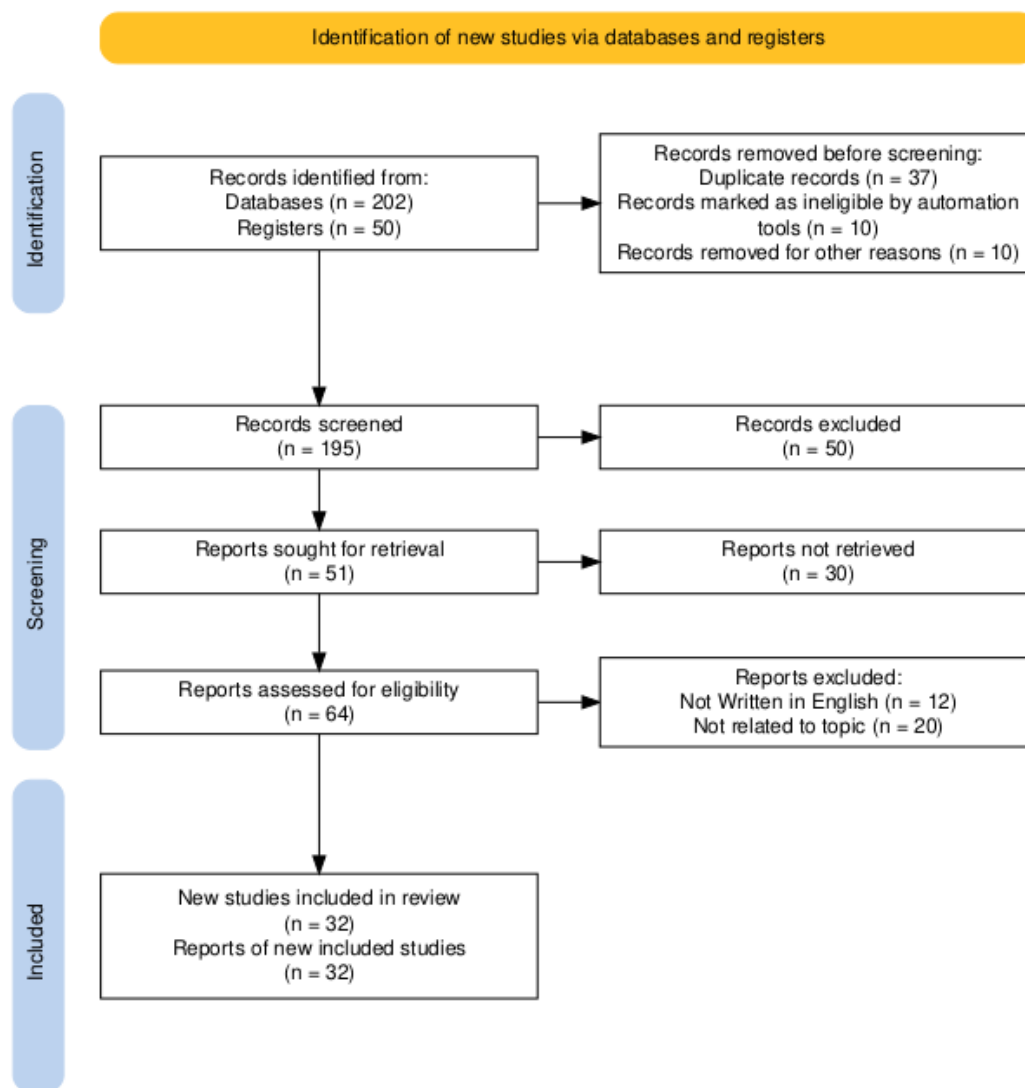


Figure 1. PRISMA 2020 flow diagram of the study identification, screening, eligibility, and inclusion process.

