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Effectiveness of a digital literacy program in High School Basic education students

Eficacia de un programa de alfabetización digital en estudiantes de educación básica de secundaria

Ana Bertha Betín De La Hoz[1], Antonio Rodríguez Fuentes[2], María Jesús Caurcel Cara[2], and Carmen del Pilar Gallardo Montes[2]

[1]Secretary of Education, Bogota, Colombia; [2]University of Granada, Granada, Spain

Abstract

The digital divide excludes more people every day, becoming a new form of social exclusion, impeding the development of countries and progress towards a more equitable society. This research aims to evaluate the effectiveness of an intervention program that allows the development of digital skills in students at High School Basic Education. A quasi-experimental methodology is followed with repeated evaluation measures in three control groups and three experimental groups. The selection of the groups was carried out through an intentional non-probability sampling, reaching a participation of 204 students, of which 55.9% were male and 44.1% were female from 11 to 19 years old (M = 14.1; SD = 2.24). The assessment was conducted using the ECODIES instrument at their educational institution. After confirming the data non-normality (Kolmogorov-Smirnov test), non-parametric descriptive and inferential analyses were performed (Mann-Whitney U test and Wilcoxon test), as well as the effect size calculation using Cohen's d. The results showed the existence of statistically significant differences in the experimental groups before and after the application of the program, unlike the control groups. This indicates that the students of the experimental groups achieved a higher degree of digital literacy than the control group after their participation in the intervention. It is concluded that the training programs that seek the development of digital skills integrated into the school curriculum positively influence the degree of ICT literacy of the educational community, and thereby contributes to mitigate the digital divide.

Keywords*:* Digital literacy; High School Education; Intervention program; Digital competence

Resumen

La brecha digital excluye cada día a más personas, convirtiéndose en una nueva forