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EDITED BY
Manuela Raposo-Rivas,
University of Vigo, Spain

REVIEWED BY
Carla Morais,
University of Porto, Portugal
Olalla García-Fuentes,
University of Vigo, Spain

*CORRESPONDENCE
Fiorela Fernández-Otoya
ffernandez@usat.edu.pe

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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

Fiorela Fernández-Otoya[1]*, Jessie Bravo[2], Gerber Pérez-Postigo[3], Manuel Alfredo Alcázar-Holguin[3] and Sandra Cecilia Loaiza Chumacero[4]

[1]Faculty of Human Sciences, Catholic University Santo Toribio de Mogrovejo, Chiclayo, Peru, [2]Digital Transformation Research Group, Pedro Ruiz Gallo Public University, Lambayeque, Peru, [3]Faculty of Education, San Agustín Public University, Arequipa, Peru, [4]Faculty of Engineering, Catholic University Santo Toribio de Mogrovejo, Chiclayo, Peru

We live in an increasingly digitalized and competitive world, so the use of technological resources in continuing education is essential. The objective was to determine the impact of the MOOC based on the flipped classroom methodology on the level of information competence and information literacy in primary school teachers. The approach was quantitative, pre-experimental design. The sample consisted of 810 teachers from the Lambayeque region. After the MOOC application, it was found that the competency of navigation, search and filtering of information, data and digital content obtained the highest score, with 2.84 in the pretest and 3.67 in the posttest on a scale of 1 to 5. The conclusion is the need to train teachers so that they are able to respond effectively and efficiently to the new challenges of this digital society.

KEYWORDS

MOOC, flipped classroom, digital competence, information literacy, teachers

1 Introduction

1.1 Context of information literacy in the digital era

In an environment shaped by the overabundance of data and the swift advancement of technology, information literacy is presented as a pivotal skill for educators and learners, aimed at locating, analyzing, and utilizing information critically, making it crucial for civic engagement and informed decision-making (Cabero-Almenara et al., 2020). Nevertheless, several studies have identified shortcomings in teacher preparation in these competencies, particularly within regular basic education settings (Hurtado-Mazeyra et al., 2022; Nieto-Isidro et al., 2021).

The digital division and associated challenges, such as misinformation and the lack of critical skills to discern reliable information and effectively manage the vast amount of data accessible in the digital age (Kadiri et al., 2024), emphasize the need to train educators in these fields. Recent research has shown that incorporating technology into classrooms effectively can be a hurdle for teachers due to insufficient infrastructure and specialized training (Chávez

et al., 2023; Torres, 2021). However, their resilience enables them to maintain the continuity of the educational process (Holguin et al., 2020).

In numerous educational systems, the instruction of skills linked to information literacy remains inadequate (Carroll and Borycz, 2024; Chase, 2024; Naveed and Saadia, 2024; Wu et al., 2024).

1.2 Flipped classroom methodology

The flipped classroom methodology represents a pedagogical approach that encourages active student participation through collaborative and practical activities conducted prior to in-person sessions. This model promotes independent and critical learning, essential elements for enhancing digital skills and information literacy in both educators and learners (Pozo et al., 2020; Pozo-Sánchez et al., 2020).

Within the context of massive open online courses (MOOCs), this methodology enables teachers to adopt a constructivist perspective, designing activities that support exploration and the creation of knowledge in an interactive setting (Gonçalves and Barrigão, 2019). These courses, in addition to being accessible, should consider the diversity of student profiles according to individual needs and goals (Qaffas et al., 2020), and their motivation levels (Huacui et al., 2024). This approach can significantly help bridge the gap in digital training in areas with limited resources (Tian et al., 2022).

1.3 Digital competencies in teacher training

Digital competencies are vital for teachers to fulfill their role as facilitators of learning in the digital age. According to López et al. (2020), these skills include information literacy and proficiency with digital tools, which are crucial for addressing contemporary educational challenges. Furthermore, their research identified that factors such as age and experience significantly impact the level of teachers' digital proficiency.

In examining information literacy (Ançanello and De Castro Silva Casarin, 2023), emphasize the importance of digital skills in combating misinformation, a challenge intensified by the growing reliance on virtual environments. In this regard, educators require specific abilities not only to filter accurate information but also to teach students how to critically assess information sources (Gómez-Pablos et al., 2020).

Additionally, there is a notable digital divide among various socioeconomic, generational, and geographic groups. Studies highlight the importance of teachers acquiring digital skills, accelerated by the pandemic, to effectively integrate technology into their educational practices. This enables them to serve as role models of digital literacy for their students (Aslan, 2021; Audrin and Audrin, 2022; Beltrán-Sánchez et al., 2019; Li and Yu, 2022).

1.4 Importance of teacher training

The role of teachers as facilitators and exemplars of digital competencies is crucial for fostering skills in their students. Recent studies underscore that information and digital literacy are interdependent and essential skills in today's educational environment (Aydınlar et al., 2024; Tang et al., 2022). However, many educators face challenges such as limited access to technological resources and insufficient training in these areas (Anaya et al., 2021; Claro et al., 2024).

Moreover, the rapid advancement of technology and the digital landscape highlights the need for training teachers to adapt and effectively utilize digital tools in their classrooms (Dias-Trindade et al., 2020).

Adding to this, the significant digital divide across socioeconomic, generational, and geographic groups remains a concern. Research emphasizes the importance of equipping teachers with digital skills, a process accelerated by the pandemic, to integrate technology effectively into their teaching practices and serve as models of digital literacy for their students (Aslan, 2021; Audrin and Audrin, 2022; Beltrán-Sánchez et al., 2019; Li and Yu, 2022).

Information literacy and digital competencies are critical skills in contemporary society, particularly in education. It is essential to implement continuous training strategies that enable teachers to develop the necessary abilities to enhance their critical and analytical capacities regarding information, effectively integrating technology into their pedagogical practices. Additionally, ensuring equitable access to technological resources and fostering a culture of digital innovation within the educational field are imperative goals. Initiatives such as using MOOCs based on the flipped classroom methodology are exemplary strategies.

This study is strongly justified by its scientific relevance, addressing how innovative methodologies like MOOCs can enhance teacher preparation in these competencies. Furthermore, its impact on student development and teaching practices makes it a valuable contribution, aiding in the implementation of effective strategies to strengthen information and digital literacy in the educational context.

The research aims to determine the impact of MOOCs based on the flipped classroom methodology on enhancing informational and information literacy competencies among primary-level teachers.

The research questions are articulated as follows: What is the impact of implementing a MOOC based on the flipped classroom methodology on strengthening informational and information literacy competencies among primary-level teachers? And, which competency emerges as predominant in the development of informational and information literacy skills among primary-level teachers?

2 Materials and methods

2.1 Participants and data collection procedures

A total of 810 teachers from the primary level of Regular Basic Education in the Lambayeque region from Ugel Chiclayo, Ugel Lambayeque and Ugel Ferreñafe participated in the study, of which 654 were women (80.74%) and 156 were men (19.26%); according to their level of study, 19.5% have a bachelor's degree; 36.5% have a bachelor's degree; 36.6% have a master's degree and 7.0% have a doctorate; with respect to work areas, 71.0% work in urban areas and 29.0% work in rural areas. With respect to the areas of work, 71.0% work in urban areas and 29.0% work in rural areas; and with respect

to age, it was determined that there are teachers with less than one year of service and a maximum of 43 years of service. They responded to a pre- and post-test. The sampling used was non-probabilistic and the sample size is relevant and adequate because it allowed identifying the necessary statistical power to detect relevant changes between both stages, thus ensuring the representativeness of the findings.

The digital competencies questionnaire of the Common European Framework Digcomp was applied using a Google form, which contained 16 questions, with a rating scale from 1 to 6. The pretest was applied, then the MOOC in the area of information and information literacy and finally the posttest, prior to the application of the tests, informed consent was requested. The instrument measures the first competency area called information and information literacy, which has three mini-competencies, the first one called Navigation, search and filtering of information, data and digital content, the second one refers to the Evaluation of Information, data and digital content and the third one refers to the storage and retrieval of information, data and digital content.

2.2 Flipped classroom methodology

The Flipped Classroom has received a lot of attention in recent years and currently has a high level of acceptance (Zhang et al., 2024), as a result, it is evolving, from structural changes that allow changes in the use of time and space and a creation of a student-centered experience (Menegaz et al., 2024). The MOOC was based on the Flipped Classroom methodology, which consisted of three stages: the first in which the participating teacher, based on the materials provided by the mentor, was able to analyze and interpret the information that gave rise to the formulation of questions or queries, the second stage, the mentor clarified the participating teachers' questions or doubts while also assisting them in the development of the programmed topic, and in the third stage, the participating teachers applied what they had learned to specific cases raised by the mentor.

2.3 MOOC development

The MOOC was organized into one Induction Module and three Learning Modules, with the following structure: Module I focused on information navigation, search, and filtering; Module II on information evaluation; and Module III on information organization and storage. The MOOC was developed in 16 sessions, with two hour-long webinars held every week. Before being implemented, the MOOC was validated by five subject experts from Granada University, Huelva University and Sevilla University, all from Spain.

At the beginning of the training, an induction on the use of the MOOC was carried out to evaluate the previous knowledge of the teachers, which made it possible to identify the level of digital competencies they possessed at the time, which allowed a better design of the MOOC. Continuous evaluation was carried out by monitoring the progress of teachers to ensure the meaningfulness of the course.

The Flipped Classroom Methodology was effectively integrated with the MOOC providing all the materials to the teachers before the synchronous sessions that allowed emphasis through the webinars with practical activities and conducting meaningful discussions with the expert teacher to dispel queries. All this allowed for adequate learning that ensured a collaborative environment among teachers and the effective use of the MOOC.

In order to learn more about the integration of flipped classroom with MOOC, you can watch the synchronous sessions in the following link: https://zenodo.org/records/14214481.

2.4 Analysis of data

SPSS software version 29, Excel spreadsheet, and Jamovi were used for statistical analysis of the pretest and posttest. Sociodemographic characteristics of teachers were identified through two-dimensional tables, descriptive measures, and box graphics. The Kolgomorov goodness-of-fit test was applied to identify the normality of the data, obtaining a ($p < 0.05$) result, therefore non-parametric methods were used (Siegel and Castellan, 1998).

The Wilcoxon test (Wilcoxon, 1992) was used to evaluate the impact of the MOOC on the first area of digital competencies called information and information literacy, in order to determine significant differences within the same group. Such a test is designed for data related to before and after measures on the same subjects, assessing whether the differences between pairs of observations (pre and post) tend to be significantly different from zero.

To answer the question, which competency stands out as predominant in the level of development of information and information literacy skills among primary school teachers? The Kruskall Wallis test was used on the posttest data to analyze comparatively the three competencies that comprise the area under study.

Therefore, the use of these statistical tools and methods ensures a detailed, valid and adequate analysis of the data collected. This makes it possible to rigorously assess the impact of the MOOC on teachers' digital competencies, respecting the characteristics of the data (non-normality) and ensuring the reliability of the findings.

3 Results

When conducting the study, the sociodemographic characteristics of the 810 teachers who participated were discovered. The characteristics described are gender, age groups, educational level, area of work, Headquarters—UGEL, and the duration of service in the institution.

Table 1 displays sociodemographic data for 810 Regular Basic Education teachers from the Lambayeque regional UGEL, including those from Chiclayo (55.1%), Lambayeque (30.6%), and Ferreñafe (14.3%) headquarters. The teachers were male (19.26%) and female (80.74%), ranging in age from 22 to 65 years (average = 50.22 ± 8.41). There is a predominance of female teachers; in this regard, the gender digital gap should be taken into account, as women have less access, are poorer and have less time available (Güezmes, 2021). Likewise, according to their level of studies, they have a Bachelor's degree (19.5%); Bachelor's degree (36.5%); Master's degree (36.9%) and Doctorate (7.0%). They work in urban (71.0%) and rural (29.0%) areas. The length of service identified teachers with less than one year and a maximum of 43 years of service (Mean = 21.69 ± 11.12).

TABLE 1 Sociodemographic characteristics of teachers engaging in flipped classroom training using MOOC to promote information and information literacy.

Sociodemographic characteristics	Gender				Total	
	Male (*n* = 156)		Female (*n* = 654)			
	n	%	*n*	%	*n*	%
Age						
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%
Educational level						
Bachelor (no degree)	19	12.2%	139	21.3%	158	19.5%
Bachelor's degree	63	40.4%	233	35.6%	296	36.5%
Master's degree	65	41.7%	234	35.8%	299	36.9%
Doctorate's degree	9	5.8%	48	7.3%	57	7.0%
Zone						
Urban	92	59.0%	483	73.9%	575	71.0%
Rural	64	41.0%	171	26.1%	235	29.0%
Headquarters—UGEL						
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%
Service time						
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%

Instruments applied to the teachers participating in the flipped classroom training with MOOC to strengthen the area of information and information literacy.