### Characteristics of the Included Studies

Table 2 presents an overview of the 32 studies included in this review, including the years of publication (from 2020 to 2025) and the different designs (quantitative, qualitative, and mixed methods) in secondary, higher education, teacher education, and vocational contexts. The studies are all connected to three interrelated foci: Design Thinking (DT), ICT integration, and creative problem-solving. Most of the studies focus on ICT's scaffolding role in DT-based or technology-enhanced EFL instruction,

Table 2. Synthesis of Included Studies (n = 32)

| No | Author(s), Year              | Context      | Design | DT/ICT/ Problem-Solving Focus | Main Cognitive Focus | Main Finding                                                                     | Research Gap Addressed / Novelty                     |
|----|------------------------------|--------------|--------|-------------------------------|----------------------|----------------------------------------------------------------------------------|------------------------------------------------------|
| 1  | Sabiri, 2020 [1]             | EFL, general | SLR    | ICT in EFL teaching           | Access & engagement  | ICT integration improves access to authentic input but faces structural barriers | Highlights fragmented ICT adoption; not linked to DT |
| 2  | Cao, Rasul, & Omar, 2023 [2] | EFL, China   | SLR    | ICT integration challenges    | Teacher readiness    | Identifies structural, pedagogical, contextual barriers to ICT use               | Confirms persistent implementation gaps              |

| No | Author(s), Year                        | Context            | Design                | DT/ICT/ Problem-Solving Focus             | Main Cognitive Focus   | Main Finding                                                         | Research Gap Addressed / Novelty                          |
|----|----------------------------------------|--------------------|-----------------------|-------------------------------------------|------------------------|----------------------------------------------------------------------|-----------------------------------------------------------|
| 3  | Cao, Wang, & Zhang, 2023 [4]           | EFL, general       | SLR                   | ICT integration challenges                | Institutional support  | Synthesizes recurring ICT adoption barriers                          | Reinforces need for structured integration models         |
| 4  | Cleminson & Cowie, 2021 [5]            | EFL classroom      | Qualitative           | DT for creative/com municative engagement | Empathize– Define      | DT fosters authentic, learner-centered communicativ e tasks          | First to link DT explicitly to EFL engagement             |
| 5  | Yu, Yu, & Lin, 2024 [6]                | Education, general | Meta-analysis         | DT effects on learning                    | Overall DT impact      | DT interventions yield consistent gains in learning outcomes         | Quantifies DT's cross-context effectiveness               |
| 6  | Zhao & Zhu, 2025 [7]                   | Education, general | Thematic review       | DT and creative performance               | Ideate– Prototype      | DT interventions enhance student creative performance                | Maps DT's creative-outcome literature thematically        |
| 7  | Kibar, Ampa, & Nappu, 2023 [8]         | EFL, Indonesia     | Qualitative           | Teacher ICT strategies                    | Instructional practice | Documents teacher-level ICT strategies in public EFL schools         | Provides Southeast Asian implementati on evidence         |
| 8  | Avsec, 2023 [9]                        | Higher education   | Empirical             | DT for sustainable teaching               | Knowledge transfer     | DT supports sustainable, technology-enhanced teaching practice       | Links DT sustainability to knowledge transfer             |
| 9  | Srisawat, 2022 [10]                    | Teacher education  | Empirical             | DT-based PLC platform                     | Test/ reflection       | Experiential DT process enhances digital teacher competency          | Rare example addressing DT's test/reflection phase        |
| 10 | Rahman et al., 2023 [12]               | Education, general | SLR                   | TPACK-integrated DT                       | Cross-phase            | Reveals emerging but underdevelop ed TPACK– DT convergence           | Direct precursor to this study's framework gap            |
| 11 | Alhafis, Abdullah, & Karim, 2024 [13]  | Education, general | SLR                   | DT meets technology                       | Cross-phase            | Synthesizes DT– technology innovation literature                     | Confirms lack of EFL-specific DT– ICT models              |
| 12 | Darmawansah et al., 2025 [14]          | EFL, L2 speaking   | Quasi-experimental    | AI-supported GFCA model                   | Ideate– Prototype      | AI scaffolding enhances speaking performance and interaction mindset | Demonstrates AI's amplifying role in generative DT phases |
| 13 | Law et al., 2025 [15]                  | Education, general | Empirical             | Generative AI in problem-solving          | Ideate– Prototype      | Generative AI supports collaborative authentic problem-solving       | Extends AI's role beyond language-specific tasks          |
| 14 | Koh, Chai, Benjamin, & Hong, 2015 [20] | Education, general | Conceptual/ empirical | TPACK and DT framework                    | Cross-phase            | Proposes framework linking TPACK to ICT lesson design                | Foundational but not EFL-or phase-specific                |

| No | Author(s), Year                | Context                        | Design                | DT/ICT/ Problem-Solving Focus      | Main Cognitive Focus | Main Finding                                                           | Research Gap Addressed / Novelty                     |
|----|--------------------------------|--------------------------------|-----------------------|------------------------------------|----------------------|------------------------------------------------------------------------|------------------------------------------------------|
| 15 | Arianto et al., 2026 [21]      | Higher education               | Quasi-experimental    | Deep Digital Learning model        | Critical thinking    | DDL model improves critical thinking and problem-solving               | Evidence from a structured digital pedagogical model |
| 16 | Pham, 2022 [27]                | Language/ literature education | SLR                   | ICT in poetry teaching             | Test/feedback        | ICT-supported peer review enhances creative writing refinement         | One of few studies addressing DT's test phase        |
| 17 | Velu, 2023 [28]                | Higher education               | Empirical             | DT and ICT mediating innovation    | Empathize– Define    | ICT mediates DT's effect on innovative action                          | Shows ICT's facilitative role in early DT phases     |
| 18 | Lin & Hwang, 2026 [29]         | EFL writing                    | Empirical             | AI-supported scaffolding           | Ideate– Prototype    | AI scaffolding improves EFL writing performance                        | Confirms AI as cognitive amplifier in drafting       |
| 19 | Ngwenya, 2025 [30]             | EFL, collaborative learning    | Empirical             | Generative AI in language learning | Ideate– Prototype    | Generative AI supports collaborative idea generation                   | Extends AI's role to collaborative EFL tasks         |
| 20 | Chen, Chen, & Shan, 2024 [31]  | Elementary education           | Quasi-experimental    | Immersive VR/3D modeling           | Ideate– Prototype    | VR-based modeling enhances creativity and problem-solving tendency     | Cross-disciplinary evidence for immersive tools      |
| 21 | Gessala, 2025 [32]             | Teacher education              | Instrument validation | DT self-assessment questionnaire   | Test/ reflection     | Validates instrument for assessing DT components                       | Rare test-phase measurement tool                     |
| 22 | Mualim et al., 2025 [33]       | EFL, flipped learning          | Empirical             | TPACK and flipped learning         | Instructional design | TPACK-informed flipped learning enhances technology-enhanced ELT       | Reinforces structural ICT embedding trend            |
| 23 | Radouani & Kharraki, 2025 [34] | EFL, general                   | Empirical             | ICT for 21st-century competencies  | Broad competencies   | ICT integration develops 21st-century EFL competencies                 | Broad support without DT-phase linkage               |
| 24 | Aditama et al., 2025 [35]      | EFL classroom                  | Empirical             | Deep learning and engagement       | Engagement           | Deep learning approaches enhance EFL student engagement                | Engagement-focused, not DT-structured                |
| 25 | Adawiyah et al., 2024 [36]     | EFL, offline learning          | Empirical             | ICT in offline EFL learning        | Access & challenges  | Identifies challenges and opportunities in offline ICT-EFL integration | Local/ contextual evidence base                      |
| 26 | Sulaeman et al., 2024 [37]     | EFL assessment                 | Empirical             | ICT in language assessment         | Feedback/ testing    | ICT transforms EFL evaluation practices                                | Assessment-focused test-phase evidence               |

