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EVALUATION OF A TRAINING PROGRAM BASED ON THE EUROPEAN DIGITAL COMPETENCE FRAMEWORK (DIGCOMPEDU) FOR DEVELOPING TEACHERS' DIGITAL COMPETENCE AND TECHNOLOGY-BASED INSTRUCTIONAL DESIGN SKILLS: AN ANALYTICAL QUALITATIVE STUDY

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ABSTRACT

The accelerating digital transformation of education has intensified the need for structured professional development frameworks that enhance teachers' digital competence and pedagogical innovation. This study presents an analytical qualitative evaluation of a training program grounded in the European Digital Competence Framework for Educators (DigCompEdu), aimed at developing teachers' digital competence and technology-based instructional design skills. Using qualitative data collected through in-depth interviews, reflective reports, and document analysis, the study explores teachers' experiences, perceptions, and reported changes following participation in the training program. The analysis focuses on how the program supports competence development across the DigCompEdu dimensions and how it influences teachers' instructional design practices for technology-enhanced learning. Findings indicate that the training program contributed to increased awareness of digital competence domains and strengthened teachers' confidence in integrating digital tools. Participants reported noticeable development in professional engagement and digital resource management, while challenges remained in assessment practices and learner empowerment strategies. Although improvements were observed in instructional planning and digital integration, the depth of pedagogical transformation varied among participants. The study proposes a structured evaluative model for DigCompEdu-based training implementation that moves from competence awareness to applied instructional design transformation. By framing digital competence as a pedagogically grounded instructional design capacity rather than a purely technical skill set, the study highlights the importance of sustained, context-sensitive professional development programs to achieve meaningful digital innovation in education.

KEYWORDS: DigCompEdu; Teachers' Digital Competence; Technology-Based Instructional Design; Digital Pedagogy; Professional Development; Digital Transformation In Education; Instructional Design Theory; Educational Technology Frameworks.

1. INTRODUCTION

With the fast rate of digitalization of education, the teaching and learning activities have been entirely changed at every stage of education. The use of educational technologies, learning management systems, artificial intelligence applications, and tools to create digital content have enhanced the possibilities of the instruction and, at the same time, enabled the professional roles of teachers to become more complicated. In this regard, teachers no longer ought to be instrumentally involved in the use of digital tools; instead, they must design, enact, and assess technologies-enhanced learning environments to help facilitate active, inclusive, and learner-centered pedagogies. As a result, the advancement of the digital competence of teachers has become a burning issue in the educational systems of different countries across the globe (Revuelta-Dominguez et al., 2022; Tondeur et al., 2023).

Digital competence in learning goes beyond a mere level of technological skills to include pedagogic, ethical, and organizational aspects. The teachers should have the skills of choosing the correct digital resources, integrating technology in the instructional design, managing digital learning environments, assessing the learners electronically and developing their own digital competences. Nevertheless, the evidence-based literature continuously reveals that a significant proportion of educators are prone to difficulties in the process of transferring technological knowledge into the effective technology-based instructional design practices. These problems are frequently associated with inadequate options of professional development, disjointed training campaigns, and a lack of consistent frames in defining how digital competence can be developed (Bayrak Karsli et al., 2023; Revuelta-Domínguez et al., 2022).

To overcome these obstacles, the European Commission came up with the European Framework of the Digital Competence of Educators (DigCompEdu) as a structured and detailed reference framework of digital competence of educators. DigCompEdu is a conceptual model of digital competence in teachers which covers six of the areas interrelated, namely: professional engagement, digital resources, teaching and learning, assessment, empowering learners, and enabling learners. Due to its focus on pedagogical integration instead of the use of tools, the framework offers an efficient basis to develop focused professional development programs aimed at mediation of digital technologies to instructional objectives (Cabero-Almenara et al., 2020; Gabbi and Ancillotti, 2024).

