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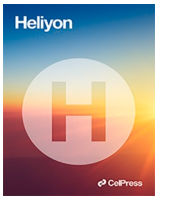

Research article

Digital competences of university students after face-to-face and remote teaching: Video-animations digital create content

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ABSTRACT

In today's digitally advanced society, there is a need to focus on collaborative educational approaches of a socio-community nature that incorporate technology. From this perspective, the FEJYLEN and FEJYLENVAL programs were conceived and implemented for both remote (online) and face-to-face teaching. These programs are based on an E-Learning-Service methodology, enabling the training of university students in digital skills, and facilitating the transfer of their interactive educational video-animations to early childhood education centers. The study sample consisted of 221 students enrolled in Early Childhood Education and Speech Therapy Degrees. The study had two objectives: first, to compare digital competences before and after participating in the mentioned programs; and second, to evaluate the impact of the type of teaching and university training on the acquisition of digital competences. The findings indicate that students receiving face-to-face teaching demonstrated significant improvement across all digital competences' factors with a medium-high effect size. Conversely, for students receiving remote instruction, improvements were limited to only certain skill factors. Our study reveals that face-to-face teaching is associated with higher scores in digital competencies and more efficient digital content creation. In conclusion, this research highlights the advantages of face-to-face teaching in comparison to remote instruction. This has facilitated a closer connection between the university and the realities faced by educational centers, fostering the exchange of knowledge between learning communities.

1. Introduction

The ongoing global impact of the COVID-19 pandemic has prompted governments and institutions to reevaluate their strategies. In this regard, the interaction between technology and globalization has introduced new challenges and opportunities. Digitalization has played a pivotal role in connecting citizens and communities, fostering a new work culture, and transforming modes of communication. This transformation has extended to education, particularly concerning how educational institutions teach and learn. This has entailed a paradigm shift from a learning-centric approach to one centered around strengthening competencies, particularly digital competencies. This new educational paradigm requires the active participation of all stakeholders (teachers, students, families, and the community) while it encourages the innovation of community projects that facilitate the exchange, integration, and dissemination of knowledge.

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Within this approach, global citizenship education aims to strengthen students' abilities to participate actively in problem-solving and achieve a more peaceful, tolerant, inclusive, and safe world [1]. For the Singapore curriculum framework — which strives to nurture engaged and responsible citizens through collaborative efforts — the challenge is to design initiatives and measures to improve the processes and quality of student learning [2,3]. This entails fostering the acquisition of essential personal, curricular, and professional competencies along with the implementation of "values in action" initiatives. These programs contribute to building a sense of citizenship and social responsibility.

In this context, the E-Service-Learning programs have been developed at the at the University of Granada (UGR), known as FEJYLEN (Development of executive functions and language in Early Childhood Education classrooms 2020–2021 (developed for remote teaching (RT) and FEJYLENVAL (More Inclusive Education, more inclusion in Education. A learning model-service in the digital era for quality Inclusive Education, 2021–2022) (developed for face-to-face teaching (FTF). These programs aim to impact the development of digital competencies, learning skills, and other related aspects among students. They also foster a collaborative process of participation among members of the educational community. In both E-Service-Learning programs (RT and FTF), university students design educational and interactive audiovisual content (video-animations) intended for use with students in the Early Childhood stage. Two research questions are posed related to the learning of university students: (1) Did university students improve their digital competencies through remote teaching and face-to-face teaching? and (2) Does the type of teaching affect digital skills?

To address these questions, we first examined possible pre- and post-training differences in both RT and FTF. We then assessed the potential effects of the type of teaching on digital competencies.

The main objective of this content is to enhance the overall development and maturity of these young learners through effective knowledge transfer. This endeavor aims to contribute to the E-Service-Learning model, where students receive feedback on their service to verify the effectiveness of transferring their knowledge and production. In this case, the focus is on utilizing video-animations to improve the executive functions of Early Childhood children.

To conduct this study, we will begin by reviewing the current state of the art. Subsequently, we will describe the methodology, results, discussion, and limitations and offer suggestions for future research before synthesizing the conclusions.

2. State of the art

2.1. Higher Education reform: a step towards digital education

Contemporary society is immersed in technological globalization, a trend that has increased since the outbreak of the global pandemic (COVID-19). This has given greater relevance to digital competences and resources across all sectors. These changes have impacted the conception, planning, and execution of the educational process [4], while also leading to a surge in the adoption of Information and Communication Technologies (ICT) [5]. In this sense, the Digital Education Action Plan (2021–2027) stresses the urgent need to harness technology more effectively within the teaching-learning process to enhance digital and audiovisual skills [6], as well as improve education in general through enhanced data analysis and predictive modeling.