| No | Author(s), Year                     | Context            | Design                 | DT/ICT/ Problem-Solving Focus           | Main Cognitive Focus   | Main Finding                                                    | Research Gap Addressed / Novelty                        |
|----|-------------------------------------|--------------------|------------------------|-----------------------------------------|------------------------|-----------------------------------------------------------------|---------------------------------------------------------|
| 27 | Sulaeman et al., 2024 [38]          | EFL, general       | Empirical              | ICT advantages/disadvantages            | Balanced appraisal     | Identifies both benefits and limitations of ICT in EFL          | Balanced view supporting nuanced framework design       |
| 28 | Blundell, 2025 [39]                 | Teacher education  | Qualitative            | DT and digital technology complexity    | Cross-phase            | DT helps teachers navigate complex digital practice             | Teacher-perspective evidence, not learner-focused       |
| 29 | Sotlikova, 2023 [40]                | ELT classroom      | Empirical              | DT empowering ELT students              | Empathize– Define      | DT empowers learners through collaborative problem framing      | Direct EFL evidence for early DT phases                 |
| 30 | Aditama et al., 2025 [24]           | Vocational English | Conference proceedings | Deep learning and engagement strategies | Engagement             | Documents strategies for fostering engagement via deep learning | Vocational-context evidence, underrepresented setting   |
| 31 | Calafato & Hunstadbråten, 2025 [25] | EFL literature     | Empirical              | Literary competence profiles            | Interpretive/ creative | Identifies distinct EFL learner literary competence profiles    | Literature-based creative engagement angle              |
| 32 | Wale & Bishaw, 2020 [26]            | EFL classroom      | Quasi-experimental     | Inquiry-based learning                  | Critical thinking      | Inquiry-based learning improves EFL critical thinking skills    | Precedent for problem-based EFL pedagogy pre-DT framing |

### Findings Addressing RQ1

#### RQ1: How does ICT function as a cognitive and collaborative scaffold across the five iterative phases of Design Thinking in EFL classrooms?

Table 2 synthesis shows that ICT's scaffolding role in the empathize and define phases relates to widening learners' access to authentic communicative material and creating shared spaces for problem articulation. In their study, Cleminson and Cowie [5] show that when digital platforms are integrated into EFL lessons, learners have access to real communicative scenarios, not only textbook prompts, and therefore the empathize phase is based on lived rather than simulated language use. In higher education settings, ICT mediate learners' exposure to diverse problem contexts, a mediating function that Velu [28] says strengthens the analytical clarity with which learners subsequently define the problems they are working on. This pattern is supported by Sotlikova [40] who suggests that digitally mediated classroom activities promote EFL learners' negotiation of meaning in a collaborative manner while setting out communicative challenges, positioning ICT as the facilitator of shared understanding rather than the source of new content in itself. In addition to these EFL-specific findings, Adawiyah et al. [36] point out that in offline-dominant EFL contexts, the employment of targeted ICT expands learners' access to authentic input during the early stages of instructional design, suggesting that the empathy function of ICT is not necessarily contingent on fully digital contexts but can be realized through the selective purposeful integration of ICT use.

According to the studies reviewed, ICT operation changes significantly in the ideate and prototype phases. ICT, particularly AI-enabled and immersive technologies, do not just extend access, they actively boost the learners' ability to create, picture and improve ideas. Darmawansah et al., [14] found that the AI-supported Generalization, Formulation, Correction, dan Appreciation (GFCA) learning model significantly enhanced EFL learners' speaking performance and their willingness to take interactional risks in role-play tasks. The authors argued that the model could reduce affective barriers that were usually associated with spontaneous spoken production. Similarly, Lin and Hwang [29] discovered that AI-supported scaffolding enhanced EFL writing performance, providing learners the opportunity to draft, receive feedback, and revise iteratively within a single digital workflow. Ngwenya [30] extends this evidence to collaborative

contexts, showing that generative AI tools support joint idea generation among learners working on shared language tasks, thereby scaffolding the ideation process not only individually but socially. Outside the language-specific literature, Chen et al., [31] provide corroborating cross-disciplinary evidence that immersive VR-based 3D modeling significantly enhances elementary students' creativity and problem-solving tendency, indicating that the amplifying function of ICT during ideation and prototyping is not unique to language learning but reflects a broader pattern in technology-enhanced pedagogy.

