TechTrends
https://doi.org/10.1007/s11528-025-01107-8

ORIGINAL PAPER

Boosting Digital Competence: Impact of an Educational Program on Primary-to-Secondary Transitioning Students from a Gender Perspective

Andrea Bueno-Baquero[1] · **Javier Del Olmo-Muñoz**[2] · **José Antonio González-Calero**[3] · **María del Carmen Sánchez Pérez**[4]

Accepted: 30 May 2025

Abstract
The present study analyses the effect of an educational program on the digital competence (DC) level of 126 sixth-grade students from three schools in a mid-sized urban area of Spain, based on the DigComp framework, which defines five areas: information and data literacy, communication and collaboration, digital content creation, safety, and problem solving. A validated questionnaire was applied to analyse the students' DC level before and after the educational program. Findings reveal improvements in all DC areas, except area 5. The gender variable was analysed, revealing that female students outperformed male students after the program developed. Results suggest that more educational initiatives and further research are necessary to train students in digital literacy and to study the factors contributing to gender differences. In this context, this work provides practitioners with a set of open-access resources, experimentally validated for their effectiveness in enhancing students' DC.

Keywords Transitioning students · Digital competence · Educational program

Introduction

The importance of technology in education is an essential topic which is transforming society and has the potential to significantly enhance the learning process of students (Bonfield et al., 2020). During the pandemic, technology was crucial in maintaining educational continuity, and this experience has underscored the need to permanently integrate technology into the teaching–learning process to ensure all students have access to quality education (Haleem et al., 2022). That is, society demands the population be trained in different skills, highlighting digital skills as the most essential ones (Feijao et al., 2021; van Laar et al., 2017).

The Digital Education Action Plan (2021–2027) is a European Union initiative to foster high-quality, accessible digital education across Europe, including two main strategic priorities: developing a highly effective digital education ecosystem and enhancing students' digital skills to facilitate digital transformation (European Commision, 2020). The current Spanish educational law (BOE, núm. 340, de 29 de diciembre, 2020) states that the digital world is a 'new habitat' in which students learn and interact (p.6). Therefore, it aims to foster the development of students' DC through a transversal perspective, raising awareness of the digital gender divide. By the end of the primary education stage students must have acquired a competent level of DC (Real Decreto 157/2022 [Royal Decree 157/2022]). In this framework, it is becoming essential to train students digitally so that they are prepared for life changes and transitions (Cranmer, 2014). This study was developed with sixth grade transitioning students as the transition from primary to secondary education is considered to be of the most important moments in students' lives, and being prepared is essential

✉ Andrea Bueno-Baquero
andrea.bueno@alu.uclm.es; a.buenobaquero@gmail.com

1 Faculty of Education, University of Castilla-La Mancha, Plaza de la Universidad, nº 3, CP 02071 Albacete, Spain

2 Lab of Technology Integration in Classrooms (LabinTic), University of Castilla-La Mancha, Albacete, Spain

3 Educación, Género, Trabajo y Sociedad en Castilla-La Mancha (EDUTRASOC), University of Castilla-La Mancha, Albacete, Spain

4 Lab of Technology Integration in Classrooms. (LabinTic), University of Castilla-La Mancha, Albacete, Spain

Published online: 10 June 2025

to adapt to the new secondary education stage (Fabuel, 2015). In particular, the transition to secondary education is a crucial period to embed digital skills as students encounter more complex subjects and sophisticated learning environments that require a higher level of digital proficiency (Xing & Marwala, 2017). The educational program which is proposed in this research entails a link between these two educational stages.

The present study focuses on analysing the impact of an educational program on the DC level of transitioning students (students in the last year of primary education) from the city of Albacete, a mid-sized urban area in Castilla-La Mancha, Spain. Based on the DC framework for citizens (DigComp), a questionnaire was administered before and after the educational program consisting of four educational workshops. Each of these workshops was related to a specific area of the DC framework, providing comprehensive instruction and assessment of the students' progress in terms of digital skills. The brevity of the intervention proposed makes it applicable and useful to schools.

Student Digital Competence

According to DigComp, digital competence can be defined as the 'confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society' (European Commission, 2019, p.10).

It is noteworthy that not all students have the same access to technology, and some of them may find barriers because of the lack of devices or Internet access (Acuña-Torres et al., 2024). Although the last PISA report revealed that access to ICT has improved over recent years (OECD, 2015), there are still many gaps. According to Van Deursen and Van Dijk (2010), the digital divide is unequal access to technology, which can be limited for different reasons such as social, psychological or cultural ones. Ertl et al. (2020) suggest that it is necessary to consider not only the unequal access to digital resources, but also the lack of competences in the use of technology.

Nowadays, most students use technology in their daily lives as part of the digital society we are immersed in. However, following Prensky's (2012) concept of digital wisdom, it is just as important to know the functions of technology as to know how to use them. Studies like Machete and Turpin (2020) find that students tend to show low levels of critical thinking skills in daily actions such as detecting fake news on the Internet. This lack of critical thinking lead students to unknowingly share misleading information, potentially impacting their lives (Buchan et al., 2024). Mena Marcos (2020) indicates that students obtained the lowest averages on Area 5 of the DigComp framework, specifically related to Problem Solving. Paradoxically, Godaert et al. (2022) found in their systematic review concerning DC that safety and problem-solving areas were the least studied and worked on with primary education students. Hence, it is increasingly important to promote students' training by providing them with correct criteria to use technology (Fernández-Montalvo et al., 2017).

Gender Gap in Technology Skills in Education

Several studies emphasize the digital gender divide as one relevant aspect in education (Campos & Scherer, 2023; Niño-Cortés et al., 2023). Campos and Scherer (2023) distinguish three different levels of digital gender gaps: disparities in access to technology, ICT skills and learning achievement.

Maon et al. (2021), in their study with secondary students, revealed that male students outperformed female students considering problem solving skills when using the Internet, whereas female students outperformed male students in ethical knowledge variables when using digital devices. The same authors suggest that the total means comparing DC in general was higher in female students. Existing studies suggest that there is an existing digital gap favoring male students, showing that male students obtained higher scores in DC perception and attitudes (Niño-Cortés et al., 2023).

On the other hand, authors like Siddiq and Scherer (2019) suggest in their meta-analysis that female students obtain higher results in digital skills in primary education compared to male students. West et al. (2019) highlight that despite primary and lower secondary female students surpassing males in their DC level, they tend to have lower confidence in their digital skills, especially in more complex tasks. Haddon et al. (2020) support this idea of a gender gap favoring females, this being more pronounced in primary than in secondary education. However, they highlight that these differences appear less substantial when assessed through performance-based measures rather than self-report surveys. Similarly, Mena Marcos (2020) reported that female students obtained higher scores than male students in all the Areas of the DigComp framework, except for problem solving skills (Area 5), where male students overperformed females. According to Perifanou and Economides (2020), females perform Science, Technology, Engineering, and Mathematic (STEM) skills at the same or even higher levels than males in primary education, but the gender gap starts in secondary education, showing a loss of interest on the part of females. This loss of interest can cause the gap that exists in the gender composition of the total number of digital specialists, where females are in minority (Ministerio para la Transformación Digital y de la Función Pública del Gobierno de España, 2024 [Ministry for Digital Transformation and Public Administration of the Government of Spain]).

Some studies find males ahead in digital problem-solving and self-perceived competence, while others find females ahead in ethical, safety-related or general digital skills. This disparity in results seems to point more to differences in confidence, motivation and context rather than any inherent gendered ability, which would emphasize the importance of adequate educational programs.

