

Article

Assessment of Information Competence and Information Literacy in Teachers: A Sociodemographic Study Based on the DigComp Framework

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Abstract

In the context of digital transformation, teachers' information literacy has become a key factor for critical and effective teaching. This study seeks to determine its assessment and strengthening through a training intervention based on the Flipped Classroom model with a Massive Open Online Course (MOOC), supported by the DigComp Framework. To this end, a quasi-experimental pre-test–post-test design with a single group was used, complemented by comparative and correlational analyses according to sociodemographic variables. The study involved 810 primary school teachers from the Lambayeque region of Peru, considering sociodemographic variables such as age, gender, educational level, teaching experience, UGEL, and geographic area. It was found that teacher training based on the Flipped Classroom model with MOOC produced a statistically significant improvement in teachers' information and digital literacy skills, evidenced by the increase in the post-test compared to the pre-test and confirmed by the Wilcoxon test ($p < 0.05$). It is concluded that training through Flipped Classroom with MOOC significantly strengthened teachers' information skills; however, sociodemographic variables influence the levels and improvement achieved, which requires differentiated training strategies.

Keywords: assessment; information literacy; teachers; sociodemographic study; DigComp framework

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1. Introduction

The assessment of information literacy and information competence in teachers has undergone significant evolution (Acevedo-Sepúlveda, 2025; Pérez-Valles & Reeves, 2023), moving from diagnoses based on imprecise self-perceptions to models based on international frameworks such as DigComp (Acevedo-Sepúlveda, 2025; Vuorikari et al., 2022). This improvement allows for a more objective assessment of the essential skills of information search, analysis, and critical management needed to deal with and interact appropriately in a world of information, communication, and knowledge, where technology is

a mediating factor (Barbosa-Chacón et al., 2024; González, 2021; Mbandje et al., 2023). This is based on the appropriation of theoretical and practical foundations linked to education, teaching, disciplinary knowledge, teaching practice, and professional development (Bastías-Bastías & Iturra-Herrera, 2022; Maldonado-Fuentes et al., 2020).

Recent research shows that there are wide gaps between what teachers believe they have mastered and their actual performance, especially in tasks involving the evaluation and verification of digital information (Nieto-Isidro et al., 2021; *Reducir la brecha digital y garantizar la protección en el ciberespacio*, 2025; Villao & Matamoros, 2024), which has driven the development of more rigorous instruments based on authentic performance, including simulations and advanced digital environments (Bartolomé & Garaizar, 2022). Likewise, sociodemographic studies show that these competencies vary according to training, experience, and access to technologies, reinforcing the need for differentiated training strategies, including the use of MOOCs as a way to strengthen teacher information literacy (Süzer & Koç, 2024).

This scenario of accelerated digital transformation (Mejia & Mejia, 2021; Restrepo & Gómez, 2022) has made the strengthening of teachers' information literacy a strategic priority that responds to the demands of the fourth industrial revolution (J. S. Mendoza et al. 2025; G. K. Mendoza & Párraga, 2022). In this context, training programs based on open virtual environments, such as MOOCs, are a notable alternative for professional development for teachers (especially when analyzed from standardized reference frameworks such as DigComp). In addition, recent literature shows that the level of development of these competencies can vary depending on the sociodemographic and professional characteristics of teachers, making it necessary to systematically evaluate these competencies based on this approach.

MOOCs have established themselves as viable training strategies for professional teacher development (Díaz, 2024), promoting self-training processes, continuous updating, and the acquisition of techno-pedagogical knowledge (Camilleri et al., 2025; Martínez-Pérez et al., 2022), as well as strengthening teachers' awareness of the need to integrate digital resources and design relevant materials for diverse educational contexts (Arnavut et al., 2019; Romero et al., 2023). In a broader sense, systematic evidence has shown that teacher professional development has a positive impact on digital instructional integration and teaching practices, reinforcing the importance of sustained training processes for strengthening teachers' digital competences (Amemasor et al., 2025). Along the same lines, research on blended models, such as the Flipped Classroom, reveals that integrating MOOCs into teacher training enhances autonomous and collaborative learning, in addition to strengthening information skills related to the analysis, use, and production of information (Yaşar & Polat, 2021). Similarly, it has been shown that teachers' repeated participation in MOOCs helps them to articulate the digital learning they have acquired with their teaching practice, contributing to the progressive and sustained development of information skills that are essential for their professional performance (Lendínez et al., 2024).

In the Peruvian context, empirical evidence confirms that MOOCs based on active methodologies create significant improvements in teachers' information literacy and digital literacy, particularly in the areas of navigation, search, critical evaluation, and information processing, which are consistent with the areas identified in the DigComp Framework (Fernández-Otoya et al., 2025). This approach has been advocated by training initiatives that integrate MOOCs and Flipped Classroom as a way to reduce gaps in access, analysis, and ethical management of information among teachers, gaps that tend to be associated with professional and contextual conditions, such as teachers' technological proficiency, infrastructure limitations, and institutional support (Alptekin & Taneri, 2025).

The DigCompEdu framework, derived from DigComp, which operationalizes digital competence specifically in the teaching field, has been adopted in several countries to assess and strengthen teachers' digital competence through six dimensions: professional engagement, digital resources, teaching and learning, assessment, student empowerment, and facilitating student digital competence. Furthermore, studies based on this framework have demonstrated its usefulness in establishing institutional diagnoses and designing teacher training programs focused on the most deficient areas (Süzer & Koç, 2024).

With regard to sociodemographic variables, it was confirmed that older teachers have lower levels of digital literacy and less mastery of advanced information skills, suggesting that age continues to be a negative predictor in the adoption and improvement of these skills (Dağışan, 2023). Similarly, studies indicate that a higher level of education, especially postgraduate studies, is associated with a stronger digital profile and better performance in the areas of information search, critical evaluation, and management (Moreira-Choez et al., 2024; Y. Zhao et al. 2021). In terms of geographic context, there are significant gaps: teachers working in rural areas, remote provinces, or locations with less technological infrastructure report lower levels of information literacy due to limited training opportunities and less developed digital ecosystems (Mustafa et al., 2024; W. Zhao, 2024); at the national level, it has been confirmed that schools located in non-urban areas lag significantly behind urban schools in all dimensions of information literacy (Lin et al., 2023). Likewise, the findings reflect that length of service and years of experience tend to be inversely related to information literacy, as teachers with longer careers tend to have greater difficulty keeping up with technological advances and adopting efficient digital information assessment and management practices (Dağışan, 2023; Y. Zhao et al. 2021). Finally, comparative research shows that the combination of previous training experiences, school location, and level of education directly influences teachers' ability to build more complex information knowledge and transfer these skills to educational practice (Lin et al., 2023; Moreira-Choez et al., 2024), demonstrating that strengthening information literacy depends not only on individual effort but also on structural conditions and training opportunities that vary significantly among teacher groups.

Within this framework of ideas, the assessment of teachers' information competence and information literacy, from a sociodemographic approach and based on the DigComp Framework, allows not only to identify performance levels, but also to generate evidence to guide professional development policies that ensure that teachers have the necessary skills to train critical, ethical, and competent citizens in complex digital environments.

However, despite the growing body of research on teachers' digital competence and information literacy, there is still limited empirical evidence on training interventions that combine the DigComp Framework, the Flipped Classroom model, and MOOC-based learning to strengthen information literacy among in-service primary school teachers. Moreover, few studies have analyzed how sociodemographic variables, such as age, gender, educational level, teaching experience, and geographic context, are associated with teachers' information literacy levels and their improvement after a structured training intervention, particularly in Latin American and Peruvian educational contexts.

Therefore, this study is based on the following research questions: (1) How does teachers' information literacy vary according to their age group? (2) Is there a relationship between teachers' age and their ability to improve their information literacy skills after a training intervention? (3) Are there significant differences in teachers' information literacy skills based on gender? (4) How does gender influence the perception and improvement of information literacy after a training intervention? (5) What impact does the educational level achieved by teachers have on their information literacy? (6) Is there a relationship between the level of academic training and the improvement in information literacy after the intervention? (7) How do years of teaching experience influence the level of

information literacy? (8) How does geographical context influence teachers' information literacy skills?

Therefore, the objective of this study was to assess information competence and information literacy in primary school teachers in the Lambayeque region, based on the DigComp Framework, and to analyze the improvement achieved after a Flipped Classroom training intervention with MOOC according to sociodemographic variables.

2. Related Works

In this quantitative study, the DigComp Framework serves as the main conceptual framework for assessing teachers' information competence and information literacy. Specifically, the study focuses on the area of information and data literacy, which includes browsing, searching and filtering information, evaluating digital content, and managing digital resources. This framework guided the formulation of the research questions, the design of the DigComp-based instrument, the pre-test and post-test measurement, and the interpretation of the results according to sociodemographic variables. Therefore, DigComp provides conceptual coherence between the theoretical foundation, the methodological design, the statistical analyses, and the conclusions of the study.

The following review of related works is organized thematically around four axes: (1) conceptual frameworks and definitions of information literacy as a fundamental dimension of teachers' digital competence; (2) empirical evidence on levels of digital and information competence in in-service teachers; (3) the influence of sociodemographic variables on these competencies; and (4) training interventions based on MOOCs and active methodologies.