In this regard, Redecker and Punie [7] indicate that teachers are models for the new generations, and they must be equipped with the necessary digital and audiovisual skills to facilitate active participation in today's digital society. These educators must be able to offer their students the necessary tools and knowledge to develop these competencies and transmit their critical and creative use of digital technology. However, it must be considered that the use of a digital resource alone is not educational; instead, this educational process must integrate the three forms of knowledge, as demonstrated by the *Technology, Pedagogy, and Content Knowledge* (TPACK) model [8,9], at different educational levels.

Given that ICTs facilitate the shared and collaborative creation of knowledge through learning communities [10], establishing an integrative model is of paramount importance. This model should bring together scientific knowledge, the educational system, families, and communities, drawing from their collective knowledge and socio-cultural experiences [11], to promote more meaningful and interactive learning [12]. Therefore, the use of technology in the classroom, coupled with its didactic application, must be considered an essential requirement for the optimal advancement of contemporary education [13]. In this regard, some researchers [14] indicate that contemporary education faces the challenge of advancing dialectical pedagogies that integrate Artificial Intelligence (AI) to enable faster and more individualized learning experiences than previously achievable. By incorporating AI into teaching and learning processes, educators aim to foster creativity and innovation, particularly in the generative design of visual and audiovisual content. Thus, schools must be transformed into quality, equitable, and successful learning communities that enable the development of the skills and abilities required to function in a working, digital, and competitive world [15]. This challenge within the educational system must be closely linked to the pursuit of quality education for sustainability, an area where universities play a significant role. As noted by Lăzăroiu [16], digital competencies and skills serve as powerful tools that can advance education for sustainable development. This is accomplished by enabling access to information, encouraging critical analysis, promoting communication and collaboration, facilitating data analysis, and supporting actions toward a more sustainable future.

The changes described above have raised the question of the role and purpose of universities in contemporary society, particularly concerning the training of future professionals immersed in processes of innovation and knowledge transfer (Third mission of the University). Hence, it is imperative to explore pathways that can assist universities in transitioning toward becoming centers of excellence. Additionally, there is a necessity to devise creative teaching and research initiatives that contribute to human and societal progress [17]. Arandia and Alonso [18] advocate for enhancing the egalitarian dialogue between universities and schools, where analysis, criticism, and reflection can lead to a reconfiguration and rethink of the significance of knowledge [19]. This dialogic exchange also encourages the development of bidirectional teaching-learning processes [11,20], generating new relationships between

professionals and new modes of virtual, interactive, and collaborative training [21], where the teacher becomes "a manager of training."

2.2. Development of digital competencies in the educational environment

The 21st century is widely recognized as the era of digitalization, which highlights the need to develop mechanisms directed toward everything related to digital competencies. By equipping citizens with these skills, they will become empowered across a variety of domains including politics, economics, and employability, as well as emerging cultural and entertainment trends in this century [22]. Within the educational landscape, these competencies are regarded as instruments that enable the acquisition of attitudes, knowledge, and processes with which students acquire skills to facilitate knowledge transfer and generate innovation [22]. In this context, the support and guidance provided by teachers could significantly enhance students' capacity to acquire and process digital information [23]. Moreover, such support can promote their ability to evaluate and improve digital communication, particularly in the area of audiovisual communication [24]. Despite young people often perceiving themselves as highly proficient in digital skills due to their status as digital natives, possessing these skills is not guaranteed, as noted by De-Vicente-Domíngez, Carballeda-Camacho, and Cestino-González [25]. Therefore, fostering digital skills is crucial for achieving inclusive and diverse quality education, emphasizing gender equality to promote the development of active digital citizens, as advocated by Estanyol, Montaña, Fernández-de-Castro, Aranda, and Mohammadi [26]. Additionally, Durán, Gutiérrez, and Prendes [27] advocate for a more human-centric approach, emphasizing the importance of qualities such as collaboration, responsibility, and ethics. This requires the implementation of pedagogical models based on transversal digital competencies applicable to both face-to-face and distance education [28].

