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PROGRAM TO STRENGTHEN THE DIGITAL COMPETENCIES OF UNIVERSITY STUDENTS IN THE COLLEGE OF EDUCATION

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Abstract

The aim of this research was to determine the impact of the implementation of an information and communication technologies (ICT) program on strengthening the digital competencies of first-year students in the College of Education at a university in Lima, Peru. The study was conducted according to a quantitative applied approach, with a single-group pre-experimental design that employed a pretest and a posttest. The population consisted of the 156 incoming students in 2024; the sample, selected by non-probabilistic convenience sampling, was made up of 78 students from different majors. Data was collected by means of a structured questionnaire, validated by expert opinion and with an appropriate level of reliability. Descriptive and inferential statistics were used for data analysis, applying a Student's t-test for related samples, with a level of significance of $p < 0.05$. The results showed a significant improvement between the pretest and the posttest. In the initial measurement, 38.5% of the students were at the basic level, 30.8% at the intermediate level, 28.2% at the advanced level and 2.6% at the expert level. Following the intervention, the basic level was reduced to 0% and the intermediate level to 1.3%, and accordingly, the advanced level increased to 62.8% and the expert level to 35.9%. Likewise, the t-test showed statistically significant differences between the two measurements. It was concluded that the implementation of the ICT program has a significant effect on the strengthening of the digital competencies, which highlights the importance of systematically incorporating ICT training programs in higher education, primarily in initial teacher training, in order to meet the needs of the current digital educational environment.

Keywords – ICT program, Digital competencies, Training.

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1. Introduction

We live in a setting where the development of digital competencies has become a determining factor for the comprehensive training of future professionals, particularly in the educational context. The transformations derived from the generalized use of Information and Communication Technologies (ICT) require instructors who are aware of and integrate these tools in their daily tasks in a critical, ethical and pedagogical manner. However, the scientific literature evidences that most university students, including those training as teachers, show deficiencies in the efficient, creative and ethical use of technology.

In response to this, institutions of higher education must design and implement instructional strategies that promote the development of digital competencies, defined as the set of knowledge, skills, attitudes and strategies necessary to perform with confidence in digital environments in different areas, such as problem solving, communication, information management, teamwork and content creation (Carretero et al., 2017).

Likewise, digital competencies have taken on significant relevance in the educational context, given that digital technologies are present in almost every facet of everyday and work life (Marrero et al., 2024). In light of this, these skills provide an efficient adaptation to technological contexts in continuous transformation, and they promote the capacity for multi-faceted problem solving, promoting autonomy and critical, active participation in an increasingly interconnected and digitalized social environment. In this sense, achieving and acquiring this type of competencies significantly influences different areas, especially in the academic context.

In this regard, Agenda 2030 for Sustainable Development recognizes that the rise in technological tools represents an extraordinary opportunity to intensify development, address the digital divide and foster the advancement of inclusive knowledge societies. Education is faced by challenges related to changes in modalities, methodologies and resources (Abdulsattar et al., 2022), and it requires the integration of technological tools in teaching, as well as the strengthening of teachers' pedagogical and digital competencies (Buitrago & Sánchez, 2021). In this framework, it is necessary to investigate not only the level of digital competencies, but also to implement and evaluate contextualized educational interventions, especially in developing countries, where digital divides and technological limitations persist (Cevallos-Macías et al., 2024).

It is also stressed that the safe and practical integration of ICTs in the classroom could reshape teaching (León et al., 2022) and foster student autonomy (López & Sevillano, 2020, Arias et al., 2024); this is why the competencies of teachers play a crucial role in their integration in professional practice (Badajoz et al., 2022). This would safeguard the equity and quality of learning. Consequently, training and ongoing support of teachers and future educators becomes particularly relevant, to ensure that they put fundamental ICT competencies into practice, and in turn, promote the necessary digital skills in their students for life and work (UNESCO, 2023).