Regarding the conceptual foundations of information literacy in education, Plúa et al. (2021) conceptualize it as an integral process articulating knowledge, skills, and attitudes for effective information management, and document a scarcity of empirical studies assessing these competencies in teachers, underscoring the need for research grounded in consolidated theoretical frameworks. Trixa and Kaspar (2024) further frame information literacy as a key competence in teacher education, emphasizing the role of information-source selection, evaluation strategies, and perceived teaching competence in preparing future teachers for critical and responsible information use. From an evaluative standpoint, López-Nuñez et al. (2024) confirm through a systematic review in Scopus and WoS that DigCompEdu is the most widely used framework for assessing teacher digital competence, particularly in Latin America, while highlighting a lack of standardized instruments for cross-country comparisons, a gap the present study addresses through its DigComp-based instrument. Ma and Ismail (2025) corroborate this landscape through bibliometric analyses, confirming substantial growth in the field since 2015 and identifying DigComp-based assessment of teacher information literacy as an underexplored frontier in Latin American contexts.

Regarding empirical evidence on teachers' levels of information and digital competence, Moreno-Guerrero et al. (2020) analyzed digital competence in relation to information literacy in master's students in initial teacher training, finding average competence levels overall with strengths in information search but notable weaknesses in critical evaluation of digital content. Jaén-Armijos and Mena-Clerque (2021) studied information literacy deficiencies in teachers and students in basic secondary education, documenting limitations in searching, analyzing, and evaluating information that negatively affected critical thinking. Chen et al. (2025) corroborate through a systematic review of 40 studies that demographic factors such as gender and regional context significantly moderate information literacy competencies in pre-service teachers. Zhang et al. (2026) additionally confirm that DigComp and DigCompEdu have emerged as the most widely applied

frameworks for assessing digital competence in teacher education across WoS and Scopus literature (2014–2024).

Zorrilla and Castillo (2023) investigated information and digital literacy competence in students enrolled in a virtual teacher education program. Although their sample comprises pre-service rather than in-service teachers, their findings are relevant: they document persistent gaps in information evaluation and digital content production, the same areas assessed in DigComp Area 1, indicating that these deficiencies emerge before educators enter the classroom. In the Peruvian context, Hurtado-Mazeyra et al. (2022) found that most of the 3142 basic education teachers in Arequipa reached the Integrator level (B1), with differences by gender, age, and employment status. Sarango (2021) reported advanced competence in information and communication areas among Spanish pre-service teachers, but lower proficiency in security and innovation independently confirmed through systematic reviews that information evaluation is the most problematic dimension across training contexts, that DigComp provides the most operationalizable structure for cross-context comparison, and that information literacy maintains a direct bidirectional relationship with digital competence. In the same vein, Claro et al. (2024), in a systematic review of quantitative research on in-service school teachers, identified consistent evidence that teachers' digital competence is shaped by multiple explanatory variables and remains uneven across educational contexts.

Regarding the influence of sociodemographic variables, Süzer and Koç (2024) found that male teachers, those with postgraduate degrees, and those in metropolitan areas demonstrated higher digital competence levels in a sample of 368 Turkish teachers assessed with DigCompEdu, confirming gender, educational level, and geographic context as key moderating variables. Moreira-Choez et al. (2024) corroborated that higher academic preparation correlates with better digital skills, but that gender differences depend on institutional context and require intersectional analysis. Peculiauskiene et al. (2022) confirmed that self-efficacy in information evaluation has a stronger indirect impact on teachers' ICT competence than a direct one, while information search literacy shows a stronger direct relationship, highlighting the complex role of perceived information competence in shaping teachers' technological confidence.

Lin et al. (2023) confirmed a significant rural–urban divide in teachers' digital competence in a large empirical sample, with ICT attitude, digital skills, and data literacy all lower in rural teachers. Dağışan (2023) established that age is a significant negative predictor of digital literacy, with younger teachers showing higher competence and greater improvement after training. These findings are corroborated at scale by (Salehi et al., 2025), who synthesized 61 studies confirming that age presents a significant negative correlation with digital competence in most research reviewed, while experience shows context-dependent results. Bueno-Baquero et al. (2026) and Navío-Inglés et al. (2025) provide large-scale evidence: the former, with 27,087 teachers, found average levels between A2–B2 and systematically lower self-perceptions among women; the latter, in a census-based study of 3828 Spanish primary teachers, identified a significant gender-by-level interaction favoring males at the primary stage. Dringó-Horváth et al. (2025) further confirmed complex interactions among gender, age, experience, and discipline in 1103 university teachers.

In the Latin American context specifically, Arbulú et al. (2025) documented significant improvements in self-perceived digital competencies among university students in Spain, Mexico, and Peru during COVID-19, highlighting that contextual inequalities in digital access shape competency development across these countries. Nina et al. (2025), based on a self-assessment of more than 28,000 educators across six Latin American countries, including Peru, confirmed that age, gender, educational level, and technology training are determining factors associated with digital competence levels.

Regarding training interventions, Lendínez et al. (2024) diagnosed deficiencies in all three sub-competencies of DigComp Area 1 in 917 primary school teachers in Lambayeque, Peru, constituting the direct antecedent of the present study. Building on that diagnosis, Fernández-Otoya et al. (2025) confirmed statistically significant improvements in information literacy after a MOOC based on the Flipped Classroom model applied to the same population. The effectiveness of this approach is further supported by Osorio et al. (2025), whose review of 82 studies (2014–2025) identifies flipped classroom among the most effective models for developing digital competencies in school teachers, and by Ramdana et al. (2026), who found consistent evidence across 62 studies that active pedagogical approaches improve digital competence while infrastructure limitations remain the primary barrier in under-resourced settings, the central challenge facing the rural schools of Lambayeque.

The reviewed works confirm that information literacy is a fundamental dimension of teacher digital competence shaped by individual and structural factors. However, three gaps justify the present research: the scarcity of experimental studies evaluating training interventions with DigComp in naturalistic contexts with in-service teachers (Fernández-Otoya et al., 2025; Fuentes et al., 2023); the limited sociodemographic analyses of these competencies in Latin American settings (Fernández-Otoya et al., 2024; Hurtado-Mazeyra et al., 2022; Moreira-Choez et al., 2024; Süzer & Koç, 2024); and the absence of studies combining the DigComp framework with a Flipped Classroom and MOOC model for primary school teachers in Peru that examine the differential impact of age, gender, educational level, experience, and geographic context (Fernández-Otoya et al., 2025; Lendínez et al., 2024). These gaps jointly justify the design and evaluation of the intervention presented in this study.

3. Materials and Methods

3.1. Study Design

The study adopted a quantitative, applied-evaluative approach, with a quasi-experimental pre-test–post-test design with a single group (Campbell & Stanley, 1966; Shadish et al., 2002). This design is relevant because it evaluates the effectiveness of educational interventions in real contexts where random assignment of participants is not possible (Creswell & Creswell, 2018; Hernández-Sampieri et al., 2014).

3.2. Sample and Sociodemographic Characteristics

The study sample consisted of 810 teachers from the primary level of Regular Basic Education in the Lambayeque region of Peru, as summarized in Table 1. Of this total, 156 were men (19.3%) and 654 were women (80.7%). In terms of age distribution, the predominant group was in the 52–61 age range (44.6%), followed by those aged 42–51 (33%). Teachers between 32 and 41 years old represented 13.8%, while those under 32 and over 61 were the least frequent, with 2.2% and 6.4%, respectively.

In terms of educational level, 19.5% of participants had a high school diploma, 36.5% had a bachelor's or master's degree, 36.9% had a master's degree, and 7% had a doctorate. In terms of location, 71% of teachers worked in urban areas, while 29% worked in rural areas.

From an administrative perspective, 55.1% of teachers belonged to the Chiclayo Local Education Management Unit (UGEL), 30.6% to the Lambayeque UGEL, and 14.3% to the Ferreñafe UGEL. In terms of professional experience, 18.9% had between 0 and 9 years of service, 20.5% between 10 and 19 years, 24.7% between 20 and 29 years, 28.3% between 30 and 39 years, and only 7.6% had more than 40 years of teaching experience.

Participants were selected through a non-probabilistic convenience sampling process, based on accessibility and voluntary participation in the training program. The target population comprised in-service primary school teachers from Regular Basic Education institutions in the Lambayeque region, specifically from the UGELs of Chiclayo, Lambayeque, and Ferreñafe. The inclusion criteria were: (a) being an active primary school teacher during the study period, (b) agreeing to participate in the training process and in both assessment moments, and (c) completing both the pre-test and post-test instruments. Teachers who did not complete the intervention or who had incomplete responses in either measurement were excluded from the final analysis.

Overall, the sample reflects a heterogeneous teaching population in terms of age, educational attainment, geographic context, institutional affiliation, and years of professional experience, which supports the comparative and correlational analyses performed according to sociodemographic variables.

Table 1. Sociodemographic distribution of participating teachers.