With respect to the level of study, it is determined that the predominant number of teachers are graduates and / or graduates; with respect to the areas of work it is determined that most of the teachers in the Lambayeque region are concentrated in the urban area, where there are greater advantages with regard to internet services and access to technological tools, which is not the case in rural areas, since in these areas the opposite is true; that is to say, there is a lack of connectivity and technological tools. In terms of age, according to the surveyed teachers, it was determined that most of them are between 42 and 61 years old, so it can be noted that the demand for digital skills is essential in the current situation, where much of the educational process is associated with digital technology. Hence, the younger teaching population, under 35 years of age, has better domains (Fernández-Cruz and Fernández-Díaz, 2016). It should be noted that, their proximity to digital technologies is closer, unlike those older than 35 years. Overt contrasts are not decisive as they combine other factors, such as digital divides (Suárez-Guerrero et al., 2020).

Age and teaching experience revealed statistically relevant differences with small effect sizes, aligning with previous research that has shown a significant connection between age (Cabezas et al., 2017; Gallego-Arrufat et al., 2019) and, especially, teaching seniority, associating greater seniority with a higher level of digital competence (Rodríguez et al., 2016; Pozo et al., 2020).

Table 2 shows that the descriptive measures show the comparison between pretest and posttest evaluations in competencies related to information literacy. For all competencies, the means increase significantly from pretest to posttest, for information browsing, searching and filtering the values range from 2.68 to 3.59, information evaluation ranges from 2.85 to 3.68, and information storage and retrieval ranges from 2.62 to 3.49, this increase suggests an overall improvement in the competencies assessed after the intervention. In the case of the 95% confidence intervals for the means show that the post-test values are consistently higher, indicating a statistically significant improvement. For the Navigation competency, the interval goes from [2.61, 2.75] (pretest) to [3.51, 3.67] (posttest), thus between the pre and post intervals, reinforcing the validity of the differences. Likewise, measures of variance and standard deviation dispersion were determined for all competencies; these values increase slightly in the posttest, indicating greater variability in the post-intervention results. For the Evaluation competency, the variance goes from 1.44

TABLE 2 Descriptive measures of the pre and postest of information and information literacy competences according to the competences.

Descriptive measures		Information and information literacy competences		Competence 1: Navigation, search and filtering of information, data and digital content		Competence 2: Evaluation of information, data and digital content		Competence 3: Storage and retrieval of information, data and digital content	
		Pre test	Post test	Pre test	Post test	Pre test	Post test	Pre test	Post test
Average		2.68	3.59	2.85	3.68	2.62	3.49	2.59	3.63
95% confidence interval for the average	Lower limit	2.61	3.51	2.77	3.59	2.55	3.41	2.51	3.54
	Upper limit	2.75	3.67	2.93	3.77	2.69	3.57	2.67	3.72
Average cropped at 5%		2.64	3.60	2.80	3.70	2.58	3.49	2.53	3.64
Median		2.56	3.69	2.80	3.80	2.50	3.50	2.40	3.80
Variance		1.06	1.37	1.44	1.67	1.10	1.45	1.34	1.66
Standard deviation		1.03	1.17	1.20	1.29	1.05	1.20	1.16	1.29
Minimum		1	1	1	1	1	1	1	1
Maximum		6	6	6	6	6	6	6	6
Rank		5	5	5	5	5	5	5	5
Interquartile range		1.5	1.64	1.8	2	1.5	1.67	1.8	2
Asymmetry		0.49	−0.20	0.45	−0.26	0.50	−0.08	0.61	−0.20
Kurtosis		−0.31	−0.68	−0.51	−0.83	−0.28	−0.63	−0.30	−0.90

Instruments applied to the teachers participating in the flipped classroom training with MOOC to strengthen the area of information and information literacy.