Even more, Ocaña-Fernández, Valenzuela-Fernández and Garro-Aburto [29] indicate that digital competencies should be understood from a holistic standpoint. This entails that these skills should not solely encompass technological knowledge and skills taught within Higher Education but should also include a functional component that is integrated into a highly complex network of technological literacy. In this regard, the importance of digital competencies will require both teachers and students to enhance their use of innovative teaching-learning strategies facilitated by ICTs.

In short, the emergence of new technologies and the need to acquire digital competencies have generated new mechanisms of interactivity in society, transforming the role and functionality of university institutions. Therefore, new educators must possess the necessary digital competencies to effectively exploit a diverse range of pedagogical innovations related to new technologies, which will involve formulating novel curricular approaches and trends that harness the potential of the emerging paradigm of digital culture.

2.3. Innovating in the digital era: FEJYLEN and FEJYLENVAL

New educational scenarios have provided various ways of working and innovative modes of interaction. Notably, advancements have been made in the creation of materials and resources aimed at facilitating the teaching-learning process, personalizing training experiences, and introducing pioneering methodological approaches [30]. Consequently, it has become essential to implement effective, collaborative interventions tailored to the digital landscape of contemporary society [31]. This need has prompted Higher Education institutions to integrate targeted skills into their degree programs, aligned with the needs of professional fields (e.g., proficiency in ICTs), in addition to cross-disciplinary skills that foster students' flexibility, resilience, adaptability, and critical judgment [32]. Additionally, a transformative approach to pedagogical design is being pursued through the introduction of community participatory methodologies such as E-Service-Learning. This integrative pedagogy engages various stakeholders through technology in civic inquiry, community service initiatives, reflection, and purposeful action [33], where participants learn while providing a service to affect positive change by addressing genuine environmental needs. Moreover, E-Service-Learning (*E*-ApS) integrates digital technology into its activities, leading to new scenarios of digitalized learning and innovative educational immersion processes [34].

This methodology encourages the transfer of skills and knowledge to real situations where the University must be open to the needs of society and the surrounding environment [35]. This approach prioritizes collaboration with other institutions, meeting their needs in the form of knowledge transfer, strategies, and values. In this context, E-Service-Learning (*E*-ApS) requires a comprehensive framework for online activities. Specifically, there is a need to understand how such projects can be developed in terms of virtual design and how technology can be effectively incorporated into them [36–38].

Within this context, the **FEJYLEN** and **FEJYLENVAL** programs were conceived. These programs involve students of the Early Childhood Education and Speech Therapy Degrees (subjects of Early Care in Child Development and Speech Therapy Intervention in Early Childhood Care in the academic years 2020–2021 and 2021–2022 at the University of Granada, — UGR, Spain). Through the creation of interactive digital educational materials under the supervision of teachers, the aim is to improve the Executive Functions (EFs), that is, mental processes/operations that allow deliberate, organized, and self-controlled problem-solving, maintaining control of goal-directed behaviors [39] of Early Childhood students while enhancing the digital and audiovisual competences of university students. Both programs share the same model based on E-Service-Learning (Table 1). **FEJYLEN** focuses on developing the EF and the language corresponding to the Integrated Didactic Units (IDUs) applied during remote teaching[1] (RT), while **FEJYLENVAL** also includes values development for Early Childhood, which are applied during face-to-face teaching (FTF).

[1] Remote teaching is conducted online through scheduled classes via platforms such as Zoom and GoogleMeet. This teaching would usually take place in the classroom. However, due to social distancing measures, the contents and activities of the subjects have been adapted to suit the online lesson format.

Table 1
Logic model E-Service-Learning of the **FEJYLEN** and **FEJYLENVAL** programs.

INPUT	RESOURCES	ACTIVITIES	OUTPUTS	OUTCOMES
University of Granada (Spain) (UGR) Early Childhood Education Centers Early intervention centers of Granada (Spain) and province.	E-Learning/E-Service-Learning Methodology University students on Early Childhood and Speech Therapy degrees. *Genial.ly* tool for storytelling creation. Materials for student training.	Identification of best practices. Definition of the role of teachers and professionals. Initial and final assessment of digital and audiovisual skills for university students. Explanation of storytelling construction. Follow-up of work. Review of created content.	Better digital competence. Better audiovisual competence. Improved executive functions. Increased language development. Better appreciation of values.	Increased digital and audiovisual competence. Improved cognitive development. Better civic engagement.

Source: authors' own.

Two research questions are posed, related to the learning of university students: (1) Did university students improve their digital competencies through remote teaching and face-to-face teaching? and (2) Does the type of teaching affect digital skills?