Primary to Secondary Educational Transition

The transition from primary to secondary school is an important transformation as students need to face different challenges and changes (Francés et al., 2022). Providing students with continuity at this moment can avoid generating possible mistakes that determine students' paths (Donaldson et al., 2023). Passey (2014) raised the question of whether technologies are enabled to help this transition and suggests that if so, bridging points should be established between primary and secondary education to allow for continuity and the evolution of learners.

According to the Spanish educational system, by the end of the primary education stage students must reach a specific level of DC, including guided searches, creation of digital content, use of digital platforms, knowledge of Internet risks or resolution skills (Real Decreto 157/2022 [Royal Decree 157/2022]). Table 1 shows a summary of the level of performance expected for sixth-grade students at the end of the stage:

To obtain these standard levels, it is essential to promote DC instruction initiatives, especially in the sixth grade of primary education to prepare them to meet the usual demands they may find at the secondary stage.

In the context of secondary education, Estrada and Bennasar García (2021) found that there was a generalized lack of awareness about the use of ICT among students. Therefore, applying assessment tools to analyze students' DC levels presents a crucial opportunity for schools to identify deficiencies and develop appropriate intervention strategies (Calvani et al., 2012). One example is provided by Guitert et al. (2021), who reported on the importance of establishing the continuity of DC from primary to secondary education and developed a common framework to address this existing gap.

Digital Competence Framework

With the increasing importance of technology skills over the last few years, the need for a DC framework has evolved. Widely recognized and adopted across Europe, DigComp provides a standardized framework for assessing and developing DC, covering essential digital skills that are relevant at any age.

According to the European Commission (Vuorikari et al., 2022), the DC framework for citizens (DigComp) involves five areas: information and data literacy, communication and collaboration, digital content creation, safety, and problem solving. Table 2 shows a brief explanation of these areas:

Table 1 Level of expected performance for sixth-grade primary students

DC	Level of performance
DC1	Performs guided internet searches and utilizes simple strategies for digital information processing maintaining a critical attitude
DC2	Creates and integrates digital content in various formats using diverse digital tools to express ideas, emotions, and knowledge, respecting intellectual property and copyright of reused content
DC3	Engages in school activities using virtual tools and platforms to build new knowledge, collaborate, and share content in securely supervised digital environments, demonstrating an open and responsible attitude
DC4	Understands the risks and, with teacher guidance, adopts preventive measures when using digital technologies to protect devices and personal data, beginning to develop habits for critical and sustainable technology use
DC5	Begins to develop simple, sustainable digital solutions to creatively address specific problems or proposed challenges, seeking assistance when necessary

Adapted from Real Decreto 157/2022 [Royal Decree 157/2022]

Table 2 Digital competence framework areas

Area	Description
1. Information and Data Literacy	Information searches, data evaluation and managing
2. Communication and Collaboration	Sharing content and collaboration through technology
3. Digital Content Creation	Creating and re-elaborating digital content online
4. Safety	Protecting devices, personal data and well-being
5. Problem Solving	Identifying problems and solve them creatively

Own elaboration. Based on Vuorikari et al. (2022)

The Present Study

The literature review emphasizes the importance of integrating DC in education and providing students with the necessary skills to acquire a competent level of it. The present research should be considered as part of a larger study that involved a general assessment of DC among students in Castilla-La Mancha, focusing on sixth-grade primary school and first-year secondary school students. In that broader study, it was observed that the overall level of DC was relatively low across the student population. As a response to these findings, this study was conducted as a case study with the aim of improving students' DC through an educational program designed to address the gaps identified in the initial diagnosis. Based on this line of research, the present study aims to address the following research objectives:

RO1. To evaluate the impact of an educational program on students' DC.
RO2. To study the potential gender differences in the students' DC level.

Method

Participants and Design

The current study was conducted with transitioning students from the sixth grade of primary education, aged between 11 and 13 years old. Due to the age of the participants, their families were provided with an informative dossier about the study and the families expressed their agreement to participate through informed consents. The study was approved by the ethics committee of the University of Castilla-La Mancha. The participants were 126 students (60 male and 66 females) from three different schools (two state schools and one private school) from the city of Albacete, a mid-sized urban area in Castilla-La Mancha, Spain. The three selected schools were of middle socio-economic status and had adequate resources to support the study, ensuring a stable technological infrastructure. The availability of digital devices facilitated the implementation of the study. The educational program designed for this study was carried out by primary school teachers and research staff from the University of Castilla-La Mancha.

This study is designed as a collective case study, following Stake's (2006) approach, since multiple schools are considered as a collective whole for the analysis to investigate the impact of the educational program on students. This approach allows for a comprehensive examination of the educational program's impact, providing valuable insights into its effectiveness and the factors contributing to its success or challenges.

Following this methodology, a coordinated approach was implemented, employing a consistent structure comprising of a questionnaire to measure DC and four educational workshops across all cases. This structure ensured comparability and reliability in the findings derived from each school context. To apply the DC questionnaire and to achieve the research objectives proposed, the present study follows a one group pretest posttest quasi-experimental research design.

Figure 1 shows the design of the sessions employed. As can be seen, in the first session the students completed the pretest questionnaire to measure their initial DC level. Once the questionnaire was filled in, the students received a DC educational program composed of four educational workshops. Each workshop was based on a different area of the European Digital Competence framework for citizens; a more detailed explanation of these can be found below (workshop design section). The organisation of the workshops was not sequential, due to the content of the different areas and the way of working on them with the students. Area 5 (Problem Solving) was worked transversally in every workshop, and more specifically in Workshop 4. After the instruction, the students took the posttest to reassess their DC level and evaluate potential improvements.

As a complementary test, a student satisfaction questionnaire was also administered after the educational program to evaluate the students' experience and satisfaction with the DC workshops and the instruction received.

Instrument

The instrument employed for this study was the Digital Competences Evaluation Test (ECODIES), a validated questionnaire proposed by Iglesias Rodríguez et al. (2023).

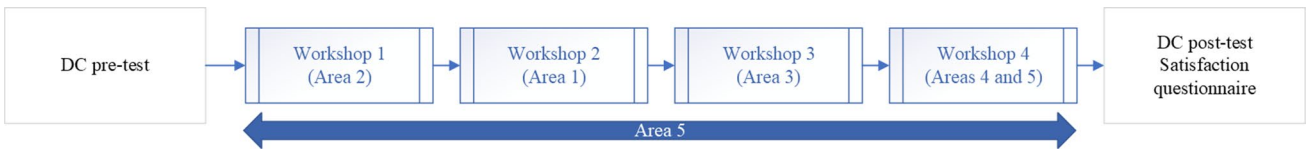

Fig. 1 Session design

This questionnaire is intended to measure the DC level of primary school students. The instrument has undergone an exhaustive validation process through expert judgement and different pilot tests with each of the areas. In particular, the questionnaire was validated with a primary-school student sample following a quantitative methodology and statistical techniques.

The questionnaire consists of 57 items divided into six different sections (Hernández and Iglesias, 2020). Sections from 1 to 6 coincide with the 5 areas of the DigComp, and Sect. 0 examines socio-demographical aspects. The items were evaluated following a 5-point Likert scale, 1 being totally disagree and 5 totally agree. Students completed the questionnaire online, in a safe environment provided by the University of Castilla-La Mancha, based on Limesurvey. All data was anonymized by assigning a unique code to each student, inspired by Lippe et al. (2019), which they created randomly themselves and allowed us to monitor their progress in both the pretest and posttest.

The assessment test was based on a validated test (Kay & Knaack, 2009) which was adapted for primary school students with a more relatable vocabulary for them. Specifically, the administered test consisted of 11 questions with a Likert scale from 1 to 5 (1 being Not interesting and 5 Very interesting), along with an open-ended question where students could express their thoughts about the workshops.