On the other hand, it is important to mention that the post-pandemic era has had a significant impact on social, educational and technological levels (Qureshi et al., 2020). In effect, the pandemic evidenced the weaknesses of educational systems around the world (Cabero-Almenara & Llorente, 2020) forcing them to strengthen ICT competencies (Schleicher, 2020). Likewise, it evidenced the persistence of the digital divide in education, revealing the pressing need to integrate technology and to acquire new knowledge and skills in the digital competencies (Portillo et al., 2020; Sánchez-Macías et al., 2024; Zhao et al., 2021). This scenario allowed us to see more clearly the importance of digital competency at its different levels, particularly in higher education.

Along these lines, the relevance of digital competencies in university students lies in their capacity to manage and protect information, contents, data and digital identities (Chávez-Márquez et al., 2023). Research such as that done by Esteve and Cervera (2013), Kihoza et al. (2016) and Lubuva et al. (2022) stresses that teacher knowledge in the area of ICT promotes the strengthening of these competencies in

students. Likewise, the development of digital competencies implies a critical and reflexive attitude regarding the use of technology (Gutiérrez-Martín et al., 2022), allowing them to validate information, understand ethical and legal aspects and interact responsibly with digital environments (García et al., 2022; Hernández, 2024). On an international level, frameworks of reference have been developed that establish the necessary digital competencies. One of the main ones was proposed by UNESCO in 2008 with the ICT Competency Standards (Instituto Nacional de Tecnologías Educativas y de Formación del Profesorado, 2013, 2017; Butcher, 2019; Redecker, 2020), defending the idea that technology constitutes a current social need (UNESCO, 2024).

However, in spite of the initiatives undertaken by countries to bridge the digital divide, significant challenges still remain (Pérez & Peréz, 2022). Thus, for example, in Costa Rica, public policies aimed at this goal have been examined and found to be insufficient, ineffective and poorly coordinated at the institutional level (Jiménez, 2025), limiting the development of digital competencies and responsible digital citizenship in the university context (Arkorful et al., 2024). Limited access to digital devices and Internet connectivity hinders the use of these tools among university students (Pakhomova et al. 2023). Furthermore, for Niyazova et al. (2023) these limitations stem from different experiences and levels of participation in digital environments, technological factors, and gender discrepancies, with greater variance in the use of ICTs being observed in men (38.1%) than in women (28.2%). In this regard, Yu and Hu (2022) emphasize the need to promote inclusive approaches that support equitable participation. Ouali (2024), in turn, stresses that ICTs influence economic growth in an unequal manner, according to the context of each nation; their promotion is key for developing countries.

Along these lines, different studies have analyzed the importance of digital competencies or have been focused on diagnostics or perceptions, leaving aside the evaluation of structured instructional strategies and their real impact on the development of said competencies (Swai et al., 2022). However, very few studies have investigated the implementation of ICT programs for strengthening of digital competencies (Rodríguez-García et al., 2019; Briceño et al., 2022). They have concluded that said programs have a positive influence on the development of skills such as the use of technology, computational thinking and problem solving, as well as allowing students to acquire competencies aligned with the demands of the labor market.

In the same vein, the study by Rebaza (2025) evidences that, while training initiatives do exist, digital competencies continue to be insufficient, due to the lack of training programs adapted to their characteristics and needs, among other factors. Therefore, this reaffirms the importance of designing and implementing structured programs that address the specific characteristics of the student body and ensure an effective impact on the development of their digital competencies.

According to the literature review, education is facing challenges derived from the changes in modalities, methodologies and resources, which require technologies to be integrated into teaching and strengthening the instructional and digital competencies of teachers (Buitrago & Sánchez, 2021). In this framework, it is necessary to investigate not only the level of digital competencies, but also to implement and evaluate contextualized educational interventions, especially in developing countries, where digital divides and technological limitations persist (Cevallos-Macías et al., 2024). This is evidenced by the limited and scarce empirical evidence on the effectiveness of specific intervention programs aimed at strengthening digital competencies among teacher trainees, particularly in Latin American university contexts and with pre-experimental designs that allow for the measurement of concrete changes before and after their implementation.