In light of the above arguments, the primary objectives of this research are two-fold. First, we aim to determine whether there are differences in digital competencies before and after the training received in remote and face-to-face teaching. Second, we aimed to evaluate the impact of instructional modality of university training on overall digital competencies. It was hypothesized that (1) the digital competence of university students improves with training, and (2) face-to-face teaching has a positive effect on digital competencies.

3. Method

3.1. Design

This research utilized a quasi-experimental [40] and a pre-post study will be conducted on the degree of adequacy of digital competence among university students. Quasi-experimental designs identify a comparison group that is as similar as possible to the treatment group in terms of baseline (pre-intervention) characteristics [41,42].

In turn, this project is framed within a Participatory Action Research design, which allows addressing issues from the community by proposing various intervention strategies generated through the social participation of different actors or institutions [43–46].

3.2. Participants

The sample was initially composed of 333 university students enrolled at the UGR in the above-mentioned subjects. Finally, 221 students participated in the pre-post evaluation of digital competencies (DNP = 96; DP = 125).

Table 2 displays only the significant differences between the RT and FTF in weekly computer use and university education variables. Thus, computer use for more than 20 h is more frequent (46.9 %) for the RT than the FTF (24.8 %) groups. Regarding the value that students give to university education, it is observed that the greatest differences are found in the "little" category, so there are more RT students (19.8 %) compared to the FTF (10.4 %) format.

The sample was recruited using a form of non-probabilistic sampling called "convenience sampling" [47]. This process entailed the following steps: (a) first stage: selection of UGR students, (b) second stage: selection of those degrees related to the subject of the study, (c) third stage: selection of the appropriate subjects where the study would be developed and request for authorization from the ethics committee 2412/CEIH/2021, and (d) fourth stage: selection of the morning and afternoon groups for students of the Bachelor's Degree in Early Childhood Education and the morning group for the Bachelor's Degree in Speech Therapy for those participants that completed the pre-post digital competences questionnaire applied in both programs. Implied consent on completion of a questionnaire.

3.3. Instruments

The following instruments were employed.

- Video-animations. Audiovisual content was created using the online tool *Genial. ly.* This tool is designed to facilitate the creation of stories, providing digital support for completing activities or games. In FEJYLEN the contents of the stories were focused on the IDUs (e.g., school, autumn, family, etc.), and the activities included in the stories were designed to promote EFs (e.g., memory, and attention). In FEJYLENVAL the content of the stories were focused on values (e.g., solidarity, respect for others, living together, ecology, among others), and the activities included in the stories were designed to promote EFs. The materials were developed separately for ages 3, 4, and 5, adapting to the evolutionary and maturity levels of each age group (DIGIFELEN website https://digifelen.ugr.es) [48].
- Questionnaire of Digital Competences in Higher Education (CDES in its Spanish acronym) [49–51]. This instrument comprises 62 items, divided into six sections, the first is about the general data of the respondent and the next five are the factors two areas (data

Table 2
Sociodemographic characteristics of the study participants.

	Remote Teaching (RT) N = 96	Face-to-face Teaching (FTF) N = 125	Test	*p*
Gender				
Female	93 (97 %)	119 (95,2 %)	$\chi^2_1 = 0.39$	0.532
Male	3 (3 %)	6 (4,8 %)		
Age	22.34 ± 1,41	22.10 ± 1,67	$T_{119} = 1.12$	0.130
University degree				
Early Childhood Education	68 (70.80 %)	81 (64.8 %)	$\chi^2_1 = 0.90$	0.343
Speech therapy	28 (29.2 %)	44 (35.2 %)		
Personal computer				
Yes	96 (100 %)	124 (99.2 %)	$\chi^2_1 = 0.77$	0.380
No	0 (0 %)	1 (0.8 %)		
WIFI access				
Yes	96 (100 %)	121 (96.8 %)	$\chi^2_1 = 3.12$	0.077
No	0 (0 %)	4 (3.2 %)		
Computer usage/hours per week				
1–5 h	10 (10.4 %)	39 (31.2 %)	$\chi^2_2 = 18.29$	<0.001
6–20 h	41 (42.7 %)	55 (44.0 %)		
More than 20 h	45 (46.9 %)	31 (24.8 %)		
Previous training				
Little (value 1)	15 (16.0 %)	13 (10.4 %)	$\chi^2_4 = 2.45$	0.652
Some (value 2)	25 (26.0 %)	28 (22.4 %)		
Regular (value 3)	33 (34.0 %)	46 (36.8 %)		
Considerable (value 4)	20 (21.0 %)	32 (25.6 %)		
Extensive (value 5)	3 (3,0 %)	6 (4.8 %)		
University training				
Little (value 1)	19 (19.8 %)	13 (10.4 %)	$\chi^2_4 = 25.36$	<0.001
Some (value 2)	17 (17.7 %)	20 (16,0 %)		
Regular (value 3)	30 (31.3 %)	47 (37.6 %)		
Considerable (value 4)	22 (23.0 %)	32 (25.6 %)		
Extensive (value 5)	8 (8.2 %)	13 (10.4 %)		