Workshop Design

As previously noted, the programs designed for this study were based on the European Digital Competence Framework for citizens. Considering the five areas of the framework, each educational workshop addressed one or two specific areas. Although Area 5 was worked on specifically in Workshop 4, it is worth noting that this area was worked on transversally in all the workshops due to its applicability.

As we were working with primary education students, the platform used for the educational program was a safe environment provided by the educational administration, *Microsoft for students*, for all compulsory stages. It is crucial to state that most students, despite being in the last trimester of the final year of Primary Education, had not used it before. Each workshop lasted 45 min, coinciding with Spanish school session timetables.

The workshops described below are adaptable to the subjects and contents worked on by the students. Although in the present study a specific example is provided, the content of these workshops is designed to be flexible, allowing its implementation in various educational contexts. In fact, to ensure the transfer of knowledge, these materials have been made available online in an educational repository, enabling any school and teacher to access and tailor them to their needs with the goal of enhancing students' DC. This adaptability ensures that the workshops can be widely used to improve digital skills across diverse educational settings. Table 3 shows a summary of the workshops including their objectives and resources, and a more detailed explanation of each workshop is given below:

Workshop 1 This workshop was aimed to cover Area 2 (Communication and Data Literacy). This area was selected as the focus of the first workshop in order to teach students how to share documents and collaborate online. By mastering these skills, students could effectively navigate and use the educational platform provided, ensuring they were well-prepared to engage in the subsequent workshops.

Firstly, students were distributed into groups of four. Then, they were shown how to create and share a folder with their classmates, step by step, following a presentation

Table 3 Workshop summary

Workshop	DC area	Objectives	Resources	Duration
Workshop 1	Area 2: Communication and Collaboration	Learning how to share files and folders in a close environment and collaborating online	Digital board for projecting a presentation, tablets or computers	45 min session
Workshop 2	Area 1: Information and Data Literacy	Raising students'awareness of the importance of conducting appropriate Internet searches and using data appropriately	Digital board for projecting a presentation, tablets or computers	45 min session
Workshop 3	Area 3: Digital Content Creation	Learning how to create content responsibly by using free image banks and respecting copyright laws	Digital board for projecting a presentation, tablets or computers	45 min session
Workshop 4	Areas 4 and 5: Safety and Problem Solving	Raising students' awareness about the potential risks found on the Internet and learning how to use it responsibly	Digital board for projecting a presentation, tablets or computers	45 min session

projected on the digital board. Secondly, once they had created the folder, they were asked to create a shared file and write on it at the same time, so they could see how this function works and learn how to collaborate together in real time. Finally, they were given an explanation of how to use the track-changes function and how to add comments to the shared file. Figure 2 shows an example of the presentation, projected step by step, so students could follow it.

Workshop 2 Workshop 2 was designed to cover Area 1 (Information and Data Literacy) so that the students could search for information and identify it reliability.

Firstly, the students were asked to brainstorm with the search engines they know, and they were provided with examples of the most known ones. Then, the students were shown, through a presentation, how to carry out an Internet search safely, step by step. Some of the aspects highlighted were using keywords, checking the date of publication and

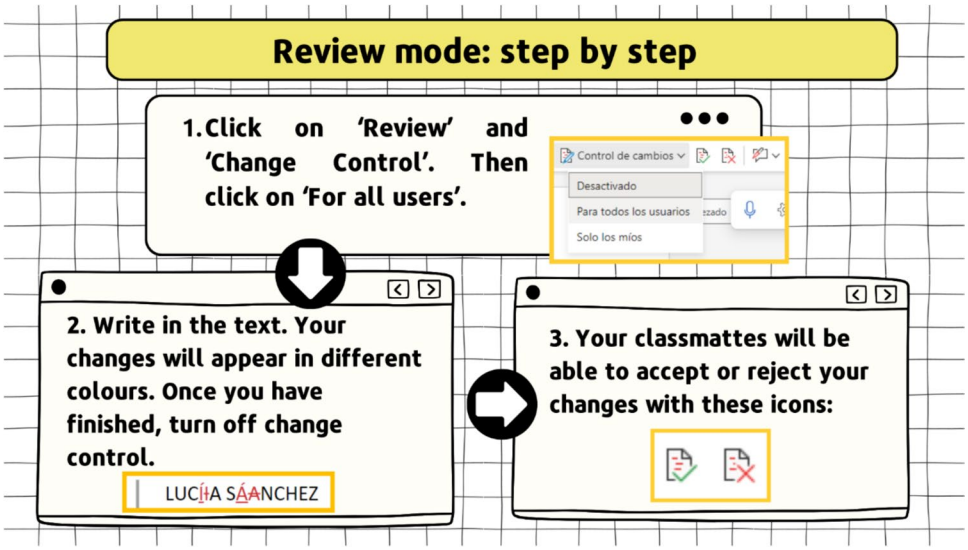

Fig. 2 Workshop 1 example

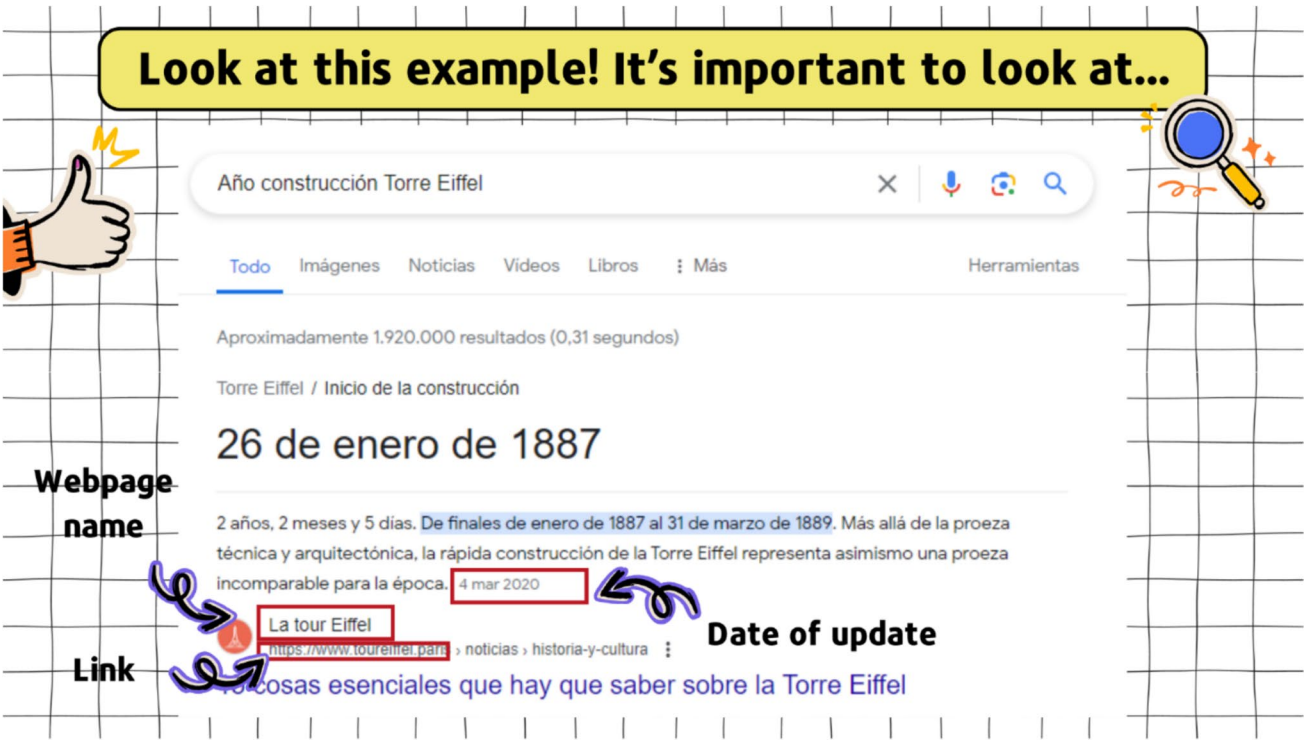

Fig. 3 Workshop 2 example

checking that the website visited is a reliable source. Figure 3 shows an example of an Internet search.

