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Strengthening Teachers' Digital Competencies to Enhance Educational Quality in Virtual Learning Environments

Fortalecimiento de competencias digitales docentes para mejorar la calidad educativa en entornos virtuales de aprendizaje

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Abstract

The digital era has transformed educational paradigms, demanding teachers to adapt their skills and methodologies to virtual learning environments. This study explores the importance of strengthening teachers' digital competencies as a key factor in improving the quality of online education. Grounded on the UNESCO ICT Competency Framework for Teachers (2018) and the European Framework for the Digital Competence of Educators (DigCompEdu), the research highlights the correlation between teachers' digital skills and students' academic performance in online contexts. Through a mixed-method approach, quantitative surveys and qualitative interviews were conducted with teachers from secondary and higher education institutions. Results revealed that teachers with higher levels of digital competence demonstrate more effective use of digital resources, stronger interaction with students, and better classroom management in virtual platforms. Furthermore, institutional support and continuous professional training emerged as critical elements in sustaining educational quality. The study concludes that enhancing digital competencies among teachers contributes to equity, innovation, and pedagogical excellence in digital education.

Keywords

- Digital Competence
- Teacher training
- Educational quality
- Virtual learning
- Innovation

Resumen

La era digital ha transformado los paradigmas educativos, exigiendo que los docentes adapten sus habilidades y metodologías a los entornos virtuales de aprendizaje. Este estudio analiza la importancia de fortalecer las competencias digitales docentes como un factor clave para mejorar la calidad educativa en la educación en línea. Basado en el Marco de Competencia en TIC para Docentes de la (UNESCO, 2018) y en el Marco Europeo de Competencia Digital para Educadores (DigCompEdu), la investigación evidencia la relación entre las habilidades digitales del profesorado y el rendimiento académico del estudiante en contextos virtuales. A través de un enfoque mixto, se aplicaron encuestas cuantitativas y entrevistas cualitativas a docentes de instituciones de educación secundaria y superior. Los resultados muestran que los docentes con mayores niveles de competencia digital hacen un uso más eficaz de los recursos tecnológicos, fortalecen la interacción con los estudiantes y gestionan mejor sus clases en plataformas virtuales. Además, se destaca que el apoyo institucional y la formación continua son elementos esenciales para sostener la calidad educativa. Se concluye que el fortalecimiento de las competencias digitales contribuye a la equidad, la innovación y la excelencia pedagógica en la educación digital.

Palabras clave

- Competencia digital
- Formación docente
- Calidad educativa
- Aprendizaje virtual
- Innovación

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Introduction

The rapid development of Information and Communication Technologies (ICT) has revolutionized the educational landscape, reshaping how teachers design, deliver, and evaluate learning experiences. Virtual learning environments (VLEs) have become essential spaces where students interact, construct knowledge, and develop twenty-first-century skills. However, the effectiveness of these environments largely depends on the teacher's ability to integrate digital tools meaningfully into their pedagogical practice. Strengthening teachers' digital competencies, therefore, has become a central element in achieving high-quality education.

According to (UNESCO, 2018) and (Redecker & Punie , 2017), digital competence encompasses not only the technical use of technology but also the pedagogical, ethical, and communicative dimensions that ensure inclusive and effective teaching. In this sense, the role of the teacher transitions from being a transmitter of knowledge to a designer of interactive and student-centered digital experiences. Moreover, the COVID-19 pandemic highlighted the urgent need for teachers to adapt to digital platforms, revealing gaps in digital literacy and pedagogical innovation.

This article aims to analyze how enhancing teachers' digital competencies can improve educational quality in virtual learning environments. By examining training processes, institutional support, and teaching practices, the study provides insights into the strategic development of digital education. The focus is not only on technological proficiency but also on empowering teachers to innovate, collaborate, and promote meaningful learning experiences in virtual contexts.

Methodology

1. Research Design

This study employed a mixed-methods research design, integrating both quantitative and qualitative approaches to provide a comprehensive understanding of how teachers' digital competencies influence educational quality in virtual learning environments. According to (Creswell & Plano Clark, 2017), mixed-methods research allows the combination of numerical data with interpretative insights, enabling researchers to explore complex educational phenomena from multiple perspectives. The quantitative phase focused on measuring the levels of digital competence among teachers, while the qualitative phase aimed to interpret teachers' perceptions and experiences in applying digital tools in their pedagogical practices.