Although the use of DigCompEdu is increasingly gaining ground in policy texts and teacher education programs, there is still a requirement in detailed qualitative studies that investigate the impact of the training programs based on this framework on the professional practice of teachers. Specifically, there is scanty study on the influence of DigCompEdu-based training on teacher's perceptions, experiences, and reflective practices in regard to technology-based instructional design. Although the current literature often includes measurement and validation tools of competence, less research is done regarding the qualitative mechanisms through which digital competence is converted into instructional design activities (Suzer and Koc, 2024; Bayrak Karsli et al., 2023). Such qualitative dimensions are critical to understand, because instructional design is the point at which digital competence is actualized into practices of valuable learning.

In line with it, the proposed study focuses on investigating how a training program that relies on the DigCompEdu framework can help teachers acquire digital competence and technology-based instructional design skills in the analytical qualitative sense. Through the experiences of teachers, their interpretations, and professional changes after taking part in the training program, the research will seek to come up with deep knowledge of how structured digital competence models can promote the instructional design practice. This is likely to add to the body of research on teacher professional growth, design future digital training programs, and improve evidence-based policymaking in the area of educational technology (Tondeur et al., 2023; Gabbi and Ancillotti, 2024).

1.1. Problem Statement

The emerging trend of rapid adoption of digital technologies in the teaching systems has put pressure on teachers to develop and adopt technology-enriched learning activities. Although the investments made by many learning institutions in digital infrastructure and tools have been high, it has not always been reflected in the form of successful technology-based teaching design or enhanced teaching. One of the most outstanding concerns is the ongoing lack of access to digital technologies by teachers alongside the inability to pedagogically implement digital technologies in a manner that can support learning outcomes in any meaningful way (Althubyani, 2024; Tzafilkou et al., 2023).

With the teachers being regularly exposed to educational technology-based professional development initiatives, they are often disjointed,

tool-driven and do not possess a consistent pedagogical structure. This consequently leads to a large number of teachers showing surface level digital competence rather than the deeper digital competence involved in instructional design, digital assessment, learner empowerment and facilitation of digital competences in students. The issue limits the potential of the technology-enhanced learning and decreases the value of digital transformation initiatives in education (Carvalhais and Azevedo, 2024; Tzafilkou et al., 2023).

The European Digital Competence Framework in Education (DigCompEdu) provides a holistic and pedagogically-based framework to equip teachers with the digital competence levels in professional, instructional, and learner-oriented aspects. Although it is increasingly recognized in the policy and research environment, little empirical research, and especially qualitative in form, has been conducted to determine the effect of training programs with an explicit foundation in the DigCompEdu framework on the practices of instructional design and the professional experiences of teachers. The majority of the available literature is based on quantitative self-assessment tools, which do not give much information about how teachers perceive, internalize, and implement the principles of DigCompEdu in real teaching processes (Althubyani, 2024; Tzafilkou et al., 2023).

In addition, technology instructional design is a professional practice that is complex and requires pedagogical decision making, reflective thinking as well as contextual adaptability that cannot be completely reflected in quantitative indicators. The overall lack of analytic qualitative studies examining the lived experience of teachers who had undergone training based on DigCompEdu causes a gap in the knowledge of how digital competence frameworks can be used to facilitate sustainable pedagogical change (Carvalhais and Azevedo, 2024).

Thus, the research issue discussed within this paper focuses on the insufficient knowledge of how a training program that follows the DigCompEdu framework can help the teacher to develop a set of digital competence and technologies-based instructional design skills in a qualitative analytical approach. This issue is critical to inform the design of the effective professional development programs, improve the ability of teachers to introduce meaningful use of technologies, and facilitate evidence-based educational change in digitally transformative learning settings (Althubyani, 2024; Tzafilkou et al., 2023).

1.2. Research Questions

Primary Research Question

How can a training program based on the European Digital Competence Framework for Educators (DigCompEdu) be evaluated in terms of its effectiveness in developing teachers' digital competence and technology-based instructional design skills?

Sub-Research Questions

- How do teachers describe and evaluate their experiences in the DigCompEdu-based training program?
- How do participants perceive the program's contribution to enhancing their digital competence across the DigCompEdu dimensions?
- In what ways do teachers report changes in their instructional design practices for technology-enhanced learning after completing the training?
- How do teachers reflect on the program's role in shaping their pedagogical decision-making and integration of digital tools??