Sociodemographic Characteristics	Gender				Total	
	Male		Female			
	(<i>n</i> = 156)		(<i>n</i> = 654)			
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
<u>Age</u>						
22–31	9	5.8%	9	1.4%	18	2.2%
32–41	13	8.3%	99	15.1%	112	13.8%
42–51	51	32.7%	216	33.0%	267	33.0%
52–61	71	45.5%	290	44.3%	361	44.6%
62–71	12	7.7%	40	6.1%	52	6.4%
<u>Level of education</u>						
High school	19	12.2%	139	21.3%	158	19.5%
Bachelor’s degree/Graduate	63	40.4%	233	35.6%	296	36.5%
Master’s degree	65	41.7%	234	35.8%	299	36.9%
Doctorate	9	5.8%	48	7.3%	57	7.0%
<u>Area</u>						
Urban	92	59.0%	483	73.9%	575	71.0%
Rural	64	41.0%	171	26.1%	235	29.0%
<u>Headquarters—UGEL</u>						
Chiclayo	73	46.8%	373	57.0%	446	55.1%
Lambayeque	45	28.8%	203	31.0%	248	30.6%
Ferreñafe	38	24.4%	78	11.9%	116	14.3%
<u>Length of service</u>						
0–9	31	19.9%	122	18.7%	153	18.89%
10–19	33	21.2%	131	20.0%	164	20.25%
20–29	48	30.8%	196	30.0%	244	30.12%
30–39	41	26.3%	194	29.7%	235	29.01%
40–49	3	1.9%	11	1.7%	14	1.73%

Note: Instruments applied to teachers participating in the Flipped Classroom Training with MOOC to strengthen the area of information and information literacy in the context of COVID-19.

3.3. Data Collection Instrument

A structured questionnaire based on the DigComp framework was used, specifically in the area of information and information literacy competence. The instrument was divided into three sub-competencies: navigation and information search, critical evaluation of digital content, and storage and retrieval of digital resources.

The instrument was administered using a digital form (Google Forms) and consisted of 16 items, each rated on a six-point Likert scale, where 1 represented the lowest level of competence and 6 the highest, ranging from level A1 (beginner) to C2 (expert).

The use of this instrument was theoretically supported by the DigComp Framework, which provides an established conceptual basis for assessing digital competence and, specifically, the area of information and data literacy. Since the questionnaire was derived from this framework, its use in the present study ensured conceptual coherence and supported comparison with previous research.

3.4. Procedure

The study procedure was organized into three phases. In the first phase, a pre-test was administered online to establish the baseline level of teachers' information and data literacy. In the second phase, participants completed a training intervention delivered through a MOOC based on the Flipped Classroom approach, as part of a project funded by PROCENCIA CONCYTEC. The intervention lasted 12 weeks and was organized into three modules. It combined autonomous learning, digital resources, and structured training activities focused on strengthening information search, critical evaluation, and management of digital content. In the third phase, a post-test was administered using the same instrument in order to assess changes after the intervention. Before the application of the instruments, informed consent was obtained from all participants, ensuring compliance with the ethical principles of educational research.

3.5. Data Analysis

The data analysis was conducted in three stages. First, descriptive statistics were calculated, including means, medians, standard deviations, minimum and maximum values, and frequency distributions according to DigComp proficiency levels (A1–C2). Second, the normality of the pre-test and post-test score differences was examined using the Kolmogorov–Smirnov test. Since the assumption of normality was not met, the Wilcoxon signed-rank test was applied to compare paired pre-test and post-test scores. Third, sociodemographic differences were explored using Kendall's Tau-b for ordinal variables and Pearson's chi-square test for categorical variables. All statistical tests were interpreted at a significance level of $\alpha = 0.05$. This analytical strategy made it possible to assess both the overall effect of the intervention and the differences associated with age, gender, educational level, years of teaching experience, UGEL, and geographic area.

4. Results

The results obtained after administering the questionnaire to assess information literacy and digital literacy skills in primary school teachers are presented below. These results allow us to analyze performance levels before and after the pedagogical intervention based on the Flipped Classroom model with MOOC, as well as the variations observed according to sociodemographic variables such as UGEL, age, gender, educational level, years of teaching experience, and geographical area. The analysis includes descriptive measures, competency levels according to the DigComp model, and statistical tests that support the effectiveness of the intervention implemented.

4.1. Evaluation by UGEL

Table 2 shows improvements in digital competence and information literacy levels after the intervention in the UGELs of Chiclayo, Lambayeque, and Ferreñafe. In Chiclayo, the mean score increased from 2.73 to 3.72. In Lambayeque, the mean score increased from 2.68 to 3.56, while in Ferreñafe it increased from 2.72 to 3.47. These results show

improvements in the three UGELs after the intervention, although with differences in dispersion and score ranges across regions.

The greater post-test variability observed in Lambayeque and Ferreñafe may be explained by contextual inequalities related to rurality and internet access. In Lambayeque, approximately 60% of schools are located in rural areas with limited internet connectivity, while in Ferreñafe this proportion is even higher, reaching around 90%. These conditions may have generated unequal opportunities for teachers to access and complete the MOOC-based training under similar conditions, which helps explain the wider dispersion of post-test scores in these UGELs. Therefore, the higher variability does not necessarily reflect lower effectiveness of the intervention but rather the greater heterogeneity in the contextual conditions under which it was implemented.

Table 2. Descriptive measures of digital competence and literacy levels by UGEL.

UGEL	Statistics	Pre-test	Post-Test
Chiclayo	Average	2.73	3.72
	Median	2.69	3.78
	Standard deviation	1.045	1.12
	Minimum	1	1.00
	Maximum	5.56	6.00
Lambayeque	Average	2.68	3.56
	Median	2.63	3.46
	Standard deviation	0.997	1.19
	Minimum	1.00	1.00
	Maximum	5.81	5.00
Ferreñafe	Average	2.72	3.47
	Median	2.66	3.38
	Standard deviation	1.037	1.26
	Minimum	1.00	1.00
	Maximum	5.44	5.88

Figures 1 and 2 show the distribution of scores obtained by teachers in the pre-test and post-test on digital competence and information literacy, broken down by UGEL. Figure 1 (Pre-test) shows a concentration of low scores in the three UGELs, with a more homogeneous distribution in Chiclayo and slight variations in Lambayeque and Ferreñafe. In contrast, Figure 2 (Post-test) reveals a shift in scores towards higher levels, especially in Ferreñafe and Lambayeque, indicating a significant improvement in the skills assessed after the training intervention, although with differences in dispersion according to each UGEL.

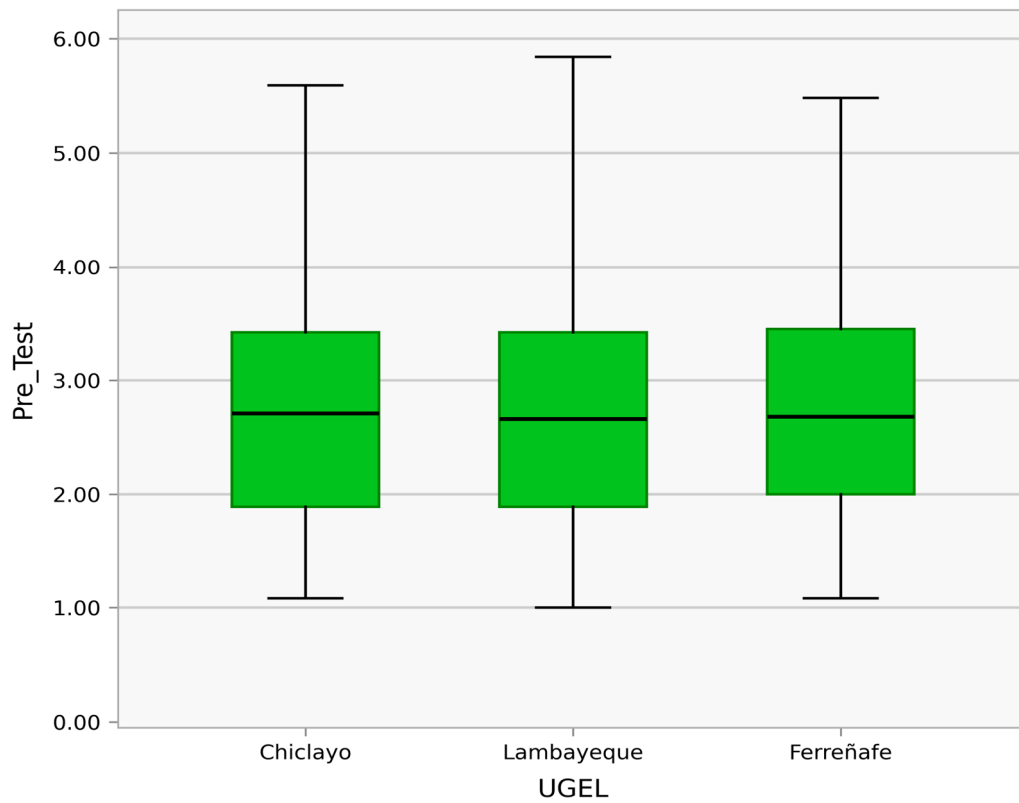


Figure 1. Distribution of pre-test scores in digital competence and literacy by UGEL.