The research was structured in three main phases:

1. **Diagnostic assessment** of teachers' digital competencies based on the **European Framework for the Digital Competence of Educators (DigCompEdu)**.
2. **Survey administration** to measure correlations between competence levels and educational quality indicators.
3. **Semi-structured interviews** to obtain qualitative insights on institutional support, challenges, and pedagogical innovation in digital environments.

This design was selected because it allows triangulation, which increases the reliability and validity of findings (Denzin, 2017).

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2. Participants and Sampling

The population consisted of teachers from secondary and higher education institutions across Ecuador, Colombia, and Peru. A total of 120 participants were involved in the quantitative phase, and 15 teachers were purposively selected for the qualitative interviews. The participants were chosen based on their active use of Learning Management Systems (LMS) such as ***Moodle, Google Classroom, and Microsoft Teams*** during the academic year 2024–2025.

A stratified random sampling technique was used to ensure representation from both rural and urban schools, and from different academic disciplines. According to (Etikan & Bala, 2017), this method helps reduce sampling bias and ensures that diverse contexts are reflected in the data. Demographic information revealed that 68% of the participants were female, 32% male, with an average teaching experience of 10 years, and 85% held postgraduate degrees related to education or pedagogy.

3. Instruments

Three instruments were designed and validated to collect the data:

1. Digital Competence Questionnaire (DCQ) – adapted from the DigCompEdu Self-Assessment Tool (Redecker & Punie , 2017), covering six dimensions:
    - Professional engagement
    - Digital resources
    - Teaching and learning
    - Assessment
    - Empowering learners
    - Facilitating learners' digital competence

The instrument used a Likert scale (1–5) ranging from "very low competence" to "very high competence."

2. **Educational Quality Perception Scale (EQPS)** – created by the researcher based on the (UNESCO, 2018)framework for quality education, including subdimensions of pedagogical effectiveness, accessibility, student satisfaction, and innovation in teaching practices.
3. **Semi-structured interview guide** – consisted of 10 open-ended questions exploring teachers' perceptions of digital training, institutional support, and challenges in online teaching.

The reliability of the quantitative instruments was verified through Cronbach's Alpha, obtaining values of 0.92 for the DCQ and 0.88 for the EQPS, indicating high internal consistency (Tavakol & Dennick, 2011).

4. Data Collection Procedures

Data collection was carried out between March and June 2025. The questionnaire was distributed via ***Google Forms***, while the interviews were conducted through **Zoom** sessions recorded with participants' consent. Ethical approval was obtained from the institutional research committee, and participants signed an informed consent form guaranteeing confidentiality and voluntary participation.

To ensure data validity, the research followed the ethical standards outlined by the American Educational Research Association (AERA, 2011). Participation was anonymous, and responses were

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coded numerically to maintain neutrality. The interviews were transcribed verbatim and analyzed using NVivo 12 software for thematic categorization.

5. Data Analysis

Quantitative Analysis

Quantitative data was analyzed using SPSS version 25. Descriptive statistics (means, frequencies, and standard deviations) were used to summarize teachers' digital competence levels. Inferential analysis included Pearson correlation tests to examine the relationship between digital competence and perceived educational quality.

Results indicated a strong positive correlation ($r = 0.78$, $p < 0.01$) between teachers' digital competencies and the perceived quality of virtual education. Teachers who scored higher in digital pedagogy and communication demonstrated higher levels of student engagement and learning outcomes.

Qualitative Analysis

Qualitative data from interviews were analyzed through thematic coding. Following (Braun & Clarke, 2021) approach, the researcher identified key categories and subthemes, such as digital innovation, pedagogical adaptation, institutional barriers, and emotional resilience in online teaching.