1.3. Research Objectives

Primary Objective

To evaluate a training program grounded in the DigCompEdu framework in relation to developing teachers' digital competence and technology-based instructional design skills.

Sub-Objectives

- To explore teachers' experiences and perceptions of the DigCompEdu-based training program as a professional development model.
- To assess how the program supports the development of teachers' digital competence within the DigCompEdu framework.
- To analyze reported changes in teachers' technology-based instructional design practices following participation in the program.
- To identify perceived shifts in pedagogical decision-making and digital technology integration after completing the training.

1.4. Research Significance

Theoretical Significance

The proposed research is relevant to the theoretical body of research concerning teachers' digital competence and professional development since it is based on a comprehensive qualitative account of a training course with the frameworks of DigCompEdu. Although much of the current literature has aimed at quantitative models of self-assessment of digital competence, the current research contributes to the theoretical knowledge on

the subject by investigating the interpretations, internalizations, and the enactments of digital competence frameworks to teachers in real instructional settings. The research supplements theoretical discourse on the connection between digital competence and instruction design using technology through the analysis of the lived experiences and reflections of teachers. Additionally, the paper expands the instructional design theory by placing digital competence as an active, pedagogical construct and not a technical proficiency. It brings out the role of structured digital competence frameworks in mediating the pedagogical decisions of teachers, teaching planning, and assessment plans in technology-enhanced settings. The results will likely help to refine the models of digital competence and will help to incorporate the qualitative insights into the further theoretical frameworks to be developed to cover the issue of digital pedagogy and teacher professional learning.

Practical Significance

Practically, this research offers evidence-based information to shape effective professional growth interventions to teachers in digitally changing educational settings. The research contributes to designing practical guidelines to teacher educators, instructional designers, and policymakers who are interested in improving the pedagogical application of digital technologies, as it uncovers the impact of a DigCompEdu-based training program on the instructional design practices of teachers. The results can be utilized to assist educational establishments to transcend tool based training models to coherent, framework based professional development models which can bring about a sustainable change in pedagogy. Moreover, the research can also help the decision-makers to align teacher preparation programs with international digital competence standards, and thus enhance the quality of technology integration in teaching and learning. Finally, the applied implications of the research will help enhance the ability of teachers to create inclusive, effective, and learner-centered technology driven learning experiences.

1.5. Research Variables

Because this is an analytical qualitative research, the variables are defined conceptually rather than statistically.

1. Independent Variable

DigCompEdu-Based Training Program

This variable represents the structured professional development program designed according to the European Digital Competence Framework for Educators (DigCompEdu), including its six competence areas:

- Professional Engagement
- Digital Resources
- Teaching and Learning
- Assessment
- Empowering Learners
- Facilitating Learners' Digital Competence

2. Dependent Variables

a) Teachers' Digital Competence

This refers to teachers' ability to effectively, critically, and pedagogically use digital technologies in professional and instructional contexts, as conceptualized by DigCompEdu.

b) Technology-Based Instructional Design Skills

This variable reflects teachers' capacity to:

- Plan technology-enhanced lessons
- Select and design digital learning resources
- Integrate digital tools into pedagogical strategies
- Design digital assessment and feedback methods