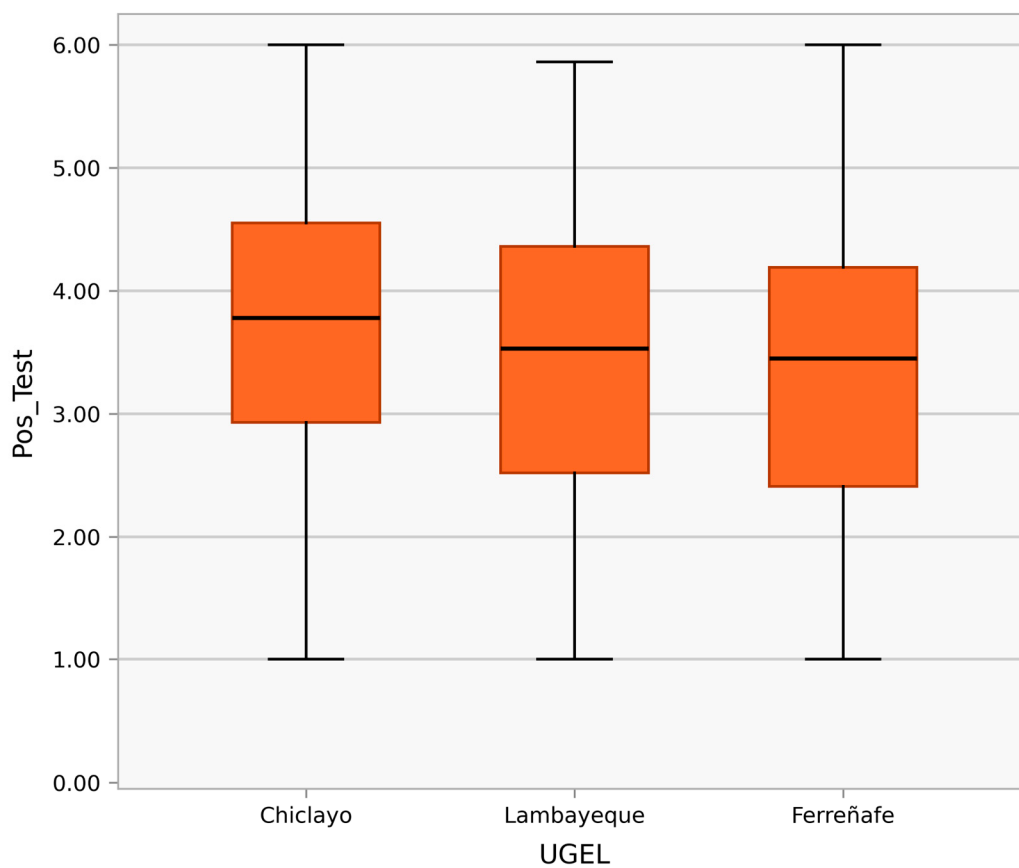


Figure 2. Distribution of post-test scores in digital competence and literacy by UGEL.

Hypothesis Testing

Table 3 presents the results of the normality test, in which a p -value of 0.000 is obtained, less than 0.05. This indicates that the differences between the pre-test and post-test do not follow a normal distribution. Since this assumption is not met, the comparison of means will be performed using the Wilcoxon statistic, a nonparametric test suitable for this type of analysis.

Table 3. Normality test for differences between the pre-test and post-test in related samples.

Variable	Kolmogorov–Smirnov ^a		
	Statistic	gl	Sig.
Pre-test and Post-test	0.044	810	0.001

^a Lilliefors significance correction.

The null hypothesis (H_0) was proposed, which states that there is no significant difference in the level of digital competence and information literacy before and after teacher training (Table 4). On the other hand, the alternative hypothesis (H_1) proposes that there is a significant difference in these levels. At 5% significance, and given that the p -value obtained is less than this threshold, the null hypothesis is rejected. Consequently, it is concluded that teacher training based on the Flipped Classroom with MOOC was effective in strengthening the area of information and information literacy in the context of COVID-19.

Table 4. Hypothesis testing with the Wilcoxon statistic to compare the results of the pre-test and post-test.

		N	Average Rank	Sum of Ranks	Asymptotic Significance (Two-Tailed)
Post-test–Pre-test	Negative ranks	225 ^a	311.87	70171.50	$p < 0.001$
	Positive ranges	574 ^b	434.54	249,428.50	
	Ties	11 ^c			
	Total	810			

^a Post-test < Pre-test. ^b Post-test > Pre-test. ^c Post-test = Pre-test.

4.2. Analysis of Information Literacy According to Age Group

How Does Teachers' Information Literacy Vary According to Age Group?

The distribution of digital competence and information literacy levels among teachers shows a clear relationship with age, as shown in Table 5. Younger teachers achieve more advanced levels, while older teachers achieve basic and intermediate levels.

At lower levels (A1 and A2), teachers aged 50 to 59 predominate, followed by those aged 40 to 49, while younger teachers (aged 22 to 29) are minimally represented. At intermediate levels (B1 and B2), the distribution follows the same pattern, with a greater presence in the 50–59 age group, although at B2 there is a more balanced distribution with those aged 40–49.

At advanced levels (C1 and C2), teachers aged 40 to 49 and 50 to 59 continue to be the most represented, but at C2 the proportion of 30 to 39-year-olds increases, while there are no teachers aged 60 to 65 at this level, suggesting that the acquisition of expert digital skills is less common in this group. We can say that age influences the level of digital competence, with younger teachers excelling at advanced levels and older teachers at intermediate and basic levels. Most teachers are at level B2 (upper intermediate).

Table 5. Distribution of digital competence and information literacy levels by age group.

			Age of Participants					Total
			[22–29]	[30–39]	[40–49]	[50–59]	[60–65]	
Levels of digital competence and literacy Post-test	A1	No.	0	2	10	16	6	34
		%	0.0%	5.9%	29.4%	47.1%	17.6%	100.0%
	A2	No.	4	7	34	55	23	123
		%	3.3%	5.7%	27.6%	44.7%	18.7%	100.0%
	B1	No.	3	16	56	88	34	197
		%	1.5%	8.1%	28.4%	44.7%	17.3%	100.0%
	B2	No.	4	21	74	129	26	254
		%	1.6%	8.3%	29.1%	50.8%	10.2%	100.0%
	C1	No.	3	21	58	74	13	169
		%	1.8%	12.4%	34.3%	43.8%	7.7%	100.0%
	C2	No.	1	11	8	13	0	33
		%	3.0%	33.3%	24.2%	39.4%	0.0%	100.0

Note: A1: Beginner; A2: Basic; B1: Lower Intermediate; B2: Upper Intermediate; C1: Advanced; C2: Expert.

Is there a relationship between teachers' age and their ability to improve their information skills after a training intervention?

According to Table 6, the analysis reveals a negative but weak relationship between teachers' age and their information literacy skills after the training intervention ($\tau b = -0.125$). This indicates that older teachers tend to improve less in these skills, although age is not the only influencing factor. The relationship is statistically significant ($p = 0.000$). Therefore, younger teachers show greater ease in improving their information literacy skills, while older teachers may face more difficulties. However, other factors, such as previous experience with technology and motivation, may also be decisive.

Table 6. Kendall's Tau_b correlation between participants' age and their information literacy (post-test).

		Age of Participants	Information Literacy (Post-Test)
Kendall's Tau_b	Correlation coefficient	1.000	−0.125 **
	Sig. (two-tailed)	.	$p < 0.001$
	N	810	810

** The correlation is significant at the 0.01 level (bilateral).

4.3. Analysis of Information Literacy According to Gender

4.3.1. Are There Significant Differences in Teachers' Information Literacy Based on Gender?

The results show that women (80.7%) are more represented at the low and intermediate levels of information literacy, while men are slightly more represented at the highest level (C2). At levels A1 and A2, women predominate, reaching 64.7% and 78%, respectively. At the intermediate levels (B1 and B2), the trend continues with a female majority of 81.2% and 81.9%. However, at C1 and C2, although women are still in the majority, men increase their representation, reaching 33.3% at C2. This is shown in Table 7.

Table 7. Distribution of digital competence and information literacy levels by gender.

			Gender		Total
			Male	Women	
Information literacy Post-test	A1	No.	12	22	34
		%	35.3%	64.7%	100.0%
	A2	No.	27	96	123
		%	22.0%	78.0%	100.0%
	B1	No.	37	160	197
		%	18.8%	81.2%	100.0%
	B2	No.	46	208	254
		%	18.1%	81.9%	100.0%
	C1	No.	23	146	169
		%	13.6%	86.4%	100.0%
	C2	No.	11	22	33
		%	33.3%	66.7%	100.0%
Total		No.	156	654	810
		%	19.3%	80.7%	100.0%

Note: A1: Beginner; A2: Basic; B1: Lower Intermediate; B2: Upper Intermediate; C1: Advanced; C2: Expert.

4.3.2. How Does Gender Influence the Perception and Improvement of Information Literacy Skills After a Training Intervention?

As shown in Table 8, Pearson's chi-square test indicated a statistically significant association between gender and post-test information literacy levels, $\chi^2 (5, N = 810) = 14.112$, $p = 0.015$. This result suggests that the distribution of information literacy levels after the intervention differed significantly by gender. However, this finding should be interpreted as an association with post-test performance rather than as direct evidence that gender determines the improvement achieved. In this sense, the results indicate that men were proportionally more represented at the highest level (C2), whereas women were more concentrated at the lower and intermediate levels.