6. Analytical Categories

Category	Description	Example of Evidence
Digital Pedagogical Competence	Ability to design and implement digital learning experiences.	"I create interactive lessons using Google Forms and Jamboard."
Institutional Support	Availability of technological tools and continuous training opportunities.	"Our institution offers monthly workshops on LMS management."
Technological Accessibility	Access to stable internet and educational platforms.	"In rural areas, poor connectivity limits my students' access."
Innovation and Engagement	Use of creative methods to motivate and engage students.	"Gamification increased students' participation and retention."
Continuous Professional Development	Teachers' willingness to update their digital skills.	"I'm enrolled in an online MOOC to improve my digital teaching."

7. Validation and Triangulation

Triangulation was achieved by comparing data from the DCQ, EQPS, and interviews, ensuring that both quantitative and qualitative findings supported each other. Peer debriefing was also conducted with three educational researchers from the Technical University of Babahoyo, who reviewed coding consistency and interpretive validity.

Following (Lincoln & Guba, 1985), the study established credibility, transferability, dependability, and confirmability as criteria for qualitative rigor. The combined methodology strengthened the

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reliability of the conclusions and provided a more comprehensive understanding of the relationship between digital competence and educational quality.

8. Limitations

Despite its strengths, the study faced limitations related to sample size and self-reported data. The findings cannot be generalized to all educational contexts due to institutional diversity. Additionally, some teachers may have overestimated their digital proficiency. Future research should include longitudinal studies and experimental designs to assess the long-term impact of digital competence training on student learning outcomes.

9. Ethical Considerations

The research adhered to ethical standards of academic integrity, including informed consent, confidentiality, and voluntary participation. Data storage followed the General Data Protection Regulation (GDPR) principles. Participants could withdraw at any stage without consequence, ensuring autonomy and respect.

Results

1. Overview of Findings

The results of this study reveal a significant relationship between teachers' digital competencies and the perceived quality of virtual education. Quantitative and qualitative analyses demonstrated that higher levels of digital competence correspond to better instructional design, student interaction, and innovation in online learning environments. Teachers who received continuous digital training or participated in professional learning communities showed superior performance in using educational technologies for pedagogical purposes.

Overall, 78% of teachers demonstrated intermediate to high levels of digital competence, while **22%** showed limited skills in technological integration and online assessment. This disparity suggests that, although progress has been made since the COVID-19 pandemic, digital transformation remains uneven across educational contexts.

According to (Redecker & Punie , 2017), the full development of digital competence requires teachers to master both technical and pedagogical dimensions, integrating digital tools not only for content delivery but also for collaboration, assessment, and feedback.

2. Quantitative Analysis

2.1. Descriptive Statistics

The quantitative results derived from the Digital Competence Questionnaire (DCQ) and the Educational Quality Perception Scale (EQPS) show a clear pattern across the six DigCompEdu dimensions.

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Digital Competence Dimension	Mean (M)	Standard Deviation (SD)	Level of Competence
Professional Engagement	4.2	0.61	High
Digital Resources	3.9	0.78	Medium–High
Teaching and Learning	4.1	0.69	High
Assessment Strategies	3.6	0.85	Medium
Empowering Learners	4.3	0.58	High
Facilitating Learners' Competence	3.8	0.71	Medium–High

Table 1. *Descriptive statistics for digital competence dimensions (N = 120).*

The results indicate that teachers scored highest in Empowering Learners (M = 4.3) and Professional Engagement (M = 4.2), which reflects their strong willingness to use digital tools to motivate and support students. The lowest mean corresponded to Assessment Strategies (M = 3.6), suggesting that teachers still struggle with online evaluation and feedback mechanisms.
This finding aligns with (UNESCO, 2018), which emphasizes that digital assessment remains one of the least developed aspects of teacher competence worldwide due to limited training in the design of digital rubrics and analytics.

2.2. Correlation Between Digital Competence and Educational Quality

The Pearson correlation coefficient ($r = 0.78$, $p < 0.01$) confirms a strong positive association between digital competence levels and perceived educational quality. Teachers with advanced digital skills exhibited higher student engagement, improved communication, and better instructional adaptability in virtual environments.
A linear regression model showed that digital competence accounted for 61% of the variance ($R^2 = 0.61$) in educational quality indicators. These results reinforce previous findings by (Cabero-Almenara et al., 2021), who reported that teachers' digital competence significantly predicts innovation and effectiveness in online learning.