Finally, they were given a specific topic and some questions that needed to be addressed. To include a significant focus, the contents from the educational curriculum were used to conduct a targeted search. The search provided was based on the Sustainable Development Goals of Agenda 2030, but it is worth noting that the workshops are easily adapted to any topic during the academic course.

Workshop 3 This workshop covers Area 3 (Content Creation) to assure that the students learn to create content following and respecting copyright laws.

To achieve the objectives, the students were divided into groups of four and they were shown how to create a PowerPoint presentation step by step. To assure that they respected copyright laws they were provided with examples of free image banks and shown how to cite an author when reusing material. The final exercise in this workshop was to create a presentation using the information they had saved in the previous workshop. To do so, the students needed to use images respecting copyright laws and share their final work. Figure 4 shows an example explaining what copyright is.

Workshop 4 Workshop 4 is designed to cover Areas 4 (Safety) and 5 (Problem Solving), as they are highly related. The students need to learn how to use Internet safely and how to solve the specific problems that can emerge when using technology.

The students were shown the main potential risks they can encounter when using the Internet covering different topics such as social media, viruses or identity fraud. A presentation and a brief video were shown to raise consciousness about them. They also were provided with some examples concerning possible problems they may encounter when using digital devices. Examples of these problems are the use of settings options, software or antivirus programs.

Finally, they were given a Breakout Edu, through the platform *Genially,* where they needed to answer questions related to the previously explained topics. Figure 5 shows an example of the Breakout Edu prepared for the students in the mentioned platform.

All the material is available at: https://procomun.intef.es/ode/view/es_2024111912_9172856.

Results

Data Analysis

To answer the research objectives proposed for this study, the validated questionnaire ECODIES was employed, before and after the educational program. To evaluate the reliability and assess the significance of the results obtained, an inferential analysis was conducted. To answer RO1 a paired-sample t-test was conducted. To address RO2, a paired t-test was conducted to examine the differences between the pretest and posttest results based on gender, and independent t-tests were also performed on both the pretest and posttest results to compare differences between males and females. Cohen's d was used as a measure of effect size. The interpretation of the results has been carried out using the benchmarks proposed by Cohen (1988), considering small (0.2), medium (0.5), and large (0.8) effect sizes, while the p-value was based on Fisher (1925), with statistical significance considered at $p < 0.05$.

Fig. 4 Workshop 3 example

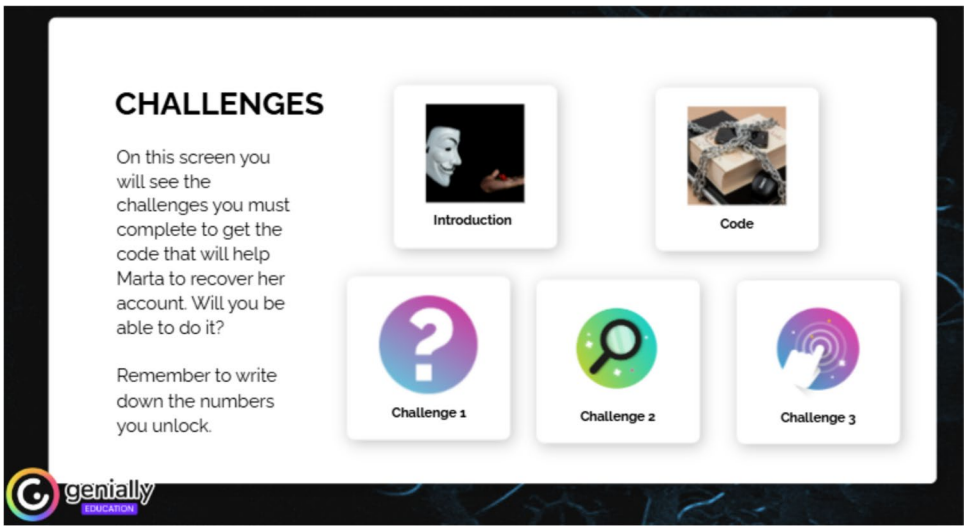

Fig. 5 Workshop 4 example

Table 4 Descriptive statistics by dimension in pretest and posttest

Dimension	M		SD		Comparison
	Pre	Post	Pre	Post	
Area 1	3.28	4.87	3.13	3.54	$p < .0001$, $d = 0.46$
Area 2	5.95	6.41	1.81	2.39	$p = 0.006$, $d = 0.29$
Area 3	4.55	5.37	1.92	2.15	$p < .0001$, $d = 0.54$
Area 4	5.61	6.49	2.18	2.57	$p < .0001$, $d = 0.49$
Area 5	2.68	2.67	2.51	2.50	$p = 0.910$, $d = -0.01$
Global	4.95	5.66	1.34	1.91	$p < .0001$, $d = 0.59$

Impact of an Educational Program on Students' DC

In order to diagnose the impact on the development of the participants'DC (RO1), as previously mentioned, a paired-samples t-test was conducted for each area and for the overall score, comparing the pretest and posttest scores. Table 4 shows, for each dimension and for the total score, the mean (M) and standard deviation (SD) comparing pretest and posttest.

The educational program had a positive and significant impact on most areas of DC, especially on Area 1 (Information and Data Literacy), Area 3 (Digital Content Creation), Area 4 (Safety), and the global media of DC. Area 2 (Communication and Collaboration) showed a significant improvement, but with a smaller effect size. Conversely, Area 5 (Problem Solving) did not show any significant improvement, indicating that the intervention did not affect this particular competence. The following graph (Fig. 6) clearly shows the evolution of the students in each area.

Gender Differences in the Students' DC Level

In order to study possible gender differences in the students' DC level (RO2), Table 5 shows the existing differences between male and female students. A comparison between pretest and posttest according to gender and each area of the DigComp is shown below.

Pretest results show that both the male and female students had a similar level of DC, as there are non-significant differences between them, except for Area 1, where there was a moderate difference in favour of male students (0.69).

After the implementation of the educational workshops, and examining posttest results, it can be seen that female students obtained, in general, higher marks than male students. The most pronounced difference was observed in Area 4 during the posttest, favouring females (1.05). Furthermore, the analysis reveals moderate gender difference in Area 1 (Information and Data Literacy) (0.84) and global scores (0.64), where females exhibited higher scores in the posttest. Area 2 also shows a moderate difference (0.70) in favour of females. However, Areas 3 and 5 show non-significant differences.

Comparing the general results of the pretest and posttest it can be seen that both genders were favoured by the educational workshop intervention. In general terms, it can be seen that female students mostly benefited from the educational workshops compared to male students. Figure 7 represents, by gender and size, the average before and after the implementation of the workshops.