Note: $p < 0.05$.

identification and five factors with information use of digital technology assessment) with five factors (46 items): F1: technological literacy; F2: access and use of information; F3: communication and collaboration; F4: digital citizenship; and F5: creativity and innovation. Each factor uses a Likert-type on which they had to assess the degree of adequacy of the items and dimensions proposed (1 = not adequate; 2 = hardly adequate; 3 = adequate; 4 = quite adequate; 5 = totally adequate) Cronbach's alpha test results were 0.962. Validation of the instrument for the Spanish population revealed a reliability of 0.8 (F1 = 0.86; F2 = 0.89; F3 = 0.89; F4 = 0.87; F5 = 0.92), which indicates high and adequate reliability indices. Regarding validity, the results showed an optimal inter-item correlation range [51]. The study by Dominguez et al. [49], a new variable has been created by calculating the average of the scale items, resulting in Global Digital Competence. The Cronbach's alpha index for all items is 0,958 [49].

3.4. Procedure

The study procedure was divided into the following phases.

Phase A Academic year 2020–21

An intervention plan was designed, with consideration given to the digital skills training of university students, the effectiveness of their productions (video-animations), and the specific needs of students in the Early Childhood stage. This plan consisted of five stages: (1) *Introduction of the concept.* Initially, this approach was introduced into the teaching guides of the relevant subjects taught by the professors; (2) *Baseline assessment.* The digital competencies of the participants were evaluated before training using the CDES questionnaire, administered online. Implied consent when completing CDES questionnaire; (3) *Remote training.* The university students carried out online training to elaborate the educational video-animations tailored to the IDUs. It was necessary for them to utilize their prior knowledge in the areas of Visual Expression and Information and Communication Technologies or Developmental Psychology; (4) *Monitoring.* The university faculty supervised the created resources. Subsequently, those with the highest quality were selected according to the criteria outlined by the UNE 71362 Standard for the quality of digital educational materials [52]. The selected video-animations were then integrated into the educational curriculum of the participating centers; and (5) *Post-training evaluation.* After the training phase, participants' digital competencies were assessed again through online evaluations.

Phase B Academic year 2021–22.

The same structured procedure was followed, except for the third stage, in which the participants underwent face-to-face training

on the video-animations, focusing on the values worked on within the IE curriculum.

4. Data analysis

Descriptive statistics were calculated for participant characteristics and study variables. SPSS 28.0.1.0 statistical software was used for data analysis. A parametric analysis was employed, since: (a) the *t-test* and Mann-Whitney-Wilcoxon test have similar power for 5-point Likert items [53], and (b) the sample size is medium-high.

The sociodemographic characteristics of the study participants were analyzed. Quantitative and qualitative data were compared using Student's t-test and Pearson's chi-square test, respectively. Differences were considered significant at $p < 00.05$.

A comparison of pre-training vs. post-training digital competencies in remote (RT) and face-to-face teaching (FTF) was conducted using Student's *t-test* for related samples. This analysis examined differences in digital competencies before and after training for both FTF and RT.

A ANOVA was used to verify the effect of the type of teaching (remote or face-to-face) on digital competences (post-training).

5. Results

Before analyzing the pre- and post-training digital competencies according to the two modes of teaching, we compared the characteristics of the students (Table 2).

5.1. Objective 1. comparison of pre-training vs. post-training digital competencies in remote and face-to-face teaching

Remote training yielded significant changes in technological literacy, communication and collaboration, creativity and innovation, and global digital competence, where post-training scores were significantly higher than those observed during pre-training. However, the effect size was small. Face-to-face training also produced significant changes in all digital competence factors, where post-training scores were significantly higher than pre-training scores. The effect size was medium for two of the six variables (global digital competence and information access and use) and high for communication and collaboration (Table 3).