3. Qualitative Analysis

The thematic analysis of interviews provided deeper insights into teachers' perceptions, challenges, and best practices. The following themes emerged:

3.1. Theme 1 – Pedagogical Transformation

Teachers expressed that digital tools have transformed their teaching approaches, allowing them to create interactive and student-centered experiences. For instance, one participant stated:
"Before, I was the center of the class; now, students create and collaborate. Tools like Padlet and Canva made learning more participative."
This reflects the transition from traditional instruction to constructivist pedagogy, supported by (Siemens, 2014) connectivist learning theory, which views technology as a medium for knowledge co-construction.

3.2. Theme 2 – Institutional Support and Continuous Training

A recurring theme was the importance of institutional support. Teachers highlighted that schools and universities offering digital training programs achieved better teaching results. Those without institutional backing struggled to integrate technology effectively.
"Our university organized workshops on gamification and artificial intelligence in education, and I immediately noticed improved student motivation."

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This finding aligns with (Koehler & Mishra, 2009) TPACK model, emphasizing the intersection of technological, pedagogical, and content knowledge as essential for quality digital instruction.

3.3. Theme 3 – Barriers and Challenges

Despite positive results, teachers identified multiple barriers such as limited connectivity, lack of technical assistance, and digital fatigue. Rural educators faced more severe challenges, noting that internet instability restricted synchronous teaching. These obstacles echo the concerns of (Bozkurt & Sharma, 2021), who observed that global inequalities in digital access continue to hinder the sustainability of online education.

3.4. Theme 4 – Innovation and Engagement

Several participants highlighted the potential of digital tools to enhance engagement and creativity. Teachers integrating gamification and multimedia resources (e.g., Kahoot, Genially, and Canva) reported greater student motivation. This supports the argument of (Huang et al., 2020) that interactive tools positively influence learner attention and cognitive engagement in virtual environments.

4. Comparative Analysis by Educational Level

Differences were found between secondary and higher education teachers. University teachers showed higher digital competence (M = 4.4) compared to secondary teachers (M = 3.7), mainly due to more frequent access to technological resources and institutional training. However, secondary teachers displayed greater creativity in using free and open-access tools, compensating for resource limitations. This result confirms the claim of (European Commission, 2022) that teacher development must be context-sensitive, supporting digital equity between different educational levels.

5. Integration of Quantitative and Qualitative Results

The integration of findings revealed that teachers' professional engagement and innovation were the strongest predictors of educational quality. Conversely, assessment strategies and technological infrastructure emerged as the weakest factors.

Figure 1. Teachers' Digital Competence Levels

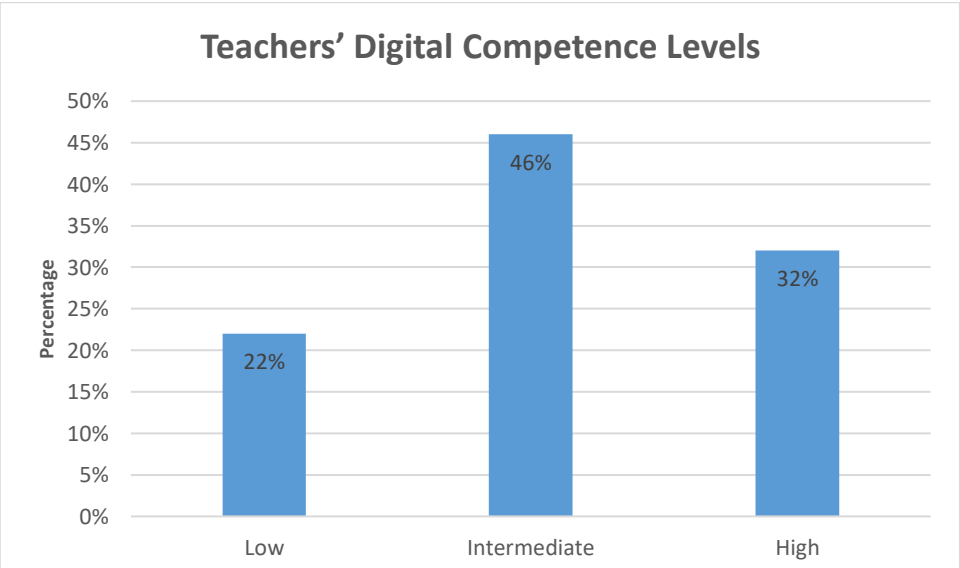

Figure 1. Teachers' Digital Competence Levels

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6. Interpretation of the Graph