Based on the above, it is necessary to delve deeper into research studies that not only describe the level of digital competencies, but also evaluate specific educational interventions aimed at their improvement, taking into account the characteristics of the institutional context and the distinctive features of the student body. This becomes especially relevant in developing countries, where according to Vicente-Ramos et al. (2024) the digital divides and the limitations in the technological infrastructure still pose an important challenge for higher education.

In the context described, it is essential for universities to train digitally competent students who are capable of using the technological tools in a responsible, critical and safe manner in their educational process. In this sense, the following research question is proposed: To what extent does the implementation of an ICT program strengthen the digital competencies in first-year students in the College of Education at Federico Villarreal National University? In line with this, the aim of the present study is to analyze the effectiveness of an ICT program in strengthening the digital competencies in first-year students of this college.

The findings of this study are expected to contribute to the identification of effective teaching strategies that address the current demands of the educational and labor context. Finally, this study takes on special relevance due to the increasing demand for digital competencies and the need to promote innovation and technological development in university education, as well as to propose a specific intervention targeting the development of digital competencies, providing empirical evidence in a field where significant gaps still exist, and promoting the training of future educators who are capable of integrating technology in a critical, responsible and innovative manner in their professional practice.

2. Methodology

2.1. Type of Research Study

A quantitative approach was chosen, with the purpose of determining the extent to which the implementation of an ICT program strengthens the digital competencies of first-year students in the College of Education. The research was of an applied type, with a single-group pre-experimental design and a pretest and a posttest. This type of design made it possible to administer an intervention with the study group and measure the variable before and after its implementation, for the purpose of identifying changes attributable to the intervention (Hernández-Sampieri & Mendoza, 2018). To accomplish this, the initial level of digital competencies was diagnosed (pretest), the ICT program was then applied, and finally a post-measurement (posttest) was performed to evaluate the impact of the intervention.

2.2. Population and Sample

The population consisted of 156 students from the College of Education at Federico Villarreal National University who enrolled in 2024. From this group of students, a sample of 78 students was selected using a non-probabilistic convenience sampling method. The following inclusion criteria were considered for the selection of the participants: Having registered in the 2024-I academic semester at the university being studied and voluntarily agreeing to take part in the research study. However, no detailed demographic information (age, gender, major) was available, which constitutes a limitation for the generalization of the results.

2.3. Data Collection Technique and Instrument

The study technique considered was a survey, and the instrument applied was a structured questionnaire with closed-ended questions, which consisted of 30 items, organized according to the dimensions of the digital competency, i.e., information on informational literacy, communication and digital collaboration, creation of digital contents, digital security and problem solving. This was evaluated on a 4-point Likert scale (basic, intermediate, advanced and expert). The questionnaire was administered in person, with an approximate duration of 20 to 25 minutes per student, making it possible to obtain direct, reliable information on the level of digital competencies.

2.4. Validity and Reliability

The content validity of the instrument was established by means of the opinion of experts, who included professionals qualified to evaluate the pertinence, clarity and coherence of the items. Likewise, the reliability of the instrument was determined by means of the Cronbach's Alpha coefficient, obtaining a value of $\alpha = 0.89$, indicating a high level of internal consistency.

2.5. Data Analysis

Descriptive and inferential statistics were used for the data analysis. Initially, a normality test (Shapiro-Wilk) was performed for the purpose of establishing the data distribution. A homogeneity of variance test was also used to evidence the equality of variances among the measurements. Since the data met the normality conditions, a Student's t-test for related samples was used (pretest and posttest) to compare the means before and after the intervention. The level of significance was determined to be $p < 0.05$. The result made it possible to determine whether there were any significant differences attributable to the implementation of the ICT program.

2.6. ICT Program Description

The ICT program had a duration of 8 weeks, structured into four modules which accounted for a total of 16 learning sessions (2 sessions per week), each lasting for approximately 90 minutes. The learning sessions were carried out in a blended learning mode, combining both classroom-based and virtual activities. The four modules of the proposal were: Digital literacy and the use of basic tools (use of platforms, office IT), information management and digital security (searches, evaluation and ethical use of information), communication and digital collaboration (use of virtual environments, collaborative work) and creation of digital contents (creation of digital educational resources).