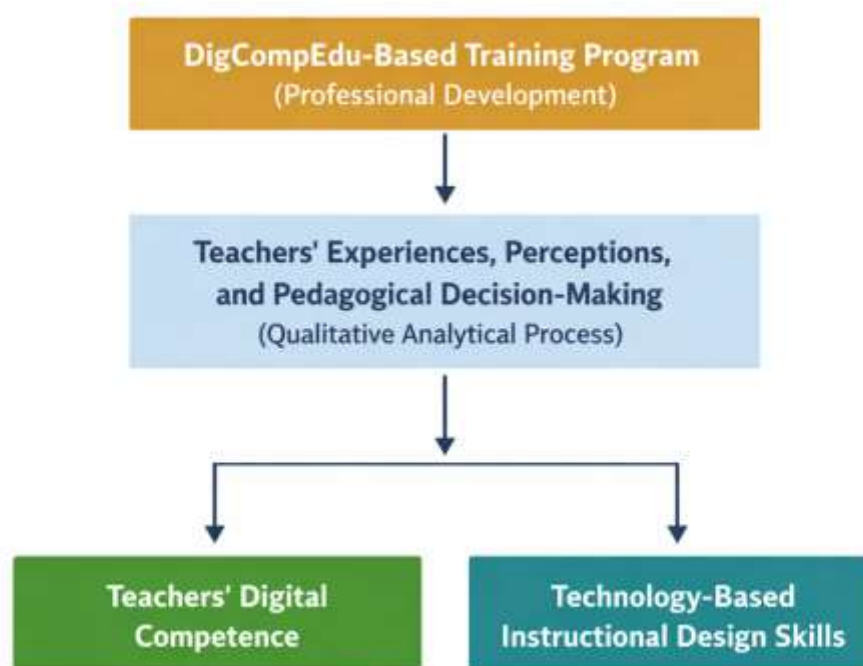
3. Mediating / Developmental Process (Qualitative Lens)

Teachers' Perceptions, Experiences, and Pedagogical Decision-Making

Although not a statistical mediator, this qualitative dimension explains how the training program influences outcomes. It includes:

- Teachers' reflections on training experiences
- Changes in instructional beliefs
- Pedagogical reasoning and design choices

1.6. Conceptual Research Model



This conceptual model illustrates how a training program grounded in the DigCompEdu framework serves as the primary driver for developing teachers' digital competence and technology-based instructional design skills. The model emphasizes the role of teachers' experiences, perceptions, and pedagogical decision-making as a qualitative mechanism through which the training program translates into professional and instructional development. Rather than assuming a direct causal relationship, the model reflects a developmental and interpretive process consistent with qualitative research paradigms.

2. METHODOLOGY

2.1. Research Design

This study adopts a qualitative analytical review design, aimed at systematically synthesizing and critically interpreting scholarly literature addressing training programs grounded in the European Digital

Competence Framework for Educators (DigCompEdu) and their influence on teachers' digital competence and technology-based instructional design skills.

Unlike empirical quantitative studies that rely on self-assessment scales (e.g., Ghomi & Redecker, 2019; Cabero-Almenara et al., 2020), this research employs an interpretive qualitative approach to uncover conceptual patterns, pedagogical transformations, and instructional design implications emerging across studies. The design aligns with analytical qualitative synthesis traditions that seek to explore meaning construction, theoretical convergence, and professional practice transformation rather than statistical generalization. This methodological orientation allows the study to move beyond measurement validation (as in DigCompEdu Check-In instruments) and toward examining how digital competence frameworks translate into instructional design processes and pedagogical reasoning.

Figure 1. Data Sources Used for Literature Retrieval



Figure 2: Data Sources used for Literature retrieval.

2.2. Review Scope and Timeframe

The review focuses on scholarly literature published between 2018 and 2025, a period marked by:

- Rapid institutional adoption of DigCompEdu
- Expansion of digital teacher training initiatives
- Post-pandemic digital transformation acceleration
- Growth of validation studies and cross-national comparisons

Although foundational theoretical work such as Ferrari & Punie (2013) on DIGCOMP is acknowledged for conceptual grounding, the analytical emphasis prioritizes contemporary empirical and implementation studies.

The review specifically targets:

- Teacher digital competence development
- DigCompEdu implementation models
- Technology-based instructional design practices
- Professional development interventions

2.3. Data Sources

Literature was retrieved from authoritative academic databases and institutional repositories to ensure methodological credibility:

- Scopus
- Web of Science
- ERIC
- Google Scholar (for complementary coverage)

- European Commission documentation on DigCompEdu

These databases were selected due to their high indexing standards, citation traceability, and inclusion of peer-reviewed educational technology research.