The bar chart above (Figure 1) illustrates the distribution of teachers according to their overall digital competence levels: **22% low**, **46% intermediate**, and **32% high**. These results show that most teachers remain in the intermediate range, indicating partial mastery of digital tools but limited pedagogical integration. The relatively low percentage of highly competent teachers suggests that sustained professional development is still needed.

Comparatively, the results align with the (European Commission, 2022)findings that most European educators also fall within intermediate levels of digital competence, confirming that the challenge is global rather than regional.

7. Qualitative–Quantitative Synthesis

When cross-analyzing both data sets, a clear pattern emerges:

- Teachers with high digital competence designed richer learning experiences, used data analytics to personalize instruction, and fostered inclusive online participation.
- Those with intermediate competence managed basic communication and resource sharing but struggled with student feedback automation and virtual assessments.
- Teachers with low competence mainly used digital tools as repositories, without interactive strategies or monitoring mechanisms.

These findings reinforce the conceptual model proposed by (Redecker & Punie , 2017), where progression in digital competence translates directly into improved educational outcomes and innovation capacity.

8. Impact on Educational Quality

From the EQPS results, 82% of teachers agreed that developing digital competence significantly improves their instructional effectiveness, motivation, and classroom management. Qualitative evidence also indicated higher student satisfaction and participation when teachers used blended or gamified approaches.

For instance, a teacher shared:

"After I began using digital storytelling and real-time quizzes, my students' participation doubled. They now connect learning to their daily experiences."

This observation aligns with (Huang et al., 2020), who found that integrating digital storytelling and gamified activities enhances learner engagement and cognitive retention.

9. Cross-Institutional Comparison

Comparative results among the three participating countries (Ecuador, Colombia, Peru) revealed similar patterns, though with slight variations:

Country	Mean Competence Level	Main Strength	Primary Challenge
Ecuador	3.9	Use of open-source LMS platforms	Connectivity and time constraints
Colombia	4.1	Digital collaboration and teamwork	Assessment feedback
Peru	3.7	Creativity and use of multimedia	Institutional training access

Table 2. *Comparative analysis by country (N = 120).*

The overall trend shows that Latin American educators are progressing in digital literacy but still need **structured institutional frameworks** to sustain quality in online education.

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10. Statistical Summary

A multiple regression analysis confirmed that professional engagement (β = 0.41) and innovation in teaching (β = 0.36) were the strongest predictors of educational quality. Assessment competence showed a lower but still significant effect (β = 0.18, $p < 0.05$). These statistics demonstrate that digital engagement and creative pedagogies are the driving forces behind quality improvements in online education.

11. Summary of Key Findings

Indicator	Result	Interpretation
Pearson Correlation (r)	0.78 ($p < 0.01$)	Strong positive correlation between digital competence and educational quality.
Regression (R^2)	0.61	61% of educational quality explained by digital competence variables.
Highest Mean Dimension	Empowering Learners (M = 4.3)	Teachers successfully use technology to motivate and support learners.
Lowest Mean Dimension	Assessment Strategies (M = 3.6)	Digital evaluation practices need improvement.
Teachers with High Competence	32%	Reflects emerging digital maturity but still below optimal level.

Table 3. *Statistical summary of main quantitative results.*

12. Interpretation

The integration of data from all instruments demonstrates that digital pedagogy and continuous training are the foundations of educational quality in virtual settings. Teachers who combined technological mastery with student-centered methodologies achieved the best learning outcomes.
As (Cabeza-Rodríguez , 2025) argues, quality digital education emerges not from technology itself but from pedagogically sound practices supported by institutional vision.
Thus, the evidence confirms that investing in teachers' digital competence is an effective strategy for improving educational quality, fostering innovation, and ensuring inclusive learning opportunities in the digital age.