(pretest) to 1.67 (posttest). As for the range and interquartile range, they increase slightly, indicating stability in the amplitude of the responses. Regarding the measures of shape (skewness and kurtosis), in the pretest, the values are positive (skewness to the right), indicating that most of the participants scored below the mean. In the posttest, the values become negative, indicating a more balanced distribution or with more participants scoring close to or above the mean.

Figure 1 shows a comparison of the Information and Information Literacy Competences in the pre- and post-test. In the pretest, an average score of (2.68 ± 1.03) was achieved; 50% of the teachers received a score less than or equal to 2.56, while the other 50% exceeded this amount, with a minimum value of 1 and a maximum value of 6 points. In the posttest, the average score was (3.59 ± 1.17); 50% of the teachers achieved a score less than or equal to 3.68, while the other 50% exceeded this amount, with a minimum value of 1 and a maximum value of 6 points.

In competence 1: Navigation, search and filtering of information, data and digital content; in the Pretest, an average score of (2.84 ± 1.19) was recorded; 50% of the teachers achieved a score less than or equal to 2.8, while the other 50% exceeded this number, with the smallest value being 1 and the maximum value being 6 points.

In the posttest, the average score was (3.67 ± 1.29); 50% of the teachers achieved a score less than or equal to 3.80, while the other 50% exceeded this amount, with a minimum value of 1 and a maximum value of 6 points.

In competence 2: Evaluation of Information, data and digital content; In the Pretest, an average score of (2.61 ± 1.04) was recorded; 50% of the teachers achieved a score less than or equal to 2.5, while the other 50% exceeded this amount, with a minimum value of 1 and a maximum value of 6 points.

The posttest resulted in an average score of (3.48 ± 1.20). 50% of the teachers scored less than or equal to 3.50, while the other 50% scored higher, with a minimum of 1 and a maximum of 6 points.

In competence 3: Storage and retrieval of information, data and digital content; In the Pretest, an average score of (2.59 ± 1.15) was recorded; 50% of the teachers obtained a score less than or equal to 2.4, while the other 50% exceeded this amount. The minimum value was 1 and the highest value was 6 points.

In the posttest, the average score was (3.62 ± 1.29). 50% of the teachers received a score less than or equal to 3.80, while the other 50% exceeded this number. The minimum value was 1 and the maximum value was 6 points.

The Kolmogorov–Smirnov goodness-of-fit test was used in Table 3 to compare pre- and post-test scores for Information and Information Literacy Competences globally ($p < 0.05$) (Siegel and Castellan, 1998). The skills observed in competence 1: navigation, search, and filtering of information, data, and digital content ($p < 0.05$); in competence 2: evaluation of information, data, and digital content ($p < 0.05$); in competence 3: storage and retrieval of information, data, and digital content ($p < 0.05$), indicating that the null hypothesis should be rejected. These findings enabled the selection of non-parametric statistics, as shown in Table 4.

Table 4 shows the results of the test statistics for the comparison between the pre- and post-test scores; therefore, at 95% confidence, it is estimated that there is a significant difference in the score of the Information and Information Literacy Competences in the pretest and posttest, with the posttest score being higher. As a result, it is established that the teacher has improved greatly in: Competence 1: Navigation, search and filtering of information, data, and digital content; Competence 2: Evaluation of information, data, and digital content; and in competence 3 involves the storage and retrieval of information, data, and digital content.

Table 5 shows a significant difference in competences at a 95% confidence level ($p < 0.05$). Competence 1 received the highest score in Navigation, search, and filtering of information, data, and digital