Thus, differences are observed in participants' digital competencies between the pre-training and post-training phases for both types of teaching. Higher scores are observed in the post-training competencies following face-to-face teaching, with a larger effect size, that is, the size of the pre/post-training difference is greater for the face-to-face teaching format.

5.2. Objective 2. effect of the type of university teaching on digital competencies

The aim was to examine the effect of the type of teaching university training on global digital competencies. To this end, the final results, that is, post-training digital competencies, were analyzed using a ANOVA (Table 4).

Table 4 displays the main effects of teaching type on post-training digital competences. These results indicate that face-to-face teaching produced greater digital competencies than remote teaching in all factors (technological literacy, information access and use, communication and collaboration, digital citizenship, creativity and innovation) and in global digital competence, with a high effect size on factors: information access and use, communication and collaboration y global digital competence.

6. Discussion

The aim of this study was twofold. First, to compare the digital skills of students before and after their participation in E-Service-Learning programmes, and second to determine whether university students improved their digital skills after the creation of video-

Table 3
Comparison of the mean scores obtained on digital competence factors between pre- and post-training for remote and face-to-face teaching.

Digital Competencies Factor [50,51]. Remote teaching	Pre-training Mean (SD)	Post-training Mean (SD)	*t*	*p*	*d*
Technological literacy	4.15 ± 0,56	4.33 ± 0,43	3.40	<0.001	0.31
Information access and use	4.33 ± 0,51	4.36 ± 0,54	0.64	0.25	0.06
Communication and Collaboration	4.26 ± 0,55	4.37 ± 0,52	1.97	0.02	0.28
Digital citizenship	4.30 ± 0,51	4.28 ± 0,54	0.54	0.29	0.05
Creativity and innovation	4.24 ± 0,49	4.32 ± 0,52	1.60	0.04	0.24
Global digital competence	4.25 ± 0,44	4.32 ± 0,41	1.93	0.02	0.28
Digital Competencies Factor [50,51]. Face-to-face Teaching	Pre-training Mean (SD)	Post-training Mean (SD)	*t*	*p*	*d*
Technological literacy	4.35 ± 0,44	4.60 ± 0,83	2.69	0.004	0.30
Information access and use	4.40 ± 0,50	4.70 ± 0,44	5.07	<0.001	0.56
Communication and Collaboration	4.37 ± 0,44	4.81 ± 0,52	6.37	<0.001	0.70
Digital citizenship	4.27 ± 0,46	4.47 ± 0,55	3.17	0.001	0.35
Creativity and innovation	4.36 ± 0,78	4.67 ± 0,81	2.5	0.007	0.28
Global digital competence	4.35 ± 0,39	4.64 ± 0,50	4.70	<0.001	0.53

Note: $p < 0.05$.

Table 4
Results for differences according to teaching type of university training in digital competences.

	Teaching type					
	Face-to-Face Mean (SD)	**Remote Mean (SD)**	**F**	**p-value**	**Power**	**η2 partial**
Technological literacy	4.55 (0.69)	4.32 (0.43)	7.82	0.006	0.80	0.04
Information access and use	4.70 (0.44)	4.36 (0.53)	21.19	<0.001	0.99	0.10
Communication and Collaboration	4.81 (0.53)	4.36 (0.52)	33.30	<0.001	1.00	0.15
Digital citizenship	4.48 (0.56)	4.25 (0.54)	7.52	0.007	0.78	0.04
Creativity and innovation	4.68 (0.81)	4.30 (0.51)	16.07	<0.001	0.98	0.08
Global digital competence	4.62 (0.46)	4.31 (0.41)	23.05	<0.001	0.99	0.11

animations. The analyses of this study revealed that the educational interventions carried out through E-Service-Learning have led to positive changes in students' digital competences. It is worth noting that in the face-to-face type, students have achieved a greater improvement in digital competences than in the e-learning type.

The findings of this study are compatible with other research highlighting the benefits of participating in these types of programs. Notably, these programs contribute to an enhanced learning experience through the incorporation of technology, fostering improved creative processes, and digital proficiencies [54–56]. Specifically, our results indicate that students' digital competences improve after participation in both programs, similar to the outcomes of Littlefield, Rubinstein and Pittman's [57] study, which also demonstrated that technology usage increases digital competences. Although in our research, a stronger effect was recorded for the face-to-face educational modality. Thus, we could conclude that the research question regarding whether university students improve their digital competence in remote teaching and face-to-face teaching is supported. However, the data suggest a more pronounced effect when the teaching is conducted face-to-face.