For these sessions, different technological tools were used, such as a virtual classroom (LMS), collaborative applications, office IT tools and multimedia resources. The methodological strategies included task-based learning, collaborative work, problem solving and guided practice activities, promoting the active intervention by the students. The activities that were carried out were aimed at creating digital products, participation on forums, the use of collaborative tools and participation in brief projects. Every session included phases of introduction, practical development and feedback.

3. Results

The following tables present the most salient findings of the research that was conducted, derived from the instruments administered to the participants at two points in time—before and after the implementation of the intervention—in order to assess its effectiveness.

3.1. Levels of Digital Competencies Before and After the ICT Program

In Table 1, the results show a significant change in the levels of the participants' digital competency following the implementation of the ICT program. On the pretest, it can be observed that 69.3% of the students initially scored at a basic (38.5%) or intermediate (30.8%) level, reflecting a limited mastery of digital skills. However, on the posttest, a substantial improvement can be observed, as these levels practically disappear (0.0% and 1.3%, respectively).

On the contrary, the higher levels show a noticeable increase. The advanced level increased from 28.2% to 62.8%, while the expert level increased from 2.6% to 35.9%. These findings show that most of the students achieved high levels of digital competency after the implementation of the intervention. Therefore, these results indicate that the ICT program positively impacted the strengthening of the students' digital competency. Likewise, these findings are corroborated by the paired-samples Student's t-test, which revealed statistically significant differences ($p < 0.05$) between the pretest and the posttest.

			GROUP	
			Pretest	Post-test
Digital competencies	Basic	Number	30	0
		%	38.5%	0.0%
	Intermediate	Number	24	1
		%	30.8%	1.3%
	Advanced	Number	22	49
		%	28.2%	62.8%
	Expert	Number	2	28
		%	2.6%	35.9%
Total		Number	78	78
		%	100.0%	100.0%

Level	Pretest n (%)	Posttest n (%)
Basic	30 (38.5%)	0 (0.0%)
Intermediate	24 (30.8%)	1 (1.3%)
Advanced	22 (28.2%)	49 (62.8%)
Expert	2 (2.6%)	28 (35.9%)
Total	78 (100.0%)	78 (100.0%)

Table 1. Results before and after the implementation of an ICT program for digital competencies

3.2. Level Of Digital Competency in Information and Information Literacy

			GROUP	
			Pretest	Post-test
Information literacy	Basic	Number	36	0
		%	46.2%	0.0%
	Intermediate	Number	30	4
		%	38.5%	5.1%
	Advanced	Number	12	54
		%	15.4%	69.2%
	Expert	Number	0	20
		%	0.0%	25.6%
Total		Number	78	78
		%	100.0%	100.0%

Level of information and information literacy	Pretest n (%)	Posttest n (%)
Basic	36 (46.2%)	0 (0.0%)
Intermediate	30 (38.5%)	4 (5.1%)
Advanced	12 (15.4%)	54 (69.2%)
Expert	0 (0.0%)	20 (25.6%)
Total	78 (100.0%)	78 (100.0%)

Table 2. Results before and after the implementation of an ICT program for digital competencies at the information level of information literacy

Table 2 shows that on the pretest administered to a group of 78 students in the Federico Villarreal National University (UNFV) College of Education on the information literacy aspect of digital competencies; they scored at a basic (46.2%) and an intermediate level (38.5%). After having implemented

the ICT program, these students improved their information literacy levels in digital competencies to advanced (69.2%) and expert (25.6%) levels.

3.3. Level of Digital Competency in Communication and Digital Collaboration

It can be seen in Table 3 that when the pretest is given to a group of 78 students from the UNFV College of Education on the collaboration of the incoming students in relation to digital competencies, they were found to have a basic (46.2%) and an intermediate (30.8%) level. After the implementation of the ICT program, these students improved their levels of collaboration in digital competencies, reaching advanced levels (52.6%) and expert levels (43.6%).