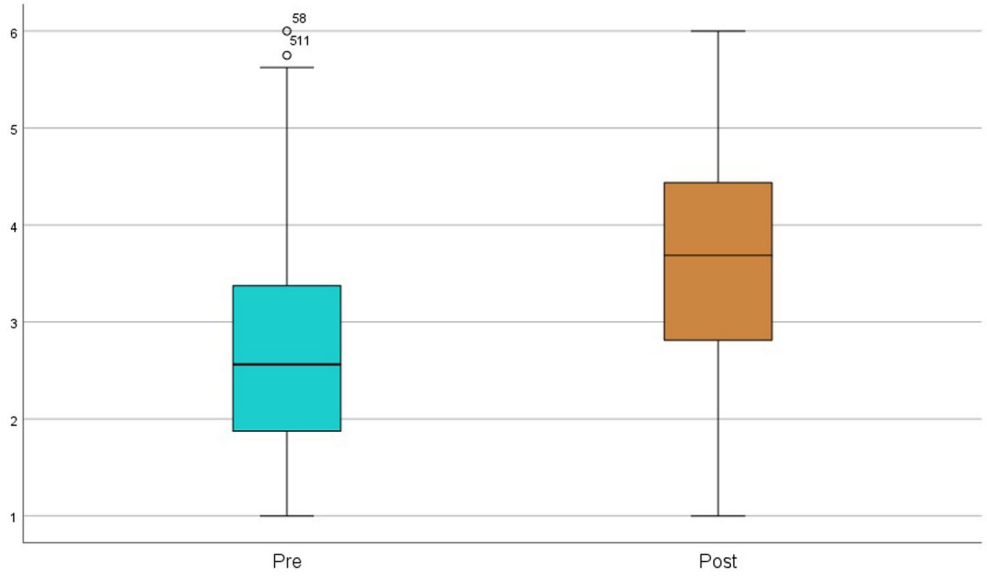

FIGURE 1
Graphic of pre- and post-test of the information and information literacy competence.

TABLE 3 Goodness-of-fit test of the pre- and post-test of the information and information literacy competence.

		Kolmogorov-Smirnov[a]			Shapiro–Wilk		
		Statistical	gl	Sig.	Statistical	gl	Sig.
Information and information literacy competences	Pre	0.061	810	0.000	0.971	810	0.000
	Post	0.046	810	0.000	0.984	810	0.000
Competence 1: Navigation, search and filtering of information, data and digital content	Pre	0.082	810	0.000	0.965	810	0.000
	Post	0.087	810	0.000	0.970	810	0.000
Competence 2. Evaluation of Information, data and digital content	Pre	0.078	810	0.000	0.968	810	0.000
	Post	0.053	810	0.000	0.986	810	0.000
Competence 3: Storage and retrieval of information, data and digital content	Pre	0.096	810	0.000	0.951	810	0.000
	Post	0.082	810	0.000	0.971	810	0.000

a. Lilliefors significance correction. H_0: The data follows a normal distribution. H_1: The data follows a normal distribution.

content; Competence 3: Storage and retrieval of information, data, and digital content came in second; and Competence 2: Evaluation of information, data, and digital content came in third.

4 Discussion

In this research, the main objective was to carry out an analysis of the impact of the MOOC through the use of the flipped classroom in the development of the training of Primary Education teachers in the Lambayeque Region, with the purpose of achieving Information and Information Literacy Competences; navigation, searching and filtering information, data and digital content; evaluation of Information, data and digital content; and Storage and retrieval of information, data and digital content; the study considered sociodemographic data such as gender, age of the teachers, degree of education, job location, UGEL, and duration of employment.

The survey included 810 teachers, of which 654 were women (80.74%) and 156 were men (19.26%). According to the level of education, 19.5% are bachelors (no degree); 36.5% hold a bachelor's degree; 36.6% hold master's degrees; and 7.0% hold a doctorate's degree. In terms of job areas, 71.0% work in urban regions and 29.0% in rural areas; In terms of age, it was established that there are teachers with less than one year of service and up to 43 years of service.

The results of this research show that there is a predominance of female teachers in the Lambayeque region. In this regard, we must take into account the digital gender gap, which is shown according to an CEPAL study that women have less access, are more poor, and have a smaller amount of time available (Güezmes, 2021).

With respect to the level of study, it is determined that the number of teachers with a bachelor's degree predominates; with respect to work areas, it is determined that the majority of teachers in the Lambayeque region are concentrated in the urban area,

TABLE 4 Wilcoxon signed rank test of the pre and postest of the information and information literacy competences.