Thus, amid the ongoing emergence of digitalization across all sectors, the educational sphere has not remained on the sidelines of this development. Consequently, Higher Education bears the responsibility for equipping its students with the tools, knowledge, and skills necessary to actively participate in the digital society with confidence and competence [58].

In this regard, our second research question sought to determine whether the type of teaching influences the acquisition of digital skills. In the context of the FEJYLEN program, the results reveal a significant improvement in several dimensions, including "technological literacy", "communication and collaboration", "creativity and innovation", and "global digital competence", although with a small effect size. Conversely, within the framework of the FEJYLENVAL program, university students obtain significantly higher scores in post-training in all factors evaluated with a moderate effect size. It is important to note that this improvement is marked across all factors, particularly in "global digital competence" ("access and use of information," notably "communication and collaboration") with a large effect size. Emphasizing the factor "communication and collaboration" where the size of the difference is large. Thus, it seems that the advantages that face-to-face communication and collaboration between students and teachers can contribute to increasing students' digital competences.

These findings demonstrate the effectiveness of both programs, whereby students have applied participatory, collaborative, and community-based methodologies synonymous with e-learning practices, Malvey et al. [33] reported. This instructional approach involves various stakeholders who use technology for civic inquiry, community service, reflection, and action.

The digital educational strategy to improve the digital competences and skills of the participating students Genial. ly was used to create educational and audiovisual digital resources [59]. Practices bases on the TPACK training model [8,9], which allowed us to obtain results of the use of active and collaborative e-learning methodologies are aligned with the curricular reform advocated by Rodríguez-Sánchez and Revilla-Rodríguez [15]. In our study, the use of digital technologies should prioritize the identification and selection of activities that correspond with the needs and commitments of the community. Moreover, it should align with and develop the academic, civic, and personal learning objectives of the various individuals involved, as proposed by Paz et al. [60].

This approach highlights the importance of empowering students with the skills and competencies necessary for thriving in a dynamic and competitive professional landscape characterized by technological and digital fluency, as in the study of Culcasi, Russo and Cinque [61]. Moreover, the encouraging data obtained from the implementation of both programs represent a positive response to the educational challenge set out by the European Commission [62] within the framework of the Digital Education Action Plan (2021–2027).

However, given the educational landscape during the period studied, it is important to consider that the observed increase in digital competencies in the face-to-face context might be attributed to several factors. These factors include the adaptation of teachers to the training processes, where aspects such as the current characteristics and needs of students were taken into account. This adaptation involved incorporating flexible scenarios and focusing on the acquisition of competencies and skills [63]. Moreover, it is worth noting that the previous academic year had seen students immersed in a rapid transition to fully digital activities due to the COVID-19 pandemic. This change might not be considered directly comparable to other carefully designed online initiatives [64], which could pose additional challenges for the acquisition of such competencies. Moreover, some students might not have been fully integrated into this digital environment, which could have further impacted their competency development. This aspect was observed in our study when comparing the results on the Digital Competencies Factor [50,51], which were more pronounced in face-to-face teaching compared to when the remote program was implemented, even during the pre-training phase.

In this context, the skills acquired in training seem to be dependent on physical presence, since face-to-face university teaching — but not remote teaching — predicts the overall digital competence acquired. equal to the number of weekly hours of computer use and

previous training. It is possible that, as suggested by Cho and Kim [65], satisfaction with learning is higher in face-to-face learning environments, which could potentially influence an individual's perception of their digital competence since both programs follow the same logical structure. In any case, as Escofet [55] indicates, it is vital to consider the various aspects of knowledge related to the technology used, including its benefits, limitations, and potential applications.

On the other hand, the implementation of the E-Service-Learning methodology and the creation of educational video-animations emerged as impactful, collaborative, and contextually relevant interventions. These findings are compatible with those of Korosidou et al. [31], confirming that these interventions significantly contribute to university students' conceptualization of digital citizenship, including the perception of digital technologies as tools for skill adaptation across various learning environments [66–68]. In this case, the students have benefited from these programs, as evidenced by the results indicating an improvement in global digital competence.