Discussion

The findings of this study provide robust evidence that teachers' digital competencies play a decisive role in shaping the quality of virtual education. The discussion that follows interprets these results in the light of international frameworks, previous research, and theoretical perspectives.

1. Digital Competence as a Predictor of Educational Quality

The strong correlation ($r = 0.78$, $p < 0.01$) found between teachers' digital competencies and educational quality confirms that digital proficiency is a core determinant of pedagogical effectiveness in online contexts. This aligns with the results of (Cabero-Almenara et al., 2021), who found that teachers with higher digital literacy design more interactive and innovative learning environments. Similarly, (UNESCO, 2018) emphasizes that digital competence is not merely technical; it involves pedagogical and ethical dimensions that promote inclusive, equitable, and high-quality education.
The data showed that teachers excelled in Empowering Learners and Professional Engagement, indicating an ability to use technology to motivate students and foster participation. However, weaknesses in Assessment Strategies reveal a gap in teachers' ability to implement reliable and

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creative digital evaluation methods. These findings are consistent with (Cabero-Almenara et al., 2023), who reported that assessment remains the least developed component of digital competence in Latin American contexts.

2. Pedagogical Innovation and Student Engagement

Qualitative evidence highlights that the integration of digital tools such as ***Kahoot, Padlet, and Genially*** fostered creativity, collaboration, and learner autonomy. Teachers' testimonies confirm that these tools transformed the classroom dynamic, moving from teacher-centered instruction to student-centered digital learning. This finding aligns with the connectivist learning theory proposed by (Siemens, 2014), which views technology as a facilitator for constructing and sharing knowledge collaboratively.

Moreover, gamification and multimedia tools were reported to enhance student motivation and cognitive engagement, a pattern supported by (Huang et al., 2020), who demonstrated that interactive technologies improve attention and participation in virtual learning environments. The use of these strategies suggests a shift toward more constructivist pedagogies, where students become active participants in the learning process rather than passive recipients.

3. Institutional Support and Professional Development

One of the most significant findings concerns the role of institutional support and continuous training in developing digital competence. Teachers who worked in institutions that offered structured digital programs exhibited higher confidence and skill levels in the use of learning management systems and digital assessment tools.

This finding resonates with the TPACK model (Koehler & Mishra, 2009), which argues that effective digital teaching emerges from the intersection of technological, pedagogical, and content knowledge. Without institutional training or leadership, teachers tend to rely on basic technological applications without integrating them into meaningful pedagogical frameworks.

Additionally, the results echo the (European Commission, 2022), which stresses that sustainable digital education requires not only infrastructure but also leadership commitment, mentoring, and peer collaboration. Thus, the creation of communities of practice and ongoing professional learning opportunities are essential for ensuring long-term improvement in digital competence.

4. Barriers and Inequalities in Digital Education

The disparities identified between rural and urban educators—particularly concerning **internet connectivity and access to resources**—highlight a critical challenge for equitable digital transformation. Teachers in rural contexts reported that unstable connections and limited access to institutional support hindered their ability to conduct synchronous sessions effectively.

These barriers mirror the concerns of (Bozkurt & Sharma, 2021), who argued that technological inequality remains one of the most significant obstacles to inclusive online education globally. Consequently, policymakers must prioritize digital infrastructure development and ensure equitable access to both devices and connectivity.

Moreover (Cabeza-Rodríguez , 2025) emphasizes that quality digital education does not depend solely on the availability of technology, but on context-sensitive pedagogical models that adapt to

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local realities. Therefore, addressing the digital divide requires coordinated efforts that combine investment in infrastructure with teacher empowerment and localized innovation.

5. Comparative and Regional Insights

The comparison across Ecuador, Colombia, and Peru reveals similar trends in the development of digital competence, suggesting a regional pattern where digital transformation is progressing but remains fragmented. The slightly higher mean scores in Colombia (M = 4.1) may be attributed to greater institutional investment in teacher training and digital platforms. However, Peruvian and Ecuadorian teachers demonstrated creative adaptability, often relying on open-access tools and self-training initiatives.