		N	Average range	Sum of ranks	Test Statistics[a]	*P*-value
					Z	
Information and Information Literacy Competences Post–Pre	Negative ranges	219a	308.65	67594.5	−14,095b	0.000
	Positive ranges	579b	433.86	251206.5		
	Ties	12c				
	Total	810				
Competence 1 Navigation, searching and filtering information, data and digital content Post—Pre	Negative ranges	235a	317.07	74512.5	−12,093b	0.000
	Positive ranges	538b	417.54	224638.5		
	Ties	37c				
	Total	810				
Competence 2 Evaluation of information, data and digital content Post—Pre	Negative ranges	225a	303.83	68,361	−13,446b	0.000
	Positive ranges	558b	427.55	238,575		
	Ties	27c				
	Total	810				
Competence 3 Storage and retrieval of information, data and digital content Post—Pre	Negative ranges	216a	284.33	61,415	−14,340b	0.000
	Positive ranges	561b	429.3	240,838		
	Ties	33c				
	Total	810				
b. Post > Pre						
b. Post Competence 1—Search > Pre Competence 1—Search						
b. Post Competence 2—Evaluation > Pre Competence 2—Evaluation						
b. Post Competence 3—Storage > Pre Competence 3—Storage						

a. Wilcoxon signed rank test. b. It is based on negative ranges.

TABLE 5 Kruskal Wallis test for the comparison between information and information literacy competences.

	Median	Range	Test statistician	Degrees of freedom	*P*-value
Competence 1: Navigation, searching and filtering information, data and digital content	3.8	1,263.66	11.807	2	0.0027
Competence 2: Evaluation of information, data and digital content	3.5	1,148.47			
Competence 3: Storage and retrieval of information, data and digital content	3.8	1,234.36			
Total	3.67				

where they have greater advantages in terms of internet services and access to technological tools, which does not occur in rural areas, because there is a lack of connectivity and digital tools. In terms of age, according to the teachers questioned, the majority are between 42 and 61 years of age, indicating that the requirement for digital skills is vital in the current circumstances, where digital technology is used extensively throughout the teaching process. As a result, the younger teaching population, under 35 years old, demonstrates greater competence (Fernández-Cruz and Fernández-Díaz, 2016). It should be emphasized that they are closer to digital technology than those over the age of 35. Manifest disparities are not conclusive since they incorporate other elements, such as the digital gap (Suárez-Guerrero et al., 2020).

Age and teaching experience revealed statistically significant differences with small effect sizes, consistent with previous research that has shown a significant relationship between age (Cabezas et al., 2017; Gallego-Arrufat et al., 2019) and, particularly, teaching seniority, with greater seniority being associated with a higher level of digital competence (Rodríguez et al., 2016; Pozo et al., 2020).

The design and execution of this study allowed us to give substantial information on the development of Information and Information Literacy Competences by primary teachers in the Lambayeque region, which was assessed using a pre- and post-test. In the Pretest, an average score of (2.68 ± 1.03) was achieved. 50% of the teachers received a score less than or equal to 2.56, while the other 50% exceeded this amount. The minimum value was 1 and the maximum value was 6 points.

In the posttest, the average score was (3.59 ± 1.17); 50% of the teachers achieved a score less than or equal to 3.68, while the other 50% exceeded this amount, with a minimum value of 1 and a maximum value of 6 points.

With regard to the other competences, the following results could be obtained:

Competence 1: Navigation, search, and filtering of information, data, and digital content; In the Pretest, an average score of (2.84 ± 1.19) was collected; 50% of the teachers achieved a score less than or equal to 2.8, while the other 50% exceeded this number, with the smallest value being 1 and the maximum value being 6 points. In the posttest, the average score was (3.67 ± 1.29); 50% of the teachers achieved a score less than or equal to 3.80, while the other 50% exceeded this amount, with a minimum value of 1 and a maximum value of 6 points.

Competence 2: Evaluation of information, data, and digital content; In the Pretest, an average score of (2.61 ± 1.04) was collected; 50% of the teachers achieved a score less than or equal to 2.5, while the other 50% exceeded this amount, with a minimum value of 1 and a maximum value of 6 points. The posttest resulted in an average score of (3.48 ± 1.20). Half of the teachers scored less than or equal to 3.50, while the other half scored higher, with a minimum of 1 and a maximum of 6 points.

Competence 3: Storing and retrieving information, data, and digital content; In the Pretest, an average score of (2.59 ± 1.15) was collected; 50% of the teachers achieved a score less than or equal to 2.4, while the other 50% exceeded this amount, with a minimum value of 1 and a maximum value of 6 points. In the posttest, the average score was (3.62 ± 1.29); 50% of the teachers achieved a score less than or equal to 3.80, while the other 50% exceeded this amount, with a minimum value of 1 and a maximum value of 6 points.