			GROUP	
			Pretest	**Post-test**
Communication and digital collaboration	Basic	Number	36	0
		%	46.2%	0.0%
	Intermediate	Number	24	3
		%	30.8%	3.8%
	Advanced	Number	13	41
		%	16.7%	52.6%
	Expert	Number	5	34
		%	6.4%	43.6%
Total		Number	78	78
		%	100.0%	100.0%

Level of communication and digital collaboration	**Pretest n (%)**	**Posttest n (%)**
Basic	36 (46.2%)	0 (0.0%)
Intermediate	24 (30.8%)	3 (3.8%)
Advanced	13 (16.7%)	41 (52.6%)
Expert	5 (6.4%)	34 (43.6%)
Total	78 (100.0%)	78 (100.0%)

Table 3. Results before and after the implementation of an ICT program for digital competencies at the Communication and digital collaboration level

3.4. Level of Digital Competency in the Creation of Digital Contents

			GROUP	
			Pretest	**Post-test**
Creation of digital contents	Basic	Number	23	0
		%	29.5%	0.0%
	Intermediate	Number	33	1
		%	42.3%	1.3%
	Advanced	Number	20	45
		%	25.6%	57.7%
	Expert	Number	2	32
		%	2.6%	41.0%
Total		Number	78	78
		%	100.0%	100.0%

Level of creation of digital contents	Pretest n (%)	Posttest n (%)
Basic	23 (29.5%)	0 (0.0%)
Intermediate	33 (42.3%)	1 (1.3)
Advanced	20 (25.6%)	45 (57.7%)
Expert	2 (2.6%)	32 (41.0%)
Total	78 (100.0%)	78 (100.0%)

Table 4. Results before and after the implementation of an ICT program for digital competencies at the digital content creation level

Table 4 shows that when a pretest is administered to a group of 78 students from the UNFV College of Education on the creation of digital contents, they were found to be at a basic (29.5%) and intermediate level (42.3%); following the implementation of the ICT program, these students improved their levels of digital content creation to advanced (57.7%) and expert (41%) levels.

3.5. Level of Digital Competency in Security

			GROUP	
			Pretest	Post-test
Safety	Basic	Number	22	1
		%	28.2%	1.3%
	Intermediate	Number	30	1
		%	38.5%	1.3%
	Advanced	Number	22	49
		%	28.2%	62.8%
	Expert	Number	4	27
		%	5.1%	34.6%
Total		Number	78	78
		%	100.0%	100.0%

Level of security	Pretest n (%)	Posttest n (%)
Basic	22 (28.2%)	1 (1.3%)
Intermediate	30 (38.5%)	1 (1.3%)
Advanced	22 (28.2%)	49 (62.8%)
Expert	4 (5.1%)	27 (34.6%)
Total	78 (100.0%)	78 (100.0%)

Table 5. Results before and after the implementation of an ICT program for digital competencies at the Security level

Table 5 shows that when a pretest was given to a group of 78 students from the UNFV College of Education on the security aspect of digital competencies; they scored at a basic (28.2%) and an intermediate (38.5%) level. After the implementation of the ICT program, these students improved their levels in terms of security in relation to digital competencies, reaching advanced (62.8%) and expert (34.6%) levels.

3.6. Level of digital competency in problem solving

Table 6 shows that after administering the pretest to a group of 78 students from the UNFV College of Education on the problem solving aspect of digital competencies, they were shown to have a basic (38.5%) and an intermediate level (35.9%); after the implementation of the ICT program, these students improved their problem solving levels within the digital competencies to advanced (57.7%) and expert (41%) levels.