Evidence addressing the test phase is markedly thinner than that available for the earlier phases. Pham [27] report that ICT-supported peer-review functions embedded in collaborative writing platforms enable EFL learners to receive structured feedback before finalizing creative writing tasks, offering one of the few concrete examples of ICT scaffolding iterative refinement. Gessala [32], working with pre-service teachers rather than language learners directly, contributes a validated self-assessment questionnaire for evaluating DT components, providing a rare instrument explicitly designed to support reflective testing within a DT cycle. Beyond these two studies, no other study in Table 2 offers a comparably explicit account of ICT-supported testing or iteration mechanisms in an EFL context, indicating that current empirical attention to DT's final phase lags considerably behind attention to its generative middle phases.

## Findings Addressing RQ2

### **RQ2: What are the current research trends and gaps in existing studies on the integration of Design Thinking and ICT for fostering creative problem-solving in EFL learning?**

The temporal distribution of the 32 studies in Table 2 illustrates a clear shift in the way DT and ICT have been treated in the literature. Earlier studies in the review window tend to address ICT integration and DT as separate scholarly concerns: Sabiri [1] and Cao [2] both document the structural, pedagogical, and contextual barriers to ICT adoption in EFL classrooms without reference to DT, whereas Cleminson and Cowie [5] and Avsec [9] explore DT as a pedagogical approach in its own right with only incidental attention to specific ICT tools. From 2023 on, growing scholarship tries to bridge this gap with TPACK-informed models that treat technology and pedagogy as structurally interdependent. Systematic reviews by Rahman et al. [12] and Alhafis et al. [13] each identify a growing, but still underdeveloped, convergence between TPACK-based technology integration and DT, building on the earlier conceptual groundwork laid by Koh, Chai, Benjamin, and Hong [20]. Mualim et al. [33] push this convergence into practice and demonstrate that TPACK-based flipped learning designs are useful for technology-enhanced teaching of English language. This shows that the theoretical connection identified by Rahman et al. starts to transform into instructional models at the classroom level. Most recently, within roughly the past two to three years, a distinct cluster of studies has introduced generative AI and immersive technologies into this research space. As shown by Darmawansah et al. [14], Lin and Hwang [29], Ngwenya [30] and Law et al. [15], AI-assisted tools are being adopted rapidly in speaking, writing and collaborative problem-solving tasks. This trend seems to be driven largely by the pace of technological innovation itself, rather than changes in DT theory. The trend is also supported by evidence from neighboring domains, e.g. the work by Chen, Chen and Shan [31] on immersive VR modeling, which demonstrates that similar technological affordances are being explored across educational levels beyond EFL specifically.

Despite this progress, the literature reviewed has three persistent limitations. First, most studies are context-bound and short-term, generally reporting single-semester or single-institution interventions rather than sustained, multi-context implementations; this pattern is evident in Cao, Rasul, and Omar [2], Kibar, Ampa, and Nappu [8], and Blundell [39], all of which report findings bound by a specific national or institutional setting. Second, studies addressing ICT's role in the test phase of DT remain scarce relative to those addressing the ideate and prototype phases, as shown in Section 4.3, leaving an empirical imbalance across the DT cycle. Third, and most critically, none of the 32 reviewed studies offers a framework that explicitly and systematically maps distinct categories of ICT tools onto each of the five DT phases within a single, coherent EFL instructional model. Radouani and Kharraki [34] and Aditama et al. [35] both report positive relationships between ICT integration and broader EFL competencies or engagement, but neither links these results to DT's phase structure per se, further confirming the conclusion that phase-specific integration is an open area for future research and instructional design.