Based on the differences in the improvements observed in competency 1, competency 2 and competency 3 in the area of information and information literacy is due to the nature of each skill as well as the factors that are related to the training received, for example, competency 1 is focused on browsing, searching and filtering information which is a practical and everyday skill in teachers which allows an improvement since teachers apply what they have learned more immediately in their work context. Also, the use of digital tools such as search engines, institutional repositories, databases, making this competence more accessible and therefore easy to use, however, competence 2, which involves an evaluation of information, is more complex and therefore requires a critical and deep analysis that involves having the ability to find information and evaluate its relevance and veracity, which represents a major challenge for teachers, especially if they do not have training in the subject. And finally, competency 3 is related to the storage and retrieval of information, which implies the proper handling of tools or platforms, as it could become more technical and less familiar with data management systems for some teachers.

Teacher training in information competence is seen as one of the important components for the success of the digital revolution in the classroom. According to a review research conducted by Spiteri and Rundgren (2018) primary education teachers require technological training and guidelines in order to transfer to their students the abilities they will need in the information age.

In terms of teacher education, generating digitally literate students has traditionally meant prioritizing technical abilities in the use of digital tools and systems deemed acceptable for educational contexts, as well as determining how they may be applied within specific learning units (Admiraal et al., 2017).

It is important to remember that universal access to knowledge is a central principle of open education, specifically that which is developed through MOOCs (flipped classroom). It is also important to consider what some scholars of the subject point out, which is that these massive courses generate inequalities because they primarily serve already educated participants, with a bachelor's degree and even a postgraduate degree (Atenas et al., 2021; Manotas, 2018; Olcott, 2013).

Empowering primary teachers in Information and Information Literacy Competences is important, especially in light of the Educational Agenda 2030. This agenda emphasizes the use of technology for distance learning, contemplating "…the Internet, massive open and online courses [author's emphasis] and other modalities that meet quality standards to improve access" (UNESCO, 2015, p.2).

The growth of developing technologies and their integration into the educational environment presents a number of issues in terms of digital security, emphasizing the importance of promoting proper digital literacy in today's society, as well as teacher training in this area. In this regard, both DigComp 2.2 (Digital Competence Framework for Citizenship) and the Common Framework for Digital Teaching Competence (DigCompEdu) emphasize the importance of assessing and improving pedagogical digital competence in order to ensure effective instruction that prepares digitally competent young people (Marín et al., 2023).

The research findings indicate that it is critical to prioritize the development of digital skills in teachers in order to improve and innovate their academic work.

The limitations identified in the research consisted of the research design, since being a pre-experimental design without a control group, it is difficult to fully attribute the changes observed to the MOOC intervention. Another limitation is the self-selection of the sample (teachers motivated to improve their digital competencies), as well as the delineation of future plans is key to strengthen the impact and scope of the findings. The challenges identified are the lack of technological resources in rural areas, which limits the effectiveness of the flipped classroom methodology in contexts that have little access to the internet, as well as digital tools. Research is projected oriented to the design of strategies adapted to these realities, such as the use of offline resources or hybrid methodologies. The sample will also be expanded to other regions of Peru, as well as to other educational levels, which will allow us to corroborate the replicability of the findings and adapt the program design to different contexts.

5 Conclusion

The MOOC based on the flipped classroom technique had a significant favorable influence on primary school teachers' Information and Information Literacy Competences. Teachers who attended this course indicated considerable increase in their ability to search, assess, and apply information effectively. The flipped classroom methodology emphasized autonomy and self-learning, allowing teachers to plan ahead of time with teaching materials before applying and deepening their knowledge in interactive and collaborative sessions with their students.

The capacity to efficiently search and discover information is the most common information and information literacy skill among primary level teachers. Educators display exceptional ability to use search engines, databases, and digital resources to locate relevant and up-to-date material that supports their instructional practice, as well as to critically evaluate sources to ensure the credibility and relevance of the selected content.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Research Ethics Committee of the Faculty of Medicine, Universidad Católica Santo Toribio de Mogrovejo, Peru. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

FF-O: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. JB: Conceptualization, Data curation, Investigation, Methodology, Writing – review & editing. GP-P: Conceptualization, Methodology, Writing – review & editing. MA-H: Conceptualization, Methodology, Supervision, Writing – review & editing. SL: Conceptualization, Methodology, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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