			GROUP	
			Pretest	Post-test
Problem solving	Basic	Number	30	0
		%	38.5%	0.0%
	Intermediate	Number	28	1
		%	35.9%	1.3%
	Advanced	Number	18	45
		%	23.1%	57.7%
	Expert	Number	2	32
		%	2.6%	41.0%
Total		Number	78	78
		%	100.0%	100.0%

Level of security	Pretest n (%)	Posttest n (%)
Basic	30 (38.5%)	0 (0.0%)
Intermediate	28 (35.9%)	1 (1.3%)
Advanced	18 (23.1%)	45 (57.7%)
Expert	2 (2.6%)	32 (41.0%)
Total	78 (100.0%)	78 (100.0%)

Table 6. Results before and after the implementation of an ICT program for digital competencies, with regard to the level of problem solving

3.7. Testing of the Hypotheses

The hypotheses of this research study were:

Ha: *The implementation of the ICT program significantly strengthened the levels of digital competencies in students from the UNFV College of Education in 2024.*

H°: *The implementation of the ICT program did not subsequently strengthen the digital competencies in a significant manner in students from the UNFV College of Education in 2024.*

Digital competencies	GROUP	N	Mean	Standard Deviation
Information literacy	POSTTEST	78	31.19	8.241
	PRETEST	78	9.60	5.632
Collaboration of the incoming students	POSTTEST	78	23.28	6.146
	PRETEST	78	5.84	4.736
Creation of digital contents	POSTTEST	78	24.14	5.684
	PRETEST	78	8.14	5.031
Security	POSTTEST	78	24.86	5.008
	PRETEST	78	10.65	6.694
Problem solving	POSTTEST	78	48.00	9.907
	PRETEST	78	19.58	13.287
General	POSTTEST	78	123.58	8.499
	PRETEST	78	61.26	6.441

Table 7. Testing of the hypotheses

In Table 7, the findings show a significant improvement in digital competencies following the intervention program, with increases being observed in all the dimensions evaluated. With regard to information literacy, the mean increased from 9.60 on the pretest to 31.19 on the posttest, while in terms of collaboration, the incoming students increased their scores from 5.84 to 23.28. Likewise, the creation of digital contents scores increased significantly from 8.14 to 24.14, and security scores from 10.65 to 24.86. In terms of problem solving, a noticeable increase in scores from 19.58 to 48.00 was recorded. Altogether,

the overall mean score doubled, increasing from 61.26 to 123.58, which goes to show the positive impact of the intervention on the development of digital competencies.

Digital competencies	t	gl	Sig. (bilateral)
Information literacy	14.178	154	.000 (p < 0.01)
Collaboration of the incoming students	14.741	154	.000 (p < 0.01)
Creation of digital contents	13.821	154	.000 (p < 0.01)
Security	11.146	154	.000 (p < 0.01)
Problem solving	11.244	154	.000 (p < 0.01)
General	22.884	154	.000 (p < 0.01)

Digital competencies	t	gl	Sig. (bilateral)
Information literacy	14.178	77	.000 (p < 0.01)
Collaboration of the incoming students	14.741	77	.000 (p < 0.01)
Creation of digital contents	13.821	77	.000 (p < 0.01)
Security	11.146	77	.000 (p < 0.01)
Problem solving	11.244	77	.000 (p < 0.01)
General	22.884	77	.000 (p < 0.01)

Table 8. Results before and after the implementation of an ICT program for digital competencies

Table 8 shows that when the paired-samples Student's t-test was applied, the level of significance was $p < 0.05$. The degrees of freedom were calculated according to the number of participants ($n = 78$), resulting in $gl = 77$. These findings evidence statistically significant differences between the pretest and the posttest in all of the dimensions evaluated. Prior to the application of the t-test, the normality was verified using the Shapiro-Wilk test.

4. Discussion

The findings of the present research study show a statistically significant impact of the implementation of the ICT program on the strengthening of digital competency of incoming students in the College of Education at Federico Villarreal National University. It has been shown that the basic and intermediate levels shift towards advanced and expert levels, revealing that digital competency can be securely developed by implementing systematic, contextualized and structured instructional strategies. This backs what is suggested by Carretero et al. (2017), who define digital competency as a series of skills that require instructional processes specifically intended for their development.