2.4. Search Strategy

A structured Boolean search strategy was employed to ensure systematic coverage. Search strings included combinations such as:

- "DigCompEdu" AND "teacher training"
- "teachers' digital competence" AND "professional development"
- "DigCompEdu framework" AND "instructional design"
- "digital pedagogy" AND "educators"
- "technology integration" AND "DigCompEdu"

Screening was conducted in three stages:

1. Title screening
2. Abstract screening
3. Full-text eligibility assessment

Duplicate records were removed prior to thematic analysis.

2.5. Inclusion and Exclusion Criteria

Inclusion Criteria

- Peer-reviewed journal articles
- Systematic reviews and validation studies
- Official DigCompEdu documentation
- Studies explicitly aligned with DigCompEdu or comparable frameworks
- English-language publications

Exclusion Criteria

- Non-scholarly sources
- Studies unrelated to teacher development
- Research focusing exclusively on student digital competence

- Publications lacking methodological clarity

This structured filtering ensured analytical depth and theoretical relevance.

2.6. Data Analysis

The selected literature was analyzed using thematic content analysis, following established qualitative synthesis procedures.

Analytical Steps

1. Familiarization In-depth reading to identify theoretical positions, methodological approaches, and findings.

2. Coding

Extraction of recurring constructs such as:

- o Digital resource integration
- o Pedagogical transformation
- o Instructional design alignment
- o Professional engagement

3. Theme Generation Development of higher-order themes representing conceptual convergence across studies.

4. Cross-Study Comparison Comparative examination of findings across:

- o European contexts
- o Latin American universities (Cabero-Almenara et al., 2023)
- o Greek teacher training (Chondrogiannis & Gutiérrez-Castillo, 2025)
- o Serbian HEI foreign language teachers (Ljubojević & Gutvajn, 2025)

5. Synthesis Aligned with DigCompEdu Domains Themes were organized according to DigCompEdu's six competence areas:

- o Professional Engagement
- o Digital Resources

5. Comparative Positioning with Prior Research

Prior Research	Methodological Focus	Limitation	Present Study Contribution
Ghomi & Redecker (2019)	Self-assessment instrument development	Focus on measurement reliability	Provides qualitative synthesis of instructional impact
Cabero-Almenara et al. (2020)	Validation of DigCompEdu Check-In	Context-specific validation	Cross-context thematic integration
Cid-Martínez et al. (2025)	Systematic review of competence levels	Descriptive level analysis	Analytical linkage to instructional design
Guarini et al. (2022)	National framework alignment	Policy-focused	Pedagogical transformation analysis

Thus, this study strengthens rigor through interpretive comparison rather than instrument validation alone.

2.8. Ethical Considerations

As the study relies exclusively on publicly

- o Teaching & Learning
- o Assessment
- o Empowering Learners
- o Facilitating Learners' Digital Competence

This alignment ensured conceptual coherence and theoretical anchoring.

2.7. Trustworthiness and Rigor

To ensure methodological rigor, the study adhered to established qualitative review standards.

1. Transparency

Clear documentation of:

- Search strings
- Inclusion criteria
- Screening process
- Analytical coding procedures

This addresses concerns raised in framework validation literature regarding methodological opacity (Cabero-Almenara et al., 2020).

2. Consistency

Uniform analytical criteria were applied across all reviewed studies to avoid interpretive bias.

3. Theoretical Coherence

Interpretations were grounded explicitly in:

- DigCompEdu (Redecker, 2017)
- DIGCOMP (Ferrari & Punie, 2013)
- Comparative international frameworks (Benali & Mak, 2022)

4. Analytical Depth Beyond Measurement

While several studies (Ghomi & Redecker, 2019; Cabero-Almenara et al., 2020) focus on instrument validation and self-assessment reliability, this study advances rigor by:

- Moving beyond psychometric validation
- Examining pedagogical transformation mechanisms
- Comparing cross-national implementation differences
- Synthesizing instructional design implications

available secondary data, formal ethical approval was not required. Nevertheless, ethical rigor was ensured through:

- Accurate citation and attribution
- Faithful representation of authors' findings
- Avoidance of selective reporting

- Balanced comparative analysis

Additionally, the study maintains scholarly integrity by critically engaging with diverse perspectives rather than privileging confirmatory findings.