## Discussion

### **Interpreting ICT's Shifting Role Across the DT Cycle**

The findings presented in Section 4.3 indicate that ICT does not perform a single, uniform function across the DT cycle but instead shifts in character according to the cognitive demands of each phase. In the empathize and define phases, ICT functions primarily as an access-and-connection mechanism, extending learners' exposure to authentic communicative material and creating shared spaces for problem articulation

[5], [28], [40]. This facilitative role is consistent with DT's foundational premise that creative problem-solving begins with human-centered inquiry [16]; ICT, in this sense, operationalizes empathy by making authentic communicative contexts more accessible than a conventional textbook-based classroom would allow. However, the reviewed studies rarely probe whether this broadened access also improves the quality of learners' problem framing, focusing instead on demonstrating that access itself has increased. This represents an important interpretive limitation: presence of ICT and depth of empathetic understanding are being treated as equivalent outcomes in much of the literature, when they may in fact be only loosely related. The shift observed at the ideate and prototype phases where ICT becomes a genuine cognitive amplifier rather than a mere access point is best explained by the specific affordances of the tools involved. AI-assisted platforms and immersive technologies reduce the social and cognitive stakes associated with spontaneous, real-time production, allowing learners to draft, revise, and discard ideas privately before committing to a final output [14], [29], [30], [31]. This lower-stakes context offers a plausible explanation for the consistent finding, across otherwise disparate studies, of increased willingness to take creative and linguistic risks among learners with AI scaffolding. The fact that this evidence is concentrated in the period 2024–2025 also indicates that this amplifying effect only became empirically visible after generative AI tools had become sufficiently developed to allow fluent, low-friction idea generation. Thus, the magnitude of ICT's contribution to DT's middle phases is closely linked to the maturity of the specific technology available at the time of study, rather than being an inherent property of "ICT" as a general category. The comparative thinness of evidence at the test phase (Section 4.3) is unlikely to reflect a true absence of testing activity in EFL classrooms; rather, it more plausibly reflects a research-attention gap. Structured iteration and feedback are pedagogically more difficult to design, implement, and measure than generative activities such as drafting or brainstorming, which may explain why researchers have gravitated toward documenting the more visible, easily quantifiable ideate and prototype phases. The two studies that do address this phase directly Pham's [27] work on computer-mediated peer feedback, and Gessala's [32] validated self-assessment instrument suggest that when researchers do turn their attention to testing, meaningful ICT-supported mechanisms are indeed identifiable; the gap therefore appears to lie in research emphasis rather than in pedagogical impossibility.

### **Interpreting Research Trends and the Persistent Integration Gap**

The trajectory identified in Section 4.4—from parallel treatment of ICT and DT, toward TPACK-informed convergence, toward rapid AI-driven innovation—suggests that the field's fragmentation is structural, not incidental. DT and ICT scholarship appear to have developed along two largely separate trajectories: one rooted in pedagogical theory concerned with how technology should be integrated into teaching design [12], [13], [20], [33], and another driven by the pace of technological innovation itself, particularly the recent emergence of generative AI tools [14], [15], [29], [30]. Because these two trajectories have evolved on different timelines and within different research communities, individual studies tend to adopt one lens or the other rather than integrating both, which helps explain why context-specific, short-term studies continue to dominate the field [2], [8], [39]: without a shared, phase-based framework to build upon cumulatively, each new study tends to begin from first principles rather than extending an existing body of design knowledge. This interpretation is reinforced by the observation that even studies reporting strong positive outcomes for ICT integration in EFL more broadly—such as Radouani and Kharraki [34] and Aditama et al. [35]—stop short of connecting their findings to DT's phase structure. This is not necessarily a shortcoming of those individual studies, but rather evidence that the conceptual vocabulary needed to connect general ICT-integration findings to phase-specific DT processes has not yet become standard practice in the field. The absence of this connective framework is precisely the gap that motivated this review, as established in the Introduction, and the evidence synthesized here confirms that the gap remains unaddressed across the current empirical literature.