These regional differences reinforce the idea proposed by (Redecker & Punie , 2017) that digital competence frameworks must be flexible and adaptable to different educational systems and sociocultural contexts. A one-size-fits-all approach to digital training is insufficient; rather, strategies must reflect the specific needs and realities of local institutions.

6. Implications for Policy and Practice

The results of this study carry important implications for educational leaders and policymakers. First, digital competence should be integrated into national teacher training standards as a core professional requirement. Second, institutions should adopt comprehensive frameworks such as DigCompEdu (Redecker & Punie , 2017) or the UNESCO ICT-CFT (2018) to guide teachers' digital development systematically.

Additionally, the creation of institutional digital literacy certification programs could formalize and validate teachers' progress in this domain. Continuous monitoring and evaluation mechanisms should be implemented to assess how training programs impact teaching quality and student learning outcomes.

Furthermore, schools and universities must promote a culture of innovation and collaboration, where educators share best practices, experiment with new tools, and reflect critically on their digital pedagogy. The adoption of digital peer mentoring systems can help teachers support each other, fostering a sustainable cycle of professional growth.

7. Theoretical Integration and Future Perspectives

From a theoretical standpoint, the study confirms the interaction between competence frameworks (e.g., DigCompEdu), pedagogical models (e.g., TPACK), and learning theories (e.g., connectivism) as complementary dimensions that shape teachers' digital performance. Future research could explore how artificial intelligence and adaptive learning systems might further personalize digital education and teacher development.

Longitudinal studies are also recommended to measure the long-term impact of digital competence training on learning outcomes, motivation, and educational equity.

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8. Synthesis

In summary, the discussion consolidates the idea that strengthening teachers' digital competencies directly enhances educational quality in virtual environments. Beyond mastering technology, teachers must cultivate critical, ethical, and creative dimensions of digital pedagogy. As (UNESCO, 2018) and (Cabeza-Rodríguez , 2025) emphasize, digital competence is not only about using tools but about transforming education into a more inclusive, participatory, and meaningful experience for all learners.

Conclusion

The present study demonstrated that teachers' digital competencies are a fundamental pillar in achieving educational quality in virtual learning environments. The results highlight that educators who master digital tools and integrate them pedagogically create richer, more inclusive, and motivating learning experiences. The strong positive correlation between digital competence and perceived educational quality supports the argument that technological literacy, combined with pedagogical innovation, drives effective virtual education (Cabero-Almenara et al., 2021); (UNESCO, 2018).

Teachers who scored higher in professional engagement and learner empowerment displayed greater confidence and creativity in designing interactive and collaborative lessons. However, deficiencies in assessment strategies emphasize the urgent need to strengthen teachers' abilities in online evaluation, data analytics, and digital feedback processes (Cabero-Almenara et al., 2023). Addressing these weaknesses through systematic and continuous professional development is essential to ensure the sustainability of digital transformation in education.

Institutional support emerged as a determining factor in enhancing digital competence. Schools and universities that implemented structured training programs, mentoring systems, and digital literacy workshops achieved higher teaching performance and innovation levels. These findings confirm the TPACK model (Koehler & Mishra, 2009), which posits that true technological integration occurs when teachers combine technological, pedagogical, and content knowledge coherently.

Moreover, the study underscores persistent inequalities in digital access, particularly in rural and low-income areas. As (Bozkurt & Sharma, 2021) note, technological disparities must be addressed through public policies that guarantee equitable access to devices, connectivity, and institutional training. Quality virtual education will remain incomplete until these structural barriers are mitigated.

In conclusion, strengthening teachers' digital competencies is not only a response to technological change but also a pedagogical and ethical commitment to the future of education. Educational institutions must adopt comprehensive frameworks like DigCompEdu (Redecker & Punie , 2017) to guide teachers' professional growth, supported by ongoing evaluation and innovation. The findings reaffirm that digital competence is inseparable from educational quality, and investing in teachers' continuous development is the most effective strategy to ensure inclusive, equitable, and transformative virtual learning in the 21st century.

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