Table 8. Chi-square test of association between gender and post-test information literacy levels.

	Value	df	Asymptotic Significance (Two-Tailed)
Pearson's chi-square	14.112 ^a	5	0.015
Likelihood ratio	13.016	5	0.023
Linear association by linear	2.712	1	0.100
N of valid cases	810		

^a 0 cells (0.0%) have expected a count lower than 5. The minimum expected count is 6.36.

4.4. Analysis of Information Literacy According to Educational Level (Academic Training)

4.4.1. What Impact Does the Educational Level Achieved by Teachers Have on Their Information Literacy Skills?

The data show that educational level influences the development of information literacy (Table 9). High school graduates are concentrated in the intermediate levels, while university graduates are more evenly distributed, with a greater presence in the advanced levels. Master's and doctoral degree holders stand out for their high representation at the higher levels, especially at C1 and C2, indicating that postgraduate education is associated with greater mastery of these competencies. This suggests that greater academic preparation favors the development of information skills, highlighting the importance of continuing education.

Table 9. Distribution of digital competence and information literacy levels according to educational level achieved.

			Information Literacy (Post-Test)						Total
			A1	A2	B1	B2	C1	C2	
			No.						
Educational level achieved	High school	No.	6	26	48	46	28	4	158
		%	3.8%	16.5%	30.4%	29.1%	17.7%	2.5%	100.0%
	Bachelor's degree/Degree	No.	13	44	64	96	69	10	296
		%	4.4%	14.9%	21.6%	32.4%	23.3%	3.4%	100.0%
	Master's	No.	14	48	70	91	61	15	299
		%	4.7%	16.1%	23.4%	30.4%	20.4%	5.0%	100.0%
	Doctor	No.	1	5	15	21	11	4	57
		%	1.8%	8.8%	26.3%	36.8%	19.3%	7.0%	100.0%
	Total	No.	34	123	197	254	169	33	810
		%	4.2%	15.2%	24.3%	31.4%	20.9%	4.1%	100.0

Note: A1: Beginner; A2: Basic; B1: Lower Intermediate; B2: Upper Intermediate; C1: Advanced; C2: Expert.

4.4.2. Is There a Relationship Between Academic Level and Improvement in Information Literacy Skills After the Intervention?

The statistical test found no significant relationship between educational level and improvement in information skills ($\tau b = 0.039$, $p = 0.175$). This means that, although teachers with postgraduate studies appear to have better results, educational level is not a determining factor in the improvement of digital skills. It is likely that other elements, such as previous experience with technology, play a more important role in the acquisition of these skills, as shown in Table 10.

Table 10. Kendall's Tau-b correlation between educational level and post-test information literacy level

	Value	Asymptotic Standard Error ^a	Approximate T ^b	Approximate Significance
Ordinal by ordinal Kendall's tau-b	0.039	0.029	1.357	0.175
N of valid cases	810			

^a The null hypothesis is not assumed. ^b Use of the asymptotic standard error that presupposes the null hypothesis.

4.5. Analysis of Information Literacy According to Years of Teaching Experience

How Do Years of Teaching Experience Influence the Level of Information Literacy?

The analysis of years of teaching experience is presented in Table 11, which includes two complementary sections. Part A shows the distribution of post-test information literacy levels according to years of teaching experience, while Part B reports Kendall's tau-b correlation for the association between both variables. The descriptive results indicate that teachers with fewer years of service showed a relevant presence at advanced levels, whereas teachers with more years of experience tended to be concentrated at intermediate levels. Consistently, Kendall's tau-b showed a weak but statistically significant inverse association between years of teaching experience and post-test information literacy level ($\tau b = -0.076$, $p = 0.009$). This suggests that greater teaching seniority was not associated with higher information literacy performance after the intervention.

Table 11. Distribution of post-test information literacy levels and Kendall's tau-b correlation according to years of teaching experience

A. Distribution of post-test information literacy levels									
		Information Literacy (Post-test)							Total
		A1	A2	B1	B2	C1	C2		
Years of teaching experience	1 to 10 years	No.	5	22	22	32	27	10	118
		%	4.2%	18.6%	18.6%	27.1%	22.9%	8.5%	100.0%
	11 to 20 years old	No.	7	18	41	50	40	6	162
		%	4.3%	11.1%	25.3%	30.9%	24.7%	3.7%	100.0%
	21 to 30 years old	No.	3	16	34	38	22	3	116
		%	2.6%	13.8%	29.3%	32.8%	19.0%	2.6%	100.0
	31 to 40 years old	No.	8	28	51	73	51	13	224
		%	3.6%	12.5%	22.8%	32.6%	22.8%	5.8%	100.0
	Over 40	No.	11	39	49	61	29	1	190
		%	5.8%	20.5%	25.8%	32.1%	15.3%	0.5%	100.0%
Total	No.	34	123	197	254	169	33	810	
	%	4.2%	15.2%	24.3%	31.4%	20.9%	4.1%	100.0%	
B. Kendall's tau-b correlation									
		Value	Asymptotic Standard Error ^a		Approximate T ^b		Approximate Significance		
Ordinal by ordinal Kendall's tau-b		-0.076			0.029		-2.605		0.009
N of valid cases		810							

Note. A1–C2 correspond to the DigComp proficiency levels. The *p*-value indicates a statistically significant but weak inverse association between years of teaching experience and post-test information literacy level.

4.6. Analysis of Information Literacy According to Geographical Context (Urban vs. Rural)

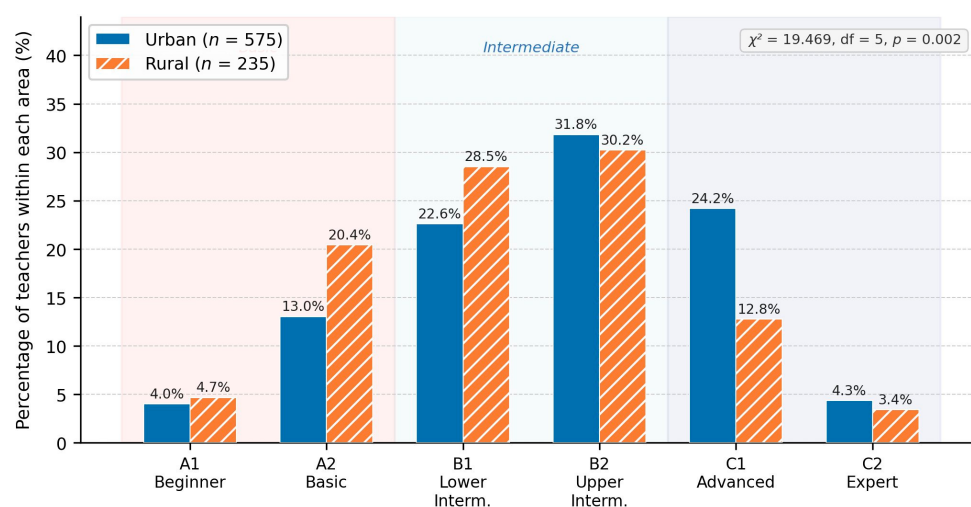
How Does Geographical Context Influence Teachers' Information Literacy?

The analysis of geographical context is presented in Table 12 and Figure 3. Table 12 includes two complementary sections: Part A shows the distribution of post-test information literacy levels according to teachers' work area, while Part B reports the chi-square test of association between geographical context and post-test information literacy levels. The descriptive results show that urban teachers achieved higher post-test information literacy levels than rural teachers. Urban teachers were more represented at the advanced levels, particularly C1 (24.2%) and C2 (4.3%), whereas rural teachers were more concentrated at the basic and lower intermediate levels, especially A2 (20.4%) and B1 (28.5%). The chi-square test confirmed a statistically significant association between work area and post-test information literacy level, $\chi^2(5, N = 810) = 19.469$, $p = 0.002$. These findings suggest that geographical context is associated with differences in information literacy performance after the intervention and highlight the need for more inclusive training strategies for teachers in rural areas.

Table 12. Distribution of post-test information literacy levels and chi-square test according to geographical context

A. Distribution of post-test information literacy levels according to geographical context									
			Information Literacy (Post-Test)						Total
			A1	A2	B1	B2	C1	C2	
Area where you work	Urban	N	23	75	130	183	139	25	575
		%	4.0%	13.0%	22.6%	31.8%	24.2%	4.3%	100.0%
	Rural	N	11	48	67	71	30	8	235
		%	4.7%	20.4%	28.5%	30.2%	12.8%	3.4%	100.0%
Total		N	34	123	197	254	169	33	810
		%	4.2%	15.2%	24.3%	31.4%	20.9%	4.1%	100.0%
B. Chi-square test of association between geographical context and post-test information literacy levels									
Chi-Square Tests									
			Value	df	Asymptotic Significance (Two-Tailed)				
Pearson’s chi-square			19.469 ^a	5	0.002				
Reason for plausibility			20.127	5	0.001				
Linear association by linear			14.859	1	<i>p</i> < 0.001				
N of valid cases			810						

^a 0 cells (0.0%) have expected a count lower than 5. The minimum expected count is 9.57. Note. A1–C2 correspond to the DigComp proficiency levels. The chi-square test was used to assess the association between geographical context and post-test information literacy level.