During the pretest, no significant differences were found between the males and females in any of the analysed variables. For the global score, the analysis did not reveal any significant differences related to gender ($t(124) = -0.2$, $p = 0.9$). Similarly, no statistical differences were observer for any of the areas. Concerning the impact of the workshops, in

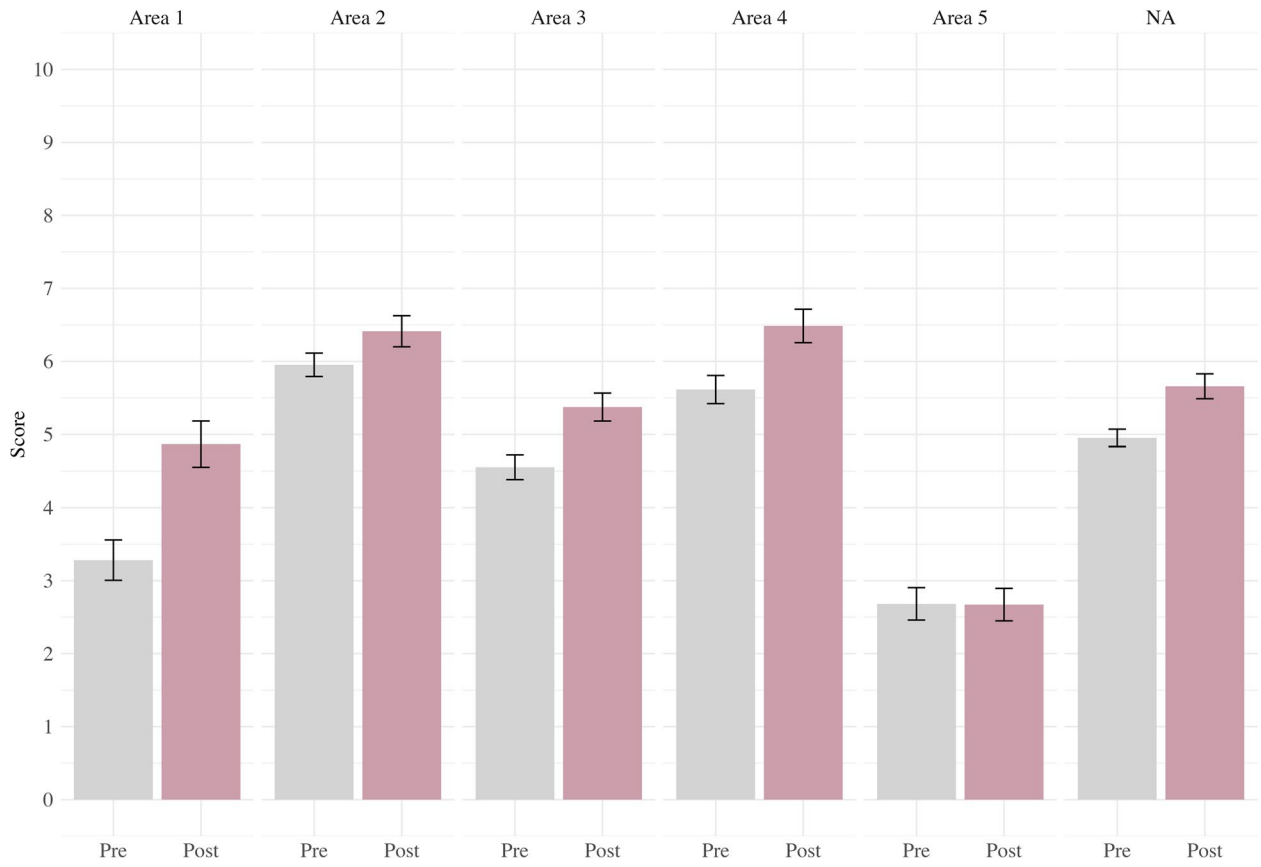

Fig. 6 Mean and standard error of DC in pretest and posttest

Table 5 Descriptive statistics by dimension and gender

Dimension	Gender	M		SD	
		Pre	Post	Pre	Post
Area 1	Female	2.98	5.30	1.32	1.70
	Male	3.67	4.46	3.10	3.30
Area 2	Female	5.94	6.93	1.70	2.24
	Male	5.97	6.23	1.94	2.34
Area 3	Female	4.76	5.71	1.91	2.00
	Male	4.36	5.25	1.94	2.21
Area 4	Female	5.46	7.05	2.25	2.24
	Male	5.76	6.00	2.14	2.78
Area 5	Female	2.73	2.51	2.40	2.33
	Male	2.56	2.80	2.63	2.68
Global	Female	4.93	6.07	1.32	1.70
	Male	4.97	5.43	1.37	2.02

the global score the females showed a significant improvement from the pretest to the posttest ($t(113) = -4.0$, $p < 0.001$), with a medium effect size ($d = -0.75$). In contrast, the males did not exhibit a significant difference between the pretest and the posttest ($t(96) = -1.0$, $p = 0.2$), with a small effect size ($d = -0.27$). For Area 1, the effect was more pronounced for the females. The females' scores significantly increased from the pretest to the posttest ($t(125) = -4.0$, $p < 0.001$, with a medium effect size ($d = 0.73$). The males, however, did not show a significant difference between the pretest and the posttest ($t(114) = -1.0$, $p = 0.2$, with a small effect size ($d = 0.23$). Concerning Area 2, both the females and the males experienced improvements, but only the females showed a significant change. The females improved significantly from the pretest to the posttest, $t(112) = -3.0$, $p = 0.006$, with a medium effect size ($d = -0.50$). The males did not show a significant difference between the pretest and the posttest, $t(114) = -0.7$, $p = 0.5$, with a negligible effect size ($d = -0.12$). In Area 3, males and females demonstrated significant gains, but the females' improvement was slightly greater. The females' scores improved from the pretest ($M = 4.76$) to the posttest ($M = 5.71$), $t(125) = -3.0$, $p = 0.007$, with a small effect size ($d = -0.49$). The males also improved from the pretest ($M = 4.36$) to the posttest ($M = 5.26$), $t(114) = -2.0$, $p = 0.02$, with a small effect size ($d = -0.43$). For Area 4, the females experienced a substantial improvement, whereas the males showed no significant change. The females improved significantly from the pretest to the posttest ($t(125) = -4.0$, $p < 0.001$), with a medium effect size ($d = -0.71$). The males did