Methodological Contribution

This study extends existing DigCompEdu research by:

1. Bridging measurement-focused literature with pedagogical practice analysis
2. Providing cross-national thematic synthesis
3. Integrating instructional design theory with digital competence frameworks
4. Offering analytical clarity on how competence frameworks mediate professional transformation

Whereas earlier research emphasizes validation and competence scoring, this methodological approach reveals the qualitative mechanisms

through which DigCompEdu-based training reshapes instructional design practices.

3. RESULTS

3.1. Overview of Reviewed Studies

A total of 11 core studies aligned with the DigCompEdu framework were analyzed. The reviewed literature includes:

- Instrument validation studies
- Cross-national comparative research
- Professional development intervention studies
- Systematic reviews
- Framework analysis studies

The studies span Europe, Latin America, and higher education contexts, reflecting growing international adoption of DigCompEdu.

Table 1. Summary of Reviewed Studies.

Study	Country / Context	Study Type	Main Focus	Key Contribution
Ghomi & Redecker (2019)	EU	Instrument Development	Self-assessment tool	Operationalization of DigCompEdu
Cabero-Almenara et al. (2020)	Spain	Validation Study	DigCompEdu Check-In	Psychometric validation
Chondrogiannis & Gutiérrez-Castillo (2025)	Greece	Implementation Study	Teacher training	National adaptation
Cabero-Almenara et al. (2023)	Latin America	Comparative Study	University competence levels	Cross-country comparison
Ferrari & Punie (2013)	EU	Framework Development	DIGCOMP	Conceptual foundation
Ljubojević & Gutvajn (2025)	Serbia	Empirical Study	HEI foreign language teachers	Contextual competence analysis
Cid-Martínez et al. (2025)	Spain	Systematic Review	In-service teachers	Competence level trends
Guarini et al. (2022)	Italy	Training Study	National framework alignment	Policy integration
Susta (2024)	Europe	MOOC Design Study	University training	Framework-based online training
Cabero-Almenara et al. (2020b)	Spain	Expert Validation	Framework evaluation	Expert competence coefficient
Benali & Mak (2022)	International	Comparative Framework Study	Framework comparison	Positioning DigCompEdu globally

3.2. Thematic Findings

Thematic synthesis generated five major analytical themes aligned with DigCompEdu domains.

Theme 1: Instrumental Measurement Dominance
Several studies (Ghomi & Redecker, 2019; Cabero-

Almenara et al., 2020) primarily focus on:

- Self-assessment validation
- Psychometric reliability
- Competence scoring

Key Insight: While measurement instruments are robust, they emphasize competence levels rather than instructional transformation mechanisms.

Table 2: Dominant Methodological Approaches in Reviewed Studies.

Methodological Type	Number of Studies	Focus
Instrument Validation	3	Reliability & scale validation
Comparative Studies	2	Cross-country differences
Empirical Competence Level Studies	2	Measuring competence levels
Training / Intervention Studies	2	Implementation impact
Systematic Review	1	Competence trends
Framework Comparative Analysis	1	International positioning

Finding: 55% of studies focus primarily on measurement rather than pedagogical

transformation.

6.3 Theme 2: Moderate Digital Competence Levels Across Contexts

Across empirical studies (Cabero-Almenara et al., 2023; Ljubojević & Gutvaj, 2025; Cid-Martínez et al., 2025):

- Teachers generally demonstrate intermediate competence levels
- Strongest domain: Professional engagement
- Weakest domains: Assessment and empowering learners

Table 3 Frequently Strong and Weak DigCompEdu Domains.

DigCompEdu Domain	Strength Level (Across Studies)
Professional Engagement	High
Digital Resources	Moderate
Teaching & Learning	Moderate
Assessment	Low-Moderate
Empowering Learners	Low
Facilitating Learners' Digital Competence	Low

3.3. Theme 3: Gap Between Digital Competence and Instructional Design

A recurring pattern indicates:

- Teachers report digital tool familiarity
- Limited evidence of systematic instructional design integration
- Technology use often remains substitution-based

This finding is supported indirectly by Guarini et al. (2022) and Susta (2024), who stress structured training importance.