Note: Percentages calculated within each geographic area. $\chi^2(5) = 19.469$, $p = 0.002$ (Pearson chi-square). A1 = Beginner; A2 = Basic; B1 = Lower Intermediate; B2 = Upper Intermediate; C1 = Advanced; C2 = Expert.

Figure 3. Post-test information literacy levels by geographic area (urban vs. rural).

The results showed a significant improvement in teachers' digital and information literacy levels after the intervention based on the Flipped Classroom model with MOOC. In the three UGELs evaluated, Chiclayo, Lambayeque, and Ferreñafe, post-test mean scores were higher than pre-test scores, indicating an overall improvement in the assessed competencies. However, differences in score dispersion were also identified. Chiclayo showed the highest post-test mean score, while Lambayeque and Ferreñafe presented greater variability, suggesting more heterogeneous performance after the intervention. This variability may be associated with contextual differences related to rurality and unequal internet access. The Wilcoxon signed-rank test confirmed that the difference

between pre-test and post-test scores was statistically significant ($p < 0.001$), leading to the rejection of the null hypothesis.

The sociodemographic analysis revealed that variables such as age, geographical area, and years of experience influence the levels of competence achieved. Younger teachers and those with less time in service tended to be at advanced levels (C1 and C2), while older teachers with more years of teaching experience were concentrated at intermediate levels. Likewise, teachers in urban areas showed a greater presence at higher levels of competence compared to their rural counterparts, highlighting a geographic digital divide that requires attention through inclusive policies.

Statistically significant differences were found in terms of gender and educational level. Although women constituted the majority of the sample and dominated the basic and intermediate levels, men were more represented at the expert level (C2). Furthermore, although teachers with postgraduate degrees (master's and doctorate) showed better results in descriptive terms, the correlation between educational level and improvement in skills was not statistically significant, suggesting that other factors such as previous technological experience or motivation could be more decisive in the acquisition of digital skills.

5. Discussion

The discussion of the findings supports the conclusion, based on the reviewed literature, that the training intervention based on MOOCs and the flipped classroom model not only confirms its effectiveness but also helps to bridge several of the gaps identified in previous research on teachers' information literacy.

First, the statistically significant improvement observed between the pre- and post-intervention tests validates the relevance of using standardized frameworks such as DigComp to assess digital and information literacy competencies. This result addresses the need highlighted by López-Núñez et al. (2024) and Liu and Xu (2025), who point to the lack of comparable and robust instruments, especially in Latin American contexts. Likewise, it reinforces the idea that information literacy should be assessed based on performance and not solely on self-perception, a limitation widely documented in the literature (Jaén-Armijos & Mena-Clerque, 2021; Moreno-Guerrero et al., 2020). In this vein, the results provide empirical evidence that complements the theoretical approaches of Plúa et al. (2021) and Trixa and Kaspar (2024), who define these competencies as comprehensive and dynamic processes capable of being developed through structured training.

Second, the empirical results are consistent with previous studies that identify persistent weaknesses in the critical evaluation of information. Moreno-Guerrero et al. (2020) and Fuentes et al. (2023) had already identified this dimension as one of the most problematic. The improvement observed following the intervention suggests that active methodologies such as the flipped classroom, combined with MOOC environments, are particularly effective in addressing these shortcomings, as also evidenced by Fernández-Otoya et al. (2025) and Osorio et al. (2025). Thus, the research not only confirms previous trends but also provides quasi-experimental evidence in a field dominated by descriptive studies, thereby addressing one of the main gaps identified.

With regard to sociodemographic variables, the results show that age acts as a significant differentiating factor. The higher level of competence achieved by younger teachers is consistent with the findings of Dağışan (2023) and Salehi et al. (2025), who identify a negative correlation between age and digital competence. Likewise, the relatively smaller improvement among older teachers confirms that, although training is effective, its impact is heterogeneous, which aligns with Jaén-Armijos and Mena-Clerque (2021). This result reinforces the need to design differentiated interventions, as suggested by Süzer and Koç (2024), taking into account factors such as prior experience and self-efficacy.

Regarding gender, the higher representation of women at advanced levels (C2) is partially consistent with studies such as Bueno-Baquero et al. (2026) and Süzer and Koç (2024), which demonstrate gender differences in certain contexts. However, it also supports the position of Moreira-Choez et al. (2024), who argue that these differences are not universal but rather dependent on the institutional and sociocultural context. Therefore, the results invite further intersectional analysis to better understand these inequalities.

With regard to educational level, although teachers with postgraduate degrees achieve higher levels of competence, in line with the findings of Süzer and Koç (2024), the absence of a significant relationship with improvement following the intervention suggests that information literacy does not depend exclusively on formal academic training. This finding aligns with the perspective of Plúa et al. (2021), which emphasizes the continuous and cross-cutting nature of the development of these competencies.

Similarly, the weak inverse relationship between teaching experience and competency level supports the arguments put forward by Dağışan (2023) and Trixa and Kaspar (2024), who challenge the notion that accumulated experience guarantees adequate mastery of digital competencies. This reinforces the need for continuous professional development programs, especially in contexts of rapid technological transformation.

On the other hand, the differences observed across geographic contexts confirm the existence of structural gaps, as demonstrated by Arbulú et al. (2025) and Lin et al. (2023). Limitations in infrastructure and connectivity, particularly in rural areas, continue to be determining factors in the development of competencies, which is also consistent with the findings of Ramdana et al. (2026). In this regard, the results underscore that information literacy cannot be analyzed in isolation but must be considered in relation to the structural conditions of the education system.

Taken together, the findings confirm that the intervention was effective, but also that the development of information literacy is mediated by multiple individual and contextual variables. This aligns with the observations of Claro et al. (2024) and Nina et al. (2025), who highlight the multifactorial nature of teachers' digital competence. Furthermore, the study helps to bridge gaps identified in the literature, particularly the scarcity of experimental research in real-world contexts with a sociodemographic focus in Latin America (Fernández-Otoya et al., 2024, 2025; Fuentes et al., 2023).

Finally, these findings open up new avenues of research aimed at designing more inclusive and context-specific interventions, as well as incorporating mediating variables such as self-efficacy and teacher motivation, in line with the suggestions of Peculiauskiene et al. (2022). They also reinforce the need for educational policies that integrate frameworks such as DigComp and promote equity in access to technological resources and ongoing training opportunities.

Overall, the findings indicate that the effectiveness of teacher training in information literacy cannot be understood only as an individual learning outcome. Rather, it is shaped by sociodemographic, professional, and contextual factors. This confirms the need for differentiated professional development strategies, especially for older teachers, teachers with longer professional trajectories, and those working in rural or infrastructure-limited contexts.

6. Conclusions

The teacher training program, based on the Flipped Classroom model and MOOC, was effective in increasing the level of information literacy among the participating teachers. Post-test results revealed a significant improvement in performance across the three UGELs studied: Chiclayo, Lambayeque, and Ferreñafe. However, differences in score dispersion were also observed, especially in Lambayeque and Ferreñafe, suggesting that contextual factors such as rurality and limited internet connectivity may have influenced the

heterogeneity of the results. The Wilcoxon signed-rank test statistically confirmed this improvement between the pre-test and post-test scores ($p < 0.001$). This finding confirms previous literature that highlights the value of active learning methodologies, MOOC-based environments, and DigComp-oriented training for strengthening teachers' digital and information literacy skills, particularly in digital resource management, critical evaluation, and information navigation.

The research also confirmed that age and geographic context are relevant factors in the acquisition and development of digital skills. A slight negative relationship was detected between age and progress in competencies; younger teachers reached higher levels more easily, particularly C1 and C2, while older and more experienced teachers tended to remain at intermediate levels. Likewise, the results confirmed the persistence of a geographic digital divide, since urban teachers achieved better post-test performance than rural teachers. These findings are consistent with prior studies indicating that digital competence is influenced not only by individual factors but also by access to infrastructure, connectivity, and institutional support.

The sociodemographic analysis also revealed important findings regarding gender and academic education. Although women represented the majority of the sample and predominated at basic and intermediate levels, men accounted for a higher proportion at the expert level, C2. In addition, although teachers with postgraduate degrees showed better descriptive performance, academic degree was not a determining factor in post-training improvement. This finding nuances previous assumptions that higher academic attainment automatically leads to greater digital competence, suggesting instead that prior technological experience, motivation, access conditions, and continuous professional development may play a more decisive role.

Overall, the study confirms that information literacy can be strengthened through structured teacher training based on active methodologies and virtual learning environments. However, it also shows that improvement is not homogeneous across all teacher groups. Therefore, teacher training should not be generic; rather, it must be designed in a differentiated manner, taking into account teachers' sociodemographic characteristics, territorial context, access to connectivity, previous experience with digital technologies, and specific professional development needs.

For educational institutions and training programs, these findings suggest the need to move away from one-size-fits-all training models. Differentiated training pathways should be designed to specifically address the needs of older teachers, teachers with lower prior digital experience, and those working in rural or infrastructure-limited settings. Professional development policies should view information literacy as a dynamic competence that requires ongoing updating beyond the attainment of academic degrees. In this sense, the study contributes empirical evidence from the Peruvian context and supports the design of more inclusive, contextualized, and equitable teacher training strategies.