From an interpretive perspective, the findings show a quantitative improvement, as well as a qualitative transformation in the way in which the students interact with technology. In this regard, Da-Costa et al. (2023) mention that the use of technology tools has promoted the quality and improvement of educational systems, primarily in higher education. The advances made in this study are explained by the pedagogical approach proposed in the program, which promoted active learning, collaborative work and problem solving, all of which are considered key aspects for the development of significant digital competency. In this regard, Marrero et al. (2024) support that the development of this competency is closely related to its integration in real learning contexts, beyond the instrumental use of technology.

Moreover, the findings are aligned with the results obtained by Casal et al. (2021), who found that most participants had intermediate levels of digital competency, evidencing a need for ongoing training in order to integrate ICTs more effectively in the field of education. In this regard, Alvarado-Rodas (2020) found that both instructors and students in higher education observe a lack of training on how to handle technology tools, to the detriment of the teaching-learning process. On the other hand, the guidelines proposed by UNESCO (2023), which stress the need to strengthen digital competency in the training of teachers and future teachers as an essential requirement for ensuring educational quality in digital contexts. From this perspective, the positive impact of the ICT program highlights that initial teacher education can

benefit significantly from interventions specifically designed to develop this competency, thereby contributing to the reduction of the existing training gaps.

In reference to the post-pandemic context, the results can be interpreted in light of what has been stated by Schleicher (2020), Ruiz-Guerrero (2020) and Zhao et al. (2021), who coincide in indicating that the health crisis sped up the integration of technology tools in education, demonstrating both the potentiality and the limitations of the educational systems. In this study, the improvement seen might be influenced not only by the program implemented, but also by the students' greater prior exposure to digital environments, which represents a relevant contextual factor.

With regard to the specific dimensions, improvements in information literacy, communication, content creation, security and problem solving were observed; this is usually attributed to the comprehensive structure of the ICT program. It is thus understood that the progress in the information literacy dimension reveals a greater capacity to manage digital information in a critical manner, which is essential in a context represented by the overabundance of information (Candia, 2023). In this regard, Tonner-Saunders and Shimi (2021) went as far as to state that information literacy represents not only the search for information, but also its critical evaluation, appropriate selection and ethical use. According to Shishaklya et al. (2024), these are fundamental competencies needed to perform in complex digital environments.

On a similar note, the progress made in the communication and digital collaboration dimensions is related to the use of interactive tools that foster social learning. In this sense, Estrada-Perea and Pinto-Blanco (2021) maintain that the use of collaborative digital platforms promotes the continuous interaction among students (Medina-Chicaiza et al., 2022); furthermore, they also strengthen communicative skills and collaborative work in virtual environments (Padilla et al., 2022). In line with this, Rodríguez et al. (2023) affirm that these tools promote the collective foundation of knowledge when active participation, an exchange of ideas and the co-creation of contents are allowed in educational contexts mediated by technology tools.

On the other hand, in terms of the digital content creation dimension, it is evident that university students are not limited to merely consuming information, they also have the capacity to create it critically and in a contextualized manner. This finding coincides with what was found by Garzón et al. (2021) and Naranjo-Toro and Guerra (2021), who underscore that this digital competency implies the capacity to design, adapt and communicate digital contents in a creative, relevant and contextualized manner, favoring more significant and innovative learning processes. Furthermore, Vuorikari et al. (2022), Abou and Alnajjar (2024), and Martinović et al. (2025) coincide in stressing the active and leading role as a generators of knowledge in digital environments.

In a similar manner, the strengthening of the digital security dimension responds to the current need to promote an ethical and responsible use of the technology tools, as stated by Turpo-Gebera et al. (2024), who believe that digital security involves the development of a critical awareness of the protection of personal data, digital identity and online risks, as a fundamental element of digital citizenship. On a similar note, Fernández-Cruz et al. (2024) emphasize that training in digital security must be aimed at preventing risks, the responsible use of information and the adoption of secure practices in virtual environments, primarily in educational settings.