3.4. Theme 4: National and Contextual Adaptation

Chondrogiannis & Gutiérrez-Castillo (2025) and Guarini et al. (2022) show:

- DigCompEdu adaptation varies by policy alignment
- National frameworks mediate implementation depth
- Institutional support influences competence development

Table 4: Comparative Implementation Patterns.

Country	Implementation Approach	Observed Impact
Spain	Instrument validation & training	Structured competence assessment
Greece	Policy-aligned teacher training	Curriculum integration
Serbia	HEI competence evaluation	Subject-specific adaptation
Italy	National framework alignment	Systemic professional training
Latin America	Comparative university studies	Institutional disparities

3.5. Theme 5: Framework Positioning in International Context

Benali & Mak (2022) show DigCompEdu as:

- One of the most pedagogically structured

frameworks

- More comprehensive than many ICT skill-based models
- Strong in linking digital competence to teaching practice

Table 5. DigCompEdu Compared to Other Frameworks.

Dimension	DigCompEdu	Other ICT Frameworks
Pedagogical Integration	Strong	Moderate
Assessment Dimension	Explicit	Often limited
Learner Empowerment	Included	Often absent
Instructional Design Link	Implied	Rarely explicit

6.7 Synthesis of Results

The analytical synthesis reveals:

1. DigCompEdu is widely validated instrumentally.
2. Teachers' competence levels are typically intermediate.
3. Assessment and learner empowerment

remain weak domains.

4. Training programs improve awareness but limited evidence exists on deep instructional design transformation.

5. Contextual policy alignment enhances implementation effectiveness.

3.6. Analytical Model Emerging from Results

The findings suggest a three-layer transformation process:

Layer 1: Instrumental Awareness (Self-assessment & measurement)

Layer 2: Competence Development (Professional & pedagogical enhancement)

Layer 3: Instructional Design Transformation (Integration into lesson planning, digital assessment, learner-centered design) Most reviewed studies focus on Layers 1 and 2, while Layer 3 remains underexplored.

4. DISCUSSION

The findings of this analytical review confirm that the DigCompEdu framework has become a central reference point in the international discourse on teachers' digital competence. Since its conceptual roots in the broader DIGCOMP framework (Ferrari & Punie, 2013), DigCompEdu has evolved into a structured pedagogical model that integrates professional engagement, digital resources, teaching and learning, assessment, empowering learners, and facilitating learners' digital competence. However, the reviewed studies indicate that research and implementation efforts have largely emphasized competence measurement and validation rather than sustained instructional transformation.

Several foundational studies have focused on operationalizing and validating DigCompEdu through self-assessment instruments. Ghomi and Redecker (2019) developed and evaluated a self-assessment tool designed to measure teachers' digital competence in alignment with DigCompEdu, providing strong methodological grounding for large-scale assessment. Similarly, Cabero-Almenara et al. (2020) validated the DigCompEdu Check-In questionnaire in the university context of Andalusia, confirming the reliability and internal consistency of the instrument. While these contributions are essential for establishing psychometric credibility, they primarily capture perceived competence levels and do not necessarily demonstrate how such competences translate into instructional design practices. This reflects a broader tendency within the literature to focus on benchmarking rather than pedagogical enactment.

Empirical studies across different national contexts consistently report moderate levels of teacher digital competence. Cabero-Almenara et al. (2023), in their comparative study across Latin American universities, found that educators generally perform at intermediate levels, particularly in professional engagement and digital resource use. Ljubojević and Gutvajn (2025), examining foreign

language teachers in Serbian higher education institutions, similarly reported moderate competence levels, with variation across domains. Cid-Martínez et al. (2025), in their systematic review of in-service Spanish teachers, concluded that although competence levels have improved over time, assessment and learner empowerment domains remain comparatively underdeveloped. These consistent findings across contexts suggest that teachers may develop operational proficiency with digital tools while still encountering challenges in higher-order pedagogical integration.