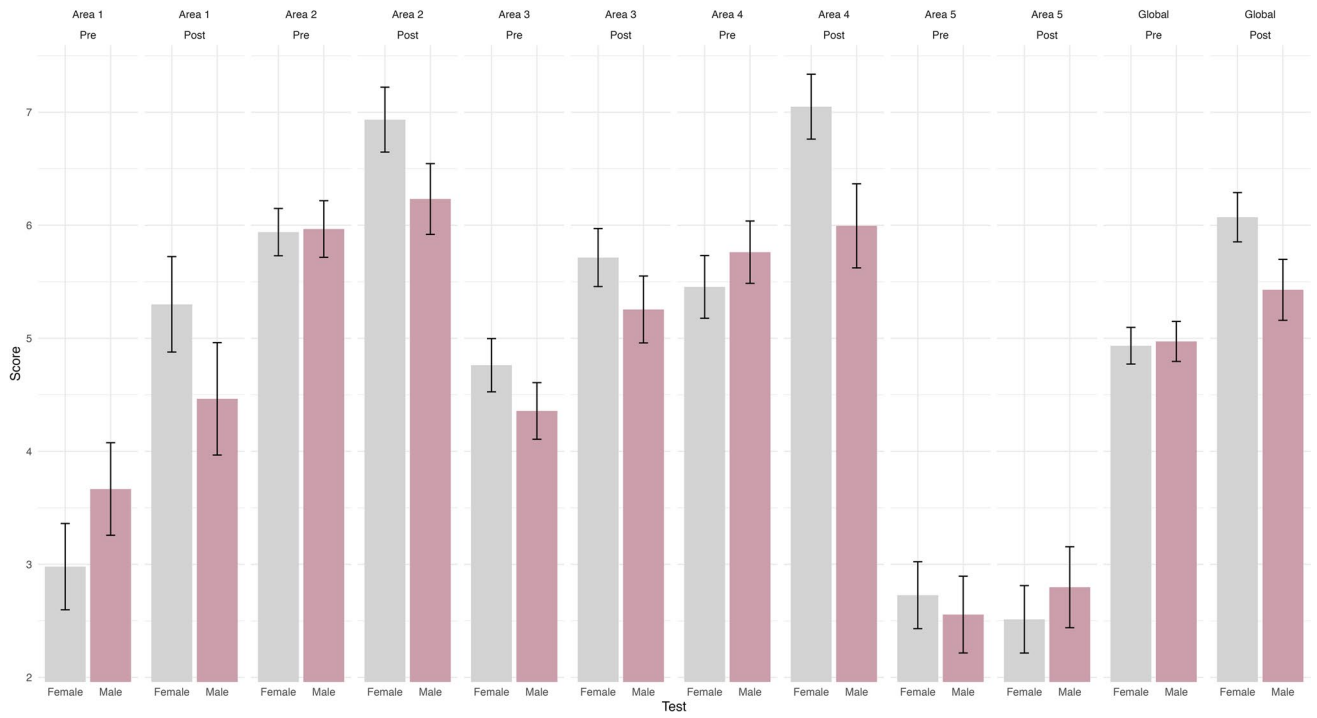

Fig. 7 Mean and standard of DC variables by test and gender

not exhibit significant differences between the pretest and posttest ($t(114) = -0.5$, $p = 0.6$), with a negligible effect size ($d = -0.09$). Lastly, in Area 5, neither the females nor the males showed significant improvements. The females' scores slightly decreased from the pretest to the posttest ($t(125) = 0.5$, $p = 0.6$), with a negligible effect size ($d = 0.09$). The males' scores increased slightly from the pretest to the posttest ($t(114) = -0.5$, $p = 0.6$, with a negligible effect size ($d = -0.09$). In summary, the educational program proposed led to significant gains in most areas of DC for females, with medium effect sizes in global scores, Areas 1, 2 and 4. The males, on the other hand, showed significant improvement only in Area 3, with small effect sizes or negligible gains in other areas. This comparison suggests that the intervention was more effective for females overall.

In the posttest, the difference in global DC between females and males approached significance, with females outperforming males. Although the difference was not statistically significant ($t(115) = 2.0$, $p = 0.06$), the medium effect size (Cohen's $d = 0.75$) suggests that the females showed a meaningful advantage over the males in this area after the intervention. For Area 1, the females performed better than the males, but the difference did not reach statistical significance ($t(115) = 1.0$, $p = 0.2$). However, the effect size (Cohen's $d = 0.73$) indicates that there was still a moderate advantage for the females. In Area 2, the results showed no significant difference between the males and females ($t(115) = 2.0$, $p = 0.1$). However, the medium effect size (Cohen's $d = 0.50$) suggests that the females tended to perform better than the males. In Area 3, no significant difference was found between the males and the females in the posttest ($t(115) = 1.0$, $p = 0.2$). The small effect size (Cohen's $d = 0.49$) suggests that the females may have performed slightly better, but the difference was not large enough to be statistically significant. In Area 4, a significant difference was found between the females and the males in the posttest ($t(106) = 2.0$, $p = 0.03$), with the females clearly outperforming the males. The effect size (Cohen's $d = 0.71$) was medium, indicating a substantial advantage for the females in this area. In Area 5, no significant difference was observed between the males and females in the posttest ($t(115) = -0.6$, $p = 0.5$, with a negligible effect size ($d = 0.09$).

Table 6 presents the means of the student satisfaction questionnaire concerning the educational program from the questionnaire results. As shown, the average scores indicate generally positive perceptions across various aspects of the workshops. The highest averages are related to the role of instructors ($M = 4.44$), the way the workshops were conducted ($M = 4.33$), the materials and resources employed ($M = 4.28$), the overall learning environment ($M = 4.25$) and the clarity of instructions ($M = 4.14$), reflecting strong approval of the educational instruction. Meanwhile, lower averages are observed in areas such as the applicability of what was learned in daily life ($M = 3.60$), and its connection to life outside of school ($M = 3.95$), suggesting that while participants valued the workshops, these areas need improvement

Table 6 Satisfaction questionnaire results

Item	M			
	W1	W2	W3	W4
How interesting did you find the topics covered in the workshops?	3.81	3.53	4.02	4.39
Do you think what you have learned will be useful in the future?	3.85	3.71	3.91	4.13
The instructions for the workshop tasks were clear	4.12			
I understood the instructions given in the workshops	4.14			
I use what I learned in the workshops in my daily life	3.60			
I can make connections between what I learned in the workshops and my life outside school	3.95			
What I learned in the workshops is useful	3.90			
How would you rate the way the workshops were conducted?	4.33			
Were the materials and resources used in the workshops adequate?	4.28			
Were the instructors in the workshops clear in their explanations and supportive of your questions? How would you evaluate their role?	4.44			
Was the environment in the workshops positive and conducive to learning?	4.25			

in order to identify the potential and use of their digital skills in practical contexts. Regarding the workshops, it can be appreciated that workshops 3 and 4 were considered to be the most interesting for the students with an average of 4.02 and 4.39, respectively. Table 6 shows the scores obtained below.

Beyond the students' evaluation test results, based on the open-ended question in the questionnaire, most of students choose not to give more information. However, what is impressive is that students who answered this question expressed high satisfaction with the experience and a demand for more educational workshops.

Discussion

The presented educational program was designed, as a consequence of the low level of DC among transitioning primary education students, as a tool to improve their DC skills. Considering the different areas of DC, the results show that students improved in most of the DC areas of the DigComp framework, except Areas 2 and 5. Of note are the pronounced differences observed in Area 1. In Areas 3 and 4 moderate differences can be appreciated comparing the pretests and posttests. These results suggest that educational programs, like the one proposed in this study, can help students to improve their DC level.

It can be seen that the most difficult area for the students was Area 5. In fact, this is the only area in which the students did not make any significant improvement. Mena Marcos (2020) obtained similar scores, showing in their studies that Area 5 had the lowest averages for students. Different authors support these results suggesting that students tend to have low levels of critical thinking skills (Machete & Turpin, 2020) and problem-solving areas are the least studied in the educational field (Godaert et al., 2022). Following this idea, Jonassen (2011) emphasizes that problem solving is not a generic skill that can be taught in isolation, but rather a complex skill that requires repeated exposure and practice across different domains and levels of education. Furthermore, his work frames technical problem solving –and, therefore, more aligned with DC– as a specific typology that shares similarities in cognitive processes with other problem categories (Jonassen, 2007). Blanc et al. (2025) consider that although problem-solving ability is essential for coping with everyday tasks, it is still a challenge to introduce it in class for teachers. This fact demonstrates the need to implement similar educational interventions to the one presented in this study from early stages of primary education, to improve this area for students and provide them with the necessary digital skills for secondary education. Furthermore, following the idea of Ertl et al. (2020) concerning the new digital divide produced because of the lack of digital competences, implementing these kinds of strategies at schools and high schools could minimize that existing gap through education.

Regarding gender, the results of this study have demonstrated that female students obtained major benefits from the educational workshops implemented, as their scores in the posttest on the ECODIES test employed outperformed the male students in most of the areas. These results corroborate the idea of Mena Marcos (2020), who highlighted that female students outperformed male students in most of the areas. However, it contradicts the findings of studies such as Niño-Cortés et al. (2023), in which male students obtained a higher level of DC compared to females. It is also noteworthy to consider the difference between perception and skills, as primary education males tend to outperform in attitude and problem-solving skills (Maon et al., 2021;

Mena Marcos, 2020) whereas female students obtained higher results when considering DC levels in general (Siddiq & Scherer, 2019).