However, in spite of the positive findings, it is essential to analyze certain limitations to the research. Firstly, the pre-experimental design without a control group tends to limit the capacity to establish definitive causal relationships, since the influence of external variables cannot be ruled out. Secondly, the choice of a non-probabilistic sample limits the generalization of the results to other contexts. The lack of sociodemographic variables also hinders the analysis of probable discrepancies in the development of digital competency, which is relevant, taking into account studies such as those by Niyazova et al. (2023) and Pakhomova et al. (2023), who show inequalities in the access to and use of ICTs.

Another aspect to reflect upon is the use of a self-perception questionnaire, which can introduce biases such as social desirability or the overestimation of one's own competencies. In this sense, it is suggested that

future studies include performance evaluations that would permit a more objective measurement of digital competencies. Likewise, it would be interesting to explore more robust methodological designs, such as quasi-experimental or experimental studies that permit fortifying the internal validity of the findings.

The results of this study thus provide empirical evidence that there is still limited research on the effectiveness of ICT programs in Latin American university contexts. Therefore, the research helps reduce this gap, having demonstrated that the implementation of structured educational programs could generate significant improvements in the development of digital competency in university students. Finally, the findings accentuate the need to integrate ICTs systematically into teacher training from the very beginning, not only a as a support tool, but also as central components of the educational process. As UNESCO (2024) suggests, technology constitutes a social need; therefore, training digitally competent instructors constitutes an essential requirement to face contemporary educational challenges.

5. Conclusions

The implementation of the ICT program had a positive impact on the strengthening of the digital competency of first-year university students in the College of Education at Federico Villarreal National University, demonstrating noticeable progress in all five dimensions evaluated (information literacy, communication and collaboration, digital content creation, digital security and problem solving) of this competency, from basic and intermediate levels to advanced and expert levels. These findings allow us to conclude that the ICT program was relevant, appropriate and comprehensive in light of the current educational needs, as it promotes the strengthening of technology skills, digital responsibility, autonomy and critical thinking.

Nonetheless, the study showed certain limitations that must be considered when interpreting the results: The pre-experimental design applied does not allow conclusive causal relationships to be determined, due to the lack of a control group. Likewise, the size and nature of the sample, selected by convenience, limits the generalization of the findings to other educational contexts. In addition, the period during which the program was implemented was relatively short, which prevented the evaluation of the sustainability of the learning over time. Finally, external factors such as unequal access to resources and technology tools or the specific conditions pertaining to the students could have influenced the results obtained.

There is evidence of the need to systematically incorporate training programs in the area of ICTs within the syllabi in higher education, primarily in the educational majors, considering the strategic role of future educators in the digital training of the new generations. For this reason, it is recommended to institutionalize programs intended to build the digital competency from the first semester of study, in order to certify a solid base in the educational use of technology. Likewise, it is suggested to promote the cross-curricular integration of ICTs into the different course subjects, through academic activities that articulate digital learning with practical contexts, thus promoting more relevant and contextualized learning that is focused on the demands of the current educational environment.

In terms of future perspectives, the development of future research studies with quasi-experimental or experimental designs are proposed, which would allow us to contrast the results obtained and strengthen the internal validity of the study. Furthermore, it is believed to be important to extend the sample to different universities and sociocultural contexts, for the purpose of generalizing the findings. Longitudinal studies are also recommended that evaluate the persistence of digital competency over time, as well as to explore the impact of these programs on professional teaching performance. Finally, it is recommended to analyze in greater depth each dimension of digital competency, adding variables such as motivation, attitude towards technology and institutional circumstances, in order to fully understand the processes of developing these competencies.

Declaration of Conflicting Interests

The authors hereby state that they have no potential conflicts of interest with regard to the research study, the authorship and/or the publication of this article.

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Authors' Contributions

Emma Margarita Wong Fajardo: conceptualization, fundraising, research.

Fiorela Anaí Fernández Otoya: data preparation, formal analysis, methodology, project management, resources, software.

Olger Huamani Jordan: supervision, validation, visualization, drafting of the original manuscript.

Joaquín Alfredo Roberto Ruiz Raymundo: drafting, review, and editing.

Data Availability

Data included in the article itself or supplementary material

Use of Artificial Intelligence

The authors declare that the content of the article has not been developed using Artificial Intelligence.

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