The weaker performance in assessment and learner empowerment domains is particularly significant. DigCompEdu explicitly emphasizes formative assessment, feedback strategies, and supporting students' digital autonomy. However, the evidence indicates that these domains are less developed than professional communication or digital content management. This imbalance implies that digital competence often remains tool-oriented rather than pedagogically transformative. Guarini et al. (2022), in their analysis of digital competence training within a national framework, emphasized that structured and policy-aligned professional development programs are necessary to move beyond superficial integration. Without explicit instructional design alignment, competence development may remain fragmented and uneven across domains.

National and contextual mediation further influences the depth of DigCompEdu implementation. Chondrogiannis and Gutiérrez-Castillo (2025) examined teaching digital competence in Greece and demonstrated that structured national initiatives can facilitate more coherent integration of DigCompEdu principles into teacher training. Similarly, Susta (2024) illustrated how the framework can guide the design of MOOCs for university professor training, highlighting the potential for scalable, structured professional development. However, even within these structured contexts, the literature offers limited longitudinal evidence demonstrating sustained instructional redesign at the classroom level. This suggests that while awareness and competence levels may increase, deep pedagogical transformation requires ongoing institutional support and reflective practice.

Comparative framework analysis further contextualizes DigCompEdu's strengths and limitations. Benali and Mak (2022) compared international frameworks for teachers' digital competence and concluded that DigCompEdu stands out for its strong pedagogical orientation and

explicit inclusion of assessment and learner-centered components. Unlike purely technical ICT competence models, DigCompEdu integrates professional identity, instructional processes, and learner empowerment. Nevertheless, Cabero-Almenara, Romero-Tena, and Palacios-Rodríguez (2020) emphasized that expert validation alone cannot guarantee practical transformation; effective implementation requires alignment between framework principles and institutional training strategies. Thus, although DigCompEdu offers conceptual comprehensiveness, its transformative potential depends on systematic pedagogical embedding. The findings of this review therefore support a reconceptualization of digital competence as an instructional design capacity. Digital competence should not be reduced to the ability to operate digital tools but should instead be understood as the capacity to align technology with pedagogical objectives, design technology-enhanced learning sequences, integrate digital assessment strategies, and foster learners' digital autonomy. The reviewed studies demonstrate that while measurement tools are well established, the qualitative processes through which teachers internalize and enact DigCompEdu principles remain underexplored. Bridging this gap requires integrating instructional design theory into digital competence research, ensuring that competence development is linked to reflective pedagogical decision-making and contextual adaptation. Moreover, the evidence suggests a multi-layered progression in DigCompEdu implementation. The first layer involves measurement and awareness through self-assessment instruments. The second layer involves structured competence development through professional training. The third and most transformative layer involves sustained instructional redesign and innovation. Most existing research, including validation and competence-level studies, focuses on the first two layers, while the third layer remains insufficiently investigated. Longitudinal and intervention-based research designs are

therefore needed to explore how DigCompEdu-based training programs can produce durable changes in instructional design and classroom practice. In practical terms, the discussion highlights the necessity of moving beyond tool-based workshops toward comprehensive, framework-integrated professional development programs. Training initiatives should explicitly connect DigCompEdu domains to collaborative lesson planning, digital assessment design, and learner-centered pedagogies. Institutional leadership, policy coherence, and sustained professional learning communities are critical for ensuring that digital competence development translates into meaningful pedagogical transformation. Strengthening the weaker domains—particularly assessment and learner empowerment—should be prioritized in future training models to achieve balanced competence development across all DigCompEdu areas..

5. CONCLUSION

In conclusion, the DigCompEdu framework provides a comprehensive and theoretically grounded structure for advancing teachers' digital competence; however, its transformative potential depends largely on how it is implemented within professional development systems. While current literature confirms improvements in competence levels, deeper instructional redesign and sustained pedagogical innovation remain underexplored. Bridging the gap between competence measurement and instructional transformation requires integrating DigCompEdu into coherent training programs that emphasize reflective practice, learner-centered strategies, and digital assessment design. Future research should therefore focus on empirical, longitudinal, and intervention-based studies to examine how DigCompEdu-based training can produce lasting improvements in instructional design and educational quality.

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