It is necessary to highlight that this study focuses on the primary education stage; therefore, the observation made by Perifanou and Economides (2020), which pointed out that female students begin to lose interest in ICT skills during secondary education, cannot be assessed. Future studies could focus on this last stage. Education can act as a social equalizer to avoid possible emerging gender gaps, and initiatives like the educational program proposed in this study, aim to improve the DC level of all students and provide them with equal opportunities. The present proposal aligns with other initiatives such as the common DC framework for primary and secondary education developed by Guitert et al. (2021), helping educators to establish a solid base for students' knowledge between these two educational stages.

Finally, following the question posed by Passey (2014) concerning the possibility of using technology as a valuable tool to support the transition process, the present study suggests that promoting educational programs could be a good resource to avoid gaps in this important moment in students' lives. In fact, different authors have highlighted the need for more studies which examine students' DC to obtain data for schools and educators (Calvani et al., 2012; Godaert et al., 2022). In this framework, diagnosing students' DC level could be useful for schools to develop specific educational programs, similar to the one suggested in this research, which help students to improve their digital skills and facilitate primary to secondary school transition. The materials designed for this study are available in an open repository and can be adapted to different educational contexts.

Limitations and Future Research

It is remarkable that the transversal perspective of introducing digital skills in the current educational system could generate limitations on students' DC acquisition. The main aim of this study was to provide students with the necessary tools to acquire a competent level of DC to help them in the transition from primary to secondary education. The case study design allows the testing of the differences gained in each area after the implementation of the educational program, and it has been shown that it could be usefully employed in the future in other primary schools. In fact, this study aims to follow the transitioning students in their secondary education in order to observe possible improvements in their CD level and avoid generating possible emerging gaps. From a digital education policy perspective, this study provides findings for curricular strategies that progressively integrate DC training, ensuring coherence across educational levels.

The results of this study suggest that DC Area 5 has not been improved on by students, this being the only area where the participants did not improve their score. This leads one to reflect on the workshop design, revealing the need to dedicate an entire workshop to this area. As explained in the Discussion sections, it would be essential to develop more educational programs covering this specific area, as it is one of the most difficult ones for students.

Conclusions of this study indicate that female students obtained higher scores than male students in the DC test. The gender results of this study highlight the need for further similar studies, which measure both students'level of DC and their perception and attitudes towards it. Furthermore, introducing the variable of academic results could add value to future studies. It is noteworthy that the complementary satisfaction questionnaire was conducted without specifying gender, which prevents the establishment of a correlation between DC skills and attitude. For future research, taking this factor into account is recommended.

As future research lines, this study has provided evidence-based, open-access educational materials designed to develop students' DC. The educational program proposed is replicable in nature, and its brevity (four workshops) allows its implementation in different contexts. Therefore, we encourage future educators to conduct further studies on this topic. Experimental designs which allow the comparison with other proposals would be enriching to establish common research lines.

Acknowledgements This work was supported by the [University of Castilla-La Mancha] and by the [European Regional Development Fund (ERDF)] under Grant [2022-GRIN-34039]; by [MCIN/AEI/110.13039/501100011033] and by the [European Union NextGenerationEU/PRTR under Project TED2021-131557B-I00]; by the [Ministry of Education, Culture and Sports of Spain under Grant FPU19/03857]; and by the [European Union NextGeneration-EU under research contract 2022-INVGO-11124].

Funding Open Access funding provided thanks to the CRUE-CSIC agreement with Springer Nature. This work was supported by the University of Castilla-La Mancha and the European Regional Development Fund (ERDF), under Grants 2022-GRIN-34039 and 2022-GRIN-34119; and project PID2023-150960NB-I00, funded by the Spanish Ministry of Science, Innovation and Universities and the European Union. This research has been conducted within the framework of the collaboration agreement between the Council of Education, Culture, and Sports of the Government of Castilla-La Mancha and the University of Castilla-La Mancha. Open Access funding provided by University of Castilla-La Mancha thanks to the CRUE-CSIC agreement with Springer Nature.

Data Availability All data provided in this article support the published claims and comply with field standards. The material provided in the data repository is original and respects copyright licenses. https://procomun.intef.es/ode/view/es_2024111912_9172856.

Declarations

Ethics Approval This study has been approved by the appropriate institutional research ethics committee. Approval was granted by the educational administration of Castilla-La Mancha (Spain) and the Social Research Ethics Committee of the University of Castilla-La Mancha (reference number: CEIS-632778-Q8T4).

Competing interests The authors have no competing interests to declare that are relevant to the content of this article.

References

Acuña-Torres, L. A., Flores-Pezo, R., Lazo-García, B. I., & Rivera-Campano, M. R. (2024). Impact of Technological Tools for Reading Comprehension in Post-Pandemic Schoolchildren. *International Journal of Religion, 5*(9), 411–424. https://doi.org/10.61707/0ebepr62

Francés, M. Á., Pérez, M. C. S., & Baquero, A. B. (2022). Factores que facilitan y dificultan la transición de educación primaria a secundaria. *Revista de Investigación Educativa, 40*(1), 147–164. https://doi.org/10.6018/rie.441441

Blanc, S., Conchado, A., Benlloch-Dualde, J.V., Monteiro, A. & Grindei, L. (2025). Digital competence development in schools: a study on the association of problem-solving with autonomy and digital attitudes. *International Journal of STEM Education, 12* (13). https://doi.org/10.1186/s40594-025-00534-6.

Bonfield, C. A., Salter, M., Longmuir, A., Benson, M., & Adachi, C. (2020). Transformation or evolution?: Education 4.0, teaching and learning in the digital age. *Higher Education Pedagogies, 5*(1), 223–246. https://doi.org/10.1080/23752696.2020.1816847

Buchan, M.C., Bhawra, J. & Katapally, T.R. (2024). Navigating the digital world: development of an evidence-based digital literacy program and assessment tool for youth. *Smart Learning Environments, 11*(8). https://doi.org/10.1186/s40561-024-00293-x.

Calvani, A., Fini, A., Ranieri, M. & Picci, P. (2012). Are young generations in secondary school digitally competent? A study on Italian teenagers. *Computers & Education, 58.* https://doi.org/10.1016/j.compedu.2011.10.004.

Campos, D. G., & Scherer, R. (2023). Digital gender gaps in Students' knowledge, attitudes and skills: An integrative data analysis across 32 Countries. *Education and Information Technologies, 29*, 655–693. https://doi.org/10.1007/s10639-023-12272-9

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* (2nd ed.). Lawrence Erlbaum Associates.

Cranmer, S. (2014). Digital Skills and Competencies in Schools. In D. Passey & A. Tatnall (Eds.), *Key Competencies in ICT and Informatics: Implications and Issues for Educational Professionals and Management* (pp. 165–176). Springer.

Donaldson, C., Moore, G., & Hawkins, J. (2023). A Systematic Review of School Transition Interventions to Improve Mental Health and Wellbeing Outcomes in Children and Young People. *School Mental Health, 15*, 19–35. https://doi.org/10.1007/s12310-022-09539-w

Ertl, B., Csanadi, A., & Tarnai, C. (2020). Getting closer to the digital divide: An analysis of impacts on digital competencies based on the German PIAAC sample. *International Journal of Educational Development, 78*, 102259. https://doi.org/10.1016/j.ijedudev.2020.102259

Estrada, J. M., & Bennasar García, M. I. (2021). Formación educativa en y desde las Tecnologías de Información y Comunicación (TIC) en educación secundaria: El reto de hoy. *Revista Educación, 45*(2), 491–505. https://doi.org/10.15517/revedu.v45i1.43424

European Commission. (2020). Digital education action plan (2021–2027). Retrieved December, 2024, from https://education.ec.europa.eu/focus-topics/digital-education/action-plan

European Commission and Directorate-General for Education, Youth, Sport and Culture. (2019). Key competences for lifelong learning. Publications Office. Retrieved December, 2024, from https://data.europa.eu/doi/10.2766/569540

Fabuel, V. (2015). Una reflexión sobre las transiciones educativas de primaria a secundaria ¿Traspaso o acompañamiento?. *Edetania, 48,* 159–183.