6.1. Limitations

Despite the robustness of the data, the study has significant limitations that must be acknowledged: the use of a quasi-experimental design with a single group limits the ability to compare results with a control group that did not receive the training. Furthermore, the sample is limited to the Lambayeque region, which could limit the generalizability of the results to other national or international contexts with different technological infrastructures. Furthermore, the instrument relies heavily on self-perception, which may not accurately reflect actual technical performance in complex digital environments.

6.2. Implications

The findings have several implications for educational policy, teacher training institutions, and school leaders. For policymakers, the results suggest that professional development programs in digital and information literacy should not be designed as homogeneous interventions, but as differentiated training pathways that consider age, teaching experience, geographic location, and access to technological infrastructure. For teacher training institutions, the study highlights the importance of integrating DigComp-based assessment and active methodologies such as the Flipped Classroom and MOOCs into continuous professional development programs. For school leaders and UGEL authorities, the findings provide evidence to prioritize support for rural teachers and those with lower levels of digital competence, especially through connectivity support, mentoring, and contextualized digital training. For teachers, the results emphasize that information literacy is a dynamic competence that requires continuous updating beyond formal academic degrees.

6.3. Future Directions for Research

It is recommended that future research incorporate longitudinal designs to assess the long-term sustainability of the competencies acquired and determine whether these improvements are transferred to pedagogical practice in the classroom. Furthermore, it is essential to explore mediating variables such as digital self-efficacy, intrinsic motivation, prior technological experience, and specific institutional conditions that may facilitate or hinder the development and application of information literacy skills. Mixed-methods approaches could also provide a deeper understanding of teachers' experiences, barriers, and perceptions during the training process, especially in rural or infrastructure-limited contexts. Finally, future research should consider performance-based assessments, simulations, or authentic digital tasks to complement self-reported instruments and provide a more objective measurement of teachers' information literacy.

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References

- Acevedo-Sepúlveda, P. C. (2025). Digital teaching competence: A benchmark for the New Era and metric analysis for institutional strengthening. *Pedagogical Studies*, 51(1), 49–67.
- Alptekin, Z., & Taneri, A. (2025). Technology integration in pedagogical processes: Digital competence and teaching practices of primary school teachers in Turkey. *Discover Education*, 4(1), 351. <https://doi.org/10.1007/s44217-025-00646-9>.
- Amemasor, S. K., Oppong, S. O., Ghansah, B., Benuwa, B.-B., & Essel, D. D. (2025). A systematic review on the impact of teacher professional development on digital instructional integration and teaching practices. *Frontiers in Education*, 10, 1541031. <https://doi.org/10.3389/educ.2025.1541031>.
- Arbulú C. G., Rosas, M. E., & Valdivia-Vizarreta, P. (2025). Self-perceived digital competencies and university change: Cross-country survey evidence from Spain, Mexico, and Peru during COVID-19. *Education Sciences*, 15(9), 1247. <https://doi.org/10.3390/educsci15091247>.
- Arnavut, A., Bicen, H., & Nuri, C. (2019). Students' approaches to massive open online courses: The case of Khan Academy. *Brain*, 10(1), 82–90. <https://doi.org/10.70594/brain/v10.i1/8>.
- Barbosa-Chacón, J. W., Martínez-Líbano, J., & Lira, M. M. (2024). Competencias informacionales en la formación inicial docente: Una revisión sistemática de la literatura. *Investigación Bibliotecológica: Archivonomía, bibliotecología e información*, 39(102), 109–134. <https://doi.org/10.22201/iibi.24488321xe.2025.102.58946>.
- Bartolomé, J., & Garaizar, P. (2022). Design and validation of a novel tool to assess citizens' netiquette and information and data literacy using interactive simulations. *Sustainability*, 14(6), 3392. <https://doi.org/10.3390/su14063392>.
- Bastías-Bastías, L. S., & Iturra-Herrera, C. (2022). La formación inicial docente en Chile: Una revisión bibliográfica sobre su implementación y logros. *Revista Electrónica Educare*, 26(1), 1–22. <https://doi.org/10.15359/ree.26-1.13>.
- Bueno-Baquero, A., González-Calero, J. A., Del Olmo-Muñoz, J., & del Carmen Sánchez Pérez, M. (2026). Bridging digital transitions: Teacher digital competence across primary and secondary education. *Education and Information Technologies*, 18, 1–28. <https://doi.org/10.1007/s10639-026-13944-y>.
- Camilleri, P., Watt, A., & Attard, M. (2025). Investigating teachers' changing perceptions towards MOOCs through the technology acceptance model. *Education Sciences*, 15(10), 1395. <https://doi.org/10.3390/educsci15101395>.
- Campbell, D. T., & Stanley, J. C. (1966). *Experimental and quasi-experimental designs for research*. Houghton Mifflin.
- Chen, S., Mohamed, S., & Mohamad Salleh, M. A. (2025). Media and information literacy among pre-service teachers: A systematic review of key trends and gaps (2013–2024). *International Journal of Information Management Data Insights*, 5(2), 100348. <https://doi.org/10.1016/j.jjime.2025.100348>.
- Claro, M., Castro-Grau, C., Ochoa, J. M., Hinostroza, J. E., & Cabello, P. (2024). Systematic review of quantitative research on digital competences of in-service school teachers. *Computers & Education*, 215, 105030. <https://doi.org/10.1016/j.compedu.2024.105030>.
- Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications Inc.
- Dağışan, E. (2023). Analysis of language teachers' digital literacy levels in terms of various variables. *Journal of Pedagogical Sociology and Psychology*, 5(3), 292–306.
- Díaz, V. (2024). Los stakeholders externos como agentes en la Transformación Digital de las Instituciones de Educación Superior (IES). *European Public & Social Innovation Review*, 9, 1–19. <https://doi.org/10.31637/epsir-2024-1120>.
- Dringó-Horváth, I., Rajki, Z., & T. Nagy, J. (2025). University teachers' digital competence and AI literacy: Moderating role of gender, age, experience, and discipline. *Education Sciences*, 15(7), 868. <https://doi.org/10.3390/educsci15070868>.
- Fernández-Otoya, F., Bravo, J., Pérez-Postigo, G., Alcázar-Holguin, M. A., & Loaiza Chumacero, S. C. (2025). Frontiers! The impact of the MOOC based on the flipped classroom methodology to increase the level of information and information literacy competence in primary school teachers. *Frontiers in Education*, 9, 1447127. <https://doi.org/10.3389/educ.2024.1447127>.
- Fernández-Otoya, F., Cabero-Almenara, J., Pérez-Postigo, G., Bravo, J., Alcázar-Holguin, M. A., & Vilca-Rodríguez, M. (2024). Digital and information literacy in basic-education teachers: A systematic literature review. *Education Sciences*, 14(2), 127. <https://doi.org/10.3390/educsci14020127>.
- Fuentes, D. R., Aguaded, I., & Estrada-Molina, O. (2023). La información y alfabetización informacional del marco común de competencia digital docente: Una revisión sistemática. *Aloma: Revista de Psicología, Ciències de l'Educació i de l'Esport*, 41(1), 35–49. <https://doi.org/10.51698/aloma.2023.41.1.35-49>.