Moreover, such programs reinforce knowledge of the associated risks [69] and emphasize citizen participation involving the triad of the university, schools, and families. This collective engagement provided the students with a global vision of the complex realities that could potentially impact and enhance their digital competencies, as found in other studies [70], suggesting that acquisition of these competencies goes beyond mere content creation. Instead, these competencies evolve into an integrated digital literacy that equips students with the necessary tools to navigate the changes brought about by the pervasive use of digital media in contemporary society [71].

According to Casablancas, Schwartzman and Burgui [72], this type of study addresses two main components. First, teachers assume the dual role of content managers and designers of both analog and digital creative activities for video-animations. Furthermore, they facilitate the teaching-learning processes both remotely and in face-to-face settings, fostering collaborative work. Second, a significant focus is placed on cultivating "digital citizenship" with an emphasis on digital and audiovisual literacy. These skills empower individuals to access, collaboratively create, and share information and content across various media and formats (using the Genial. ly platform for the first time). This is accomplished within a framework of open-access environments with an emphasis on engaging with digital spaces in a critical, ethical, democratic, inclusive, and responsible manner.

The evaluation of educational and interactive resources created by university students, as perceived by Early Childhood teachers, reveals a positive effect between the overall digital competence acquired through face-to-face teaching and the criteria relevant to its application, as evident in other initiatives such as "EDIA" [73] (Educational, Digital, Interactive, and Open) pioneered by the National Institute of Educational Technologies and Teacher Training (2012–2027). These shared outcomes highlight the important role played by such programs in effectively transferring university-generated knowledge back into society.

Finally, the implementation of these programs equips students with new digital resources that continue to expand their knowledge and digital competences, which can be effectively applied in other social contexts. In this regard, a study conducted by Van-Deursen, Helsper and Eynon [74] suggests that older demographic groups tend to have better perceptions of their competency skills, similar to the present study in which the participants were final-year students with a higher perceived educational level, would have a significant effect on the assessment of their work. Additionally, it is worth noting that having certain information-related competencies does not necessarily equate to having digital competences. Rather, this pertains to the belief that individuals possess such skills [26], a conclusion that was drawn at the end of both programs. Consequently, the cultivation of students' digital competencies is linked to the pursuit of lifelong learning, which is crucial for acquiring cognitive and technical skills, as indicated by other studies [67,75].

7. Limitations

The limitations of the present study include the fact that this research was conducted with a population sample limited to the UGR. Moreover, a gender bias was observed in the sample, which was predominantly female, which is typical in Education degree programs. Moreover, the students required an initial training period to become familiar with the video-animation creation platform (Genial.ly). Many expressed frustration and needed more time to understand how to use it effectively. Finally, no control group was included, as priority was given to the participation of all students enrolled in the relevant degree subjects.

8. Future research perspectives

From a future perspective, several promising lines of research are opened, driven by the need to formulate strategies, tools, and educational methodologies that seamlessly bridge link analog, digital-virtual, and hybrid learning paradigms. These endeavors are essential for realizing the vision of a high-quality education in the 21st century, as set out in the 2030 Agenda. Additionally, there is a need to investigate strategies and tools for the effective evaluation of emerging forms of knowledge acquisition, new digital resources, educational processes, and technology-driven methodologies.

9. Conclusions

This study highlights the advantage of face-to-face teaching in comparison with remote instruction concerning the development of digital competencies. A strong association was found between the perceived of face-to-face university training received by university students and the assessment of their digital content (educational video-animations) by early childhood teaching staff.

In this sense, the university plays a pivotal role in driving the transformation of educational centers into vibrant learning communities. This transformation is achieved by implementing innovative pedagogical designs rooted in community-oriented methodologies such as E-Service-Learning. Thus, this study contributes to educational initiatives that aim to integrate digital literacy to facilitate the transfer of acquired knowledge and encourage partnerships that enable practical experiences beneficial to both

institutions. Furthermore, introducing an integrative pedagogy alongside the use of ICTs has positively impacted students' competencies.

Finally, the objectives of this study extend beyond the confines of the educational environment, aiming to foster the advancement of digital competences through collaborative initiatives involving different communities, educational levels, and families. Achieving this goal hinges upon the adoption of meaningful methodologies, which requires continued research.

Ethical statement declarations

Approval was obtained from the ethics committee of the University of Granada with reference 2412/CEIH/2021, date: November 24, 2021.

Implied consent when completing CDES questionnaire by university students.

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Data availability statement

Data will be made available on request.

CRediT authorship contribution statement

Mirian Hervás-Torres: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization. **Mercedes Bellido-González:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Pilar Manuela Soto-Solier:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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