Feijao, C., Flanagan, I., Van Stolk, C., & Gunashekar, S. (2021). The global digital skills gap: Current trends and future directions. RAND Corporation. Retrieved December, 2024, from https://www.rand.org/pubs/research_reports/RRA1533-1.html

Fernández-Montalvo, J., Peñalva, A., Irazabal, I., & López- Goñi, J. J. (2017). Effectiveness of a digital literacy program for primary education students. *Cultura y Educación, 29*(1), 1–30. https://doi.org/10.1080/11356405.2016.1269501

Fisher, R. A. (1925). *Statistical Methods for Research Workers*. Oliver & Boyd.

Godaert, E., Aesaert, K., Voogt, J., & van Braak, J. (2022). Assessment of students' digital competences in primary school: A systematic review. *Education and Information Technologies, 27*, 9953–10011. https://doi.org/10.1007/s10639-022-11020-9

Guitert, M., Romeu, T., & Baztán, P. (2021). The digital competence framework for primary and secondary schools in Europe. *European Journal of Education., 56*, 133–149. https://doi.org/10.1111/ejed.12430

Haddon, L., Cino, D., Doyle, M-A., Livingstone, S., Mascheroni, G., & Stoilova, M. (2020). *Children's and young people's digital skills: a systematic evidence review.* Youth Skills project results in Work Package 2—Deliverable 2.1. https://doi.org/10.5281/zenodo.4160176.

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers, 3*, 275–285. https://doi.org/10.1016/j.susoc.2022.05.004

Hernández Martín, A. & Iglesias Rodríguez, A. (Eds.). (2020). *Evaluación de las competencias digitales de estudiantes de educación obligatoria: Diseño, validación y presentación de la prueba Ecodies.* Octaedro.

Iglesias Rodríguez, A., Martín González, Y., & Hernández Martín, A. (2023). Evaluación de la competencia digital del alumnado de Educación Primaria. *Revista De Investigación Educativa, 41*(1), 33–50. https://doi.org/10.6018/rie.520091

Jonassen, D. H. (2007). Engaging and supporting problem solving in online learning. In R. Luppicini (Ed.), *Online Learning Communities* (pp. 109–127). Information Age Publishing.

Jonassen, D. H. (2011). *Learning to solve problems A: Handbook for designing problem-solving learning environments*. Routledge.

Kay, R., & Knaack, L. (2009). Assessing learning, quality and engagement in learning objects: The Learning Object Evaluation Scale

for Students (LOES-S). *Educational Technology Research and Development, 57*, 147–168. https://doi.org/10.1007/s11423-008-9094-5

Lippe, M., Johnson, B., & Carter, P. (2019). Protecting Student Anonymity in Research Using a Subject-Generated Identification Code. *Journal of Professional Nursing, 35*, 120–123.

Machete, P., & Turpin, M. (2020). The use of critical thinking to identify fake news: A systematic literature review. *Responsible Design, Implementation and Use of Information and Communication Technology, 12067*, 235–246. https://doi.org/10.1007/978-3-03045002-1_20

Maon, S. N., Mohd Hassan, N., Mohamad Yunus, N., Abdul Kader Jailani, S. F. S., & Suzila Kassim, E. (2021). Gender Differences in Digital Competence Among Secondary School Students. *International Journal of Interactive Mobile Technologies (iJIM), 15*(04), 73–84. https://doi.org/10.3991/ijim.v15i04.20197

Mena Marcos, J.J. (2020). Influencia de la variable género en el nivel de rendimiento y la actitud de alumnos de secundaria en competencias digitales: resultados encontrados a partir de la aplicación de la prueba Ecodies. En A. Hernández Martínez & A. Iglesias Rodríguez (Eds.), *Evaluación de las competencias digitales de estudiantes de educación obligatoria* (pp. 117–134). Octaedro.

Ministerio para la Trasformación Digital y de la Función Pública. (2024). *Brecha digital de género Edición 2024 - Datos 2023.* Observatorio Nacional de Tecnología y Sociedad. Red.es. Secretaría de Estado de Digitalización e Inteligencia Artificial.

Niño-Cortés, L. M., Grimalt-Álvaro, C., Lores-Gómez, B., & Usart, M. (2023). The digital gender gap in secondary school: Differences in self-perceived competence and attitude towards technology. *Educación XXI, 26*(2), 299–322. https://doi.org/10.5944/educxx1.34587

OECD. (2015). "Inequalities in Digital Proficiency: Bridging the Divide". In *Students, Computers and Learning: Making the Connection,* OECD Publishing, Paris. https://doi.org/10.1787/9789264239555-8-en.

Passey, D. (2014). Life Transitions, Learning and Digital Technologies –Common Threads and Conceptions. In D. Passey & A. Tatnall (Eds.), *Key Competencies in ICT and Informatics: Implications and Issues for Educational Professionals and Management* (pp. 139–149). Springer.

Perifanou, M.A. & Economides, A.A. (2020). Gender Digital Divide in Europe. *International Journal of Business, Humanities and Technology, 10*(4). https://doi.org/10.30845/ijbht.v10n4p2.

Prensky, M. (2012). *From Digital Natives to Digital Wisdom. Hopeful Essays for 21st Century Education*. Corwin Press.

Real Decreto 157/2022, de 1 de marzo, por el que se establece la ordenación y las enseñanzas mínimas de la Educación Primaria. *Boletín Oficial del Estado, 52*, de 2 de marzo de 2022. Retrieved November, 2024, from https://www.boe.es/eli/es/rd/2022/03/01/157/con

Siddiq, F. & Scherer, R. (2019). Is there a gender gap? a meta-analysis of the gender differences in stu- dents' ICT literacy. *Educational Research Review*, 205–217. https://doi.org/10.1016/j.edurev.2019.03.007.

Stake, R. E. (2006). *Investigación con estudio de casos*. Morata.

Van Deursen, A. & van Dijk, J. (2010). Internet skills and the digital divide. *New Media & Society, 13*. https://doi.org/10.1177/1461444810386774.

Van Laar, E., van Deursen, A. J. A. M., van Dijk, J. A. G. M., & de Haan, J. (2017). The relation between 21st-century skills and digital skills: A systematic literature review. *Computers in Human Behavior, 72*, 577–588. https://doi.org/10.1016/j.chb.2017.03.010

Vuorikari, R., Kluzer, S. & Punie, Y. (2022). DigComp 2.2: The digital competence framework for citizens - with new examples of knowledge, skills and attitudes. Publications Office of the European Union. Retrieved December, 2024, from https://publications.jrc.ec.europa.eu/repository/handle/JRC128415

West, M., Kraut, R., & Chew, H. E. (2019). I'd blush if I could: Closing gender divides in digital skills through education. UNESCO. Retrieved December, 2024, from https://www.equalsintech.org/i-d-blush-if-i-could

Xing, B., & Marwala, T. (2017). Implications of the fourth industrial age for higher education. *The Thinker, 73*, 10–15. Retrieved November, 2024, from https://ssrn.com/abstract=3225331