### **Toward an Integrated DT–ICT Framework (RQ3)**

Synthesizing the interpretations above, this review proposes an integrated framework in which distinct categories of ICT tools are deliberately aligned with the specific cognitive demands of each DT phase, rather than applied uniformly across a lesson sequence. Collaborative and multimedia platforms are best suited to the empathize and define phases, where their primary contribution is broadening access to authentic communicative contexts [5], [28], [40]; generative, AI-assisted, and immersive tools are best suited to the ideate and prototype phases, where their primary contribution is amplifying fluency, originality, and creative risk-taking [14], [29], [30], [31]; and structured peer-review or self-assessment instruments are best suited to the test phase, where their primary contribution is enabling reflective iteration [27], [32]. This framework extends existing TPACK-based accounts of technology-integrated pedagogy [18], [20] by introducing a level of phase-specific granularity that none of the 32 reviewed studies makes explicit, directly addressing the fragmentation described in discussion. Pedagogically, this framework

implies that teachers and curriculum designers should treat ICT selection as a phase-sensitive decision rather than a general instructional choice selecting collaborative tools when the instructional goal is empathy and problem definition, generative tools when the goal is ideation and prototyping, and reflective or assessment tools when the goal is testing and refinement. Theoretically, the framework extends Brown's [16] and Razzouk and Shute's [17] conceptualization of Design Thinking by clarifying not only that ICT supports DT-based EFL instruction, as much of the existing literature has shown, but how and why its function changes across the empathize-to-test continuum shifting from an access mechanism, to a cognitive amplifier, to an as-yet underdeveloped support for structured iteration. In doing so, this review moves beyond confirming DT and ICT's individual pedagogical value, which is already well established in the literature, toward offering the field a coherent, phase-based structure for future instructional design and empirical inquiry.

Additional literature retained from the source bibliography provides complementary context for technology integration, design thinking, EFL learning, and creative problem-solving [41].

## CONCLUSION

This study is motivated by the limited knowledge on ways to systematically fuse the application of DT and Information and ICT so as to foster students' creative problem-solving skills in EFL classrooms. The study's main objective is to synthesize the current empirical evidence on this combination, to identify current research trends and gaps, and to suggest an integrated pedagogical framework that explicitly links ICT tools to each stage of the DT process. The findings reveal that the role of ICT in DT is not homogeneous but varies according to the cognitive load of each stage: it acts as a mechanism of access and connection in the empathize and define stages, a real cognitive amplifier in the ideate and prototype stages, and a relatively immature support in the test stage. Overall, the field is still characterized by fragmented, short-term, single-institution studies, and no previous framework maps ICT tools onto the phases of DT in a single EFL instructional model. However, these findings need to be interpreted with caution, given some methodological limitations, such as the inclusion of English-language peer-reviewed publications only during a defined 2020–2025-time frame and a chosen set of databases that may not capture relevant regional scholarship, gray literature, and non-English EFL research traditions. In addition, the uneven distribution of evidence across the DT phases means that the test-phase component of the proposed framework is relatively less supported than it empathizes–define and ideate–prototype components. These limitations notwithstanding, this study contributes uniquely to EFL pedagogy and educational technology research in that it views ICT as a phase-specific scaffold, rather than a generic add-on to instruction, the form and function of which changes throughout the design process. In theory, this revalidates the significance of the DT and TPACK-informed perspectives in understanding technology-integrated language pedagogy as a dynamic phase-differentiated process, rather than as a uniform application of digital resources. At a practical level, it implies that teachers, curriculum designers, and teacher educators must select and sequence ICT tools intentionally according to the cognitive demands of each DT phase rather than considering technology integration as a single, undifferentiated instructional decision. The study connects empirical trends across 32 studies to the Design Thinking theory and the TPACK framework, and recognizes classroom-based intervention studies, longitudinal and multi-context studies, and sustained attention to emerging AI and immersive technologies as necessary paths for future inquiry, especially to strengthen the still-thin evidence base about DT's test phase.

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