- González, G. (2021). La alfabetización informacional: Un camino hacia la mejora del proceso de enseñanza-aprendizaje. *Revista Cubana de Información en Ciencias de la Salud*, 32(1), 1–17. Available online: http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S2307-21132021000100018&lng=es&nrm=iso (accessed on 15 August 2025).
- Hernández-Sampieri, R., Fernández-Collado, C., & Baptista-Lucio, P. (2014). *Research methodology* (6th ed.). McGraw-Hill.
- Hurtado-Mazeyra, A., Núñez-Pacheco, R., Barreda-Parra, A., Guillén-Chávez, E.-P., & Turpo-Gebera, O. (2022). Digital competencies of Peruvian teachers in basic education. *Frontiers in Education*, 7, 1058653. <https://doi.org/10.3389/educ.2022.1058653>.
- Jaén-Armijos, K. E., & Mena-Clerque, S. E. (2021). Alfabetización informacional para el desarrollo de competencias digitales en Educación Básica Media. *Revista Arbitrada Interdisciplinaria Koinonía*, 6(3), 128–154. <https://doi.org/10.35381/r.k.v6i3.1307>.
- Lendínez, A., Ortiz, J. M., Lorenzo, O., & Fernández-Otoya, F. A. (2024). Proposal for a flipped classroom program with massive open online courses to improve access to information and information literacy in primary school teachers. *Societies*, 14(5), 68. <https://doi.org/10.3390/soc14050068>.
- Lin, R., Chu, J., Yang, L., Lou, L., Yu, H., & Yang, J. (2023). What are the determinants of rural-urban divide in teachers' digital teaching competence? Empirical evidence from a large sample. *Humanities and Social Sciences Communications*, 10(1), 422. <https://doi.org/10.1057/s41599-023-01933-2>.
- Liu, C., & Xu, Y. (2025). A visual analysis of the research literature on teachers' digital literacy (2015–2024). *Frontiers in Education*, 10, 1597121. <https://doi.org/10.3389/educ.2025.1597121>.
- López-Núñez, J.-A., Alonso-García, S., Berral-Ortiz, B., & Victoria-Maldonado, J.-J. (2024). A systematic review of digital competence evaluation in higher education. *Education Sciences*, 14(11), 1181. <https://doi.org/10.3390/educsci14111181>.
- Ma, H., & Ismail, L. (2025). Bibliometric analysis and systematic review of digital competence in education. *Humanities and Social Sciences Communications*, 12(1), 185. <https://doi.org/10.1057/s41599-025-04401-1>.
- Maldonado-Fuentes, A. C., Tapia-Ladino, M. I., & Arancibia-Gutiérrez, B. M. (2020). ¿Qué significa evaluar? Representaciones atribuidas por estudiantes de formación inicial docente en Chile. *Perfiles Educativos*, 42(167), 138–157. <https://doi.org/10.22201/iisue.24486167e.2019.167.59208>.
- Martínez-Pérez, S., Cabero-Almenara, J., Barroso-Osuna, J., & Palacios-Rodríguez, A. (2022). T-MOOC for initial teacher training in digital competences: Technology and educational innovation. *Frontiers in Education*, 7, 846998. <https://doi.org/10.3389/educ.2022.846998>.
- Mbandje, D. C., Loureiro, M. J., & Lucas, M. (2023). Digital competence and information literacy: Clarifying concepts based on a literature review. *Educational Media International*, 60(3–4), 306–316. <https://doi.org/10.1080/09523987.2023.2324584>.
- Mejía, O. A., & Mejía, Y. Y. (2021). Transformación digital en las instituciones de educación superior a partir del Covid-19: Madurez tecnológica de los estudiantes en Colombia. *Revista Universidad y Empresa*, 23(41), 1–36. <https://doi.org/10.12804/revistas.urosario.edu.co/empresa/a.10606>.
- Mendoza, G. K., & Párraga, S. M. (2022). Information literacy and digital competence in teaching management. *San Gregorio Journal*, 1(51), 126–138. <https://doi.org/10.36097/rsan.v0i51.2169>.
- Mendoza, J. S., Trujillo, P. L., Zúñiga, L. M., & Sallo, V. (2025). Revisión sistemática de la transformación digital en Hispanoamérica: Retos, tendencias y perspectivas. *Revista InveCom*, 6(1), 1–11. <https://doi.org/10.5281/zenodo.15421144>.
- Moreira-Choez, J. S., Lamus de Rodríguez, T. M., Arias-Iturralde, M. C., Vega-Intriago, J. O., Mendoza-Fernández, V. M., Zambrano-Acosta, J. M., & Cardenas-Hinojosa, R. D. (2024). Influence of gender and academic level on the development of digital competencies in university teachers: A multidisciplinary comparative analysis. *Frontiers in Education*, 9, 1436368. <https://doi.org/10.3389/educ.2024.1436368>.
- Moreno-Guerrero, A.-J., Miaja-Chippirraz, N., Bueno-Pedrero, A., & Borrego-Otero, L. (2020). The information and information literacy area of the digital teaching competence. *Revista Electronica Educare*, 24(3), 521–536. <https://doi.org/10.15359/REE.24-3.25>.
- Mustafa, F., Nguyen, H. T. M., & Gao, X. (2024). The challenges and solutions of technology integration in rural schools: A systematic literature review. *International Journal of Educational Research*, 126, 102380. <https://doi.org/10.1016/j.ijer.2024.102380>.
- Navío-Inglés, M., Tirado-Olivares, S., del Olmo-Muñoz, J., & Cózar-Gutiérrez, R. (2025). The digital competence landscape of teachers: A large-scale analysis on self-perceived competence and gender differences. *Technology, Knowledge and Learning*. <https://doi.org/10.1007/s10758-025-09928-5>.
- Nieto-Isidro, S., Martínez-Abad, F., & Rodríguez-Conde, M.-J. (2021). Present and future of teachers' information literacy in compulsory education. *Revista Espanola De Pedagogia*, 79(280), 477–496. <https://doi.org/10.22550/REP79-3-2021-07>.
- Nina, G. D., Forero, T., Sira, V. G., Ruiz, M. J., & Keuylian, M. L. (2025). An approach to teachers' digital competency in Latin America. In *Education division*. Inter-American Development Bank.

- Osorio Vanegas, H. D., Segovia Cifuentes, Y. d. M., & Sobrino Morrás, A. (2025). Educational technology in teacher training: A systematic review of competencies, skills, models, and methods. *Education Sciences*, 15(8), 1036. <https://doi.org/10.3390/educsci15081036>.
- Peciuliauskienė, P., Tamoliune, G., & Trepule, E. (2022). Exploring the roles of information search and information evaluation literacy and pre-service teachers' ICT self-efficacy in teaching. *International Journal of Educational Technology in Higher Education*, 19(1), 33. <https://doi.org/10.1186/s41239-022-00339-5>.
- Pérez-Valles, C., & Reeves, E. (2023). Educación inclusiva digital: Una revisión bibliográfica actualizada. Las brechas digitales en la educación inclusiva. *Actualidades Investigativas en Educación*, 23(3), 1–24. <https://doi.org/10.15517/aie.v23i3.54680>.
- Plúa, C. A., Quindemil, E. M., & Rumbaut, F. (2021). Information literacy and information skills in education sciences: An Ibero-American perspective. *ReHuso*, 1(1), 1–9. <https://doi.org/10.33936/rehuso.v6iEspecial.3769>.
- Ramdana, A. D., Munir, & Furqon, C. (2026). Advancing digital literacy in higher education through pedagogical innovations and institutional strategies between 2014 and 2025. *Discover Education*, 5(1), 227. <https://doi.org/10.1007/s44217-026-01256-9>.
- Reducir la brecha digital y garantizar la protección en el ciberespacio*. (2025). Unesco. Available online: <https://www.unesco.org/es/right-education/digitalization> (accessed on 15 August 2025).
- Restrepo, C. A., & Gómez, N. A. (2022). Aproximación a la transformación digital en instituciones de educación superior mediante la teoría del cambio. *Revista En-Contexto*, 10(17), 1–36. <https://doi.org/10.53995/23463279.1163>.
- Romero, M., Romeu, T., Guitert, M., & Baztán, P. (2023). Digital transformation in higher education: The UOC case. *RIED-Revista Iberoamericana de Educación a Distancia*, 26(1), 163–179. <https://doi.org/10.5944/ried.26.1.33998>.
- Salehi, S., Dehghani, M., Azimi, E., Javadipour, M., Salehi, K., & Narenji, F. (2025). Associated variables with digital competence of teachers: A systematic review. *Cogent Education*, 12(1), 2576135. <https://doi.org/10.1080/2331186X.2025.2576135>.
- Sarango, C. P. (2021). *Competencia digital docente como contribución a estimular procesos de innovación educativa* [Ph.D. Thesis, Universidad de Salamanca]. <https://doi.org/10.14201/gredos.149459>.
- Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Houghton Mifflin.
- Süzer, E., & Koç, M. (2024). Teachers' digital competency level according to various variables: A study based on the European DigCompEdu framework in a large Turkish city. *Education and Information Technologies*, 29(16), 22057–22083. <https://doi.org/10.1007/s10639-024-12711-1>.
- Trixa, J., & Kaspar, K. (2024). Information literacy in the digital age: Information sources, evaluation strategies, and perceived teaching competences of pre-service teachers. *Frontiers in Psychology*, 15, 1336436. <https://doi.org/10.3389/fpsyg.2024.1336436>.
- Villao, I. N., & Matamoros, Á. A. (2024). La brecha digital en la educación: The digital gap in education. *LATAM Revista Latinoamericana de Ciencias Sociales y Humanidades*, 5(4), 1522–1539. <https://doi.org/10.56712/latam.v5i4.2337>.
- Vuorikari, R., Kluzer, S., & Punie, Y. (2022). *DigComp 2.2, The digital competence framework for citizens: With new examples of knowledge, skills and attitudes*. Publications Office of the European Union. Available online: <https://data.europa.eu/doi/10.2760/115376> (accessed on 15 August 2025).
- Yaşar, M. Ö., & Polat, M. (2021). A MOOC-based flipped classroom model: Reflecting on pre-service English language teachers' experience and perceptions. *Participatory Educational Research*, 8(4), 103–123. <https://doi.org/10.17275/per.21.81.8.4>.
- Zhang, L., Yang, C., & Zheng, Y. (2026). Digital competence for sustainable education of pre-service teachers: A systematic literature review (2014–2024). *Frontiers in Psychology*, 16, 1710983. <https://doi.org/10.3389/fpsyg.2025.1710983>.
- Zhao, W. (2024). A study of the impact of the new digital divide on the ICT competences of rural and urban secondary school teachers in China. *Heliyon*, 10(7), e29186. <https://doi.org/10.1016/j.heliyon.2024.e29186>.
- Zhao, Y., Pinto, A. M., Sánchez, M. C., & Zhao, L. (2021). The impact of gender and years of teaching experience on college teachers' digital competence: An empirical study on teachers in Gansu Agricultural University. *Sustainability*, 13(8), 4163. <https://doi.org/10.3390/su13084163>.
- Zorrilla, M., & Castillo, M. (2023). Competencias de información y alfabetización digital en una licenciatura virtual. *Apertura*, 15(1), 22–39. <https://doi.org/10.32870/Ap.v15n1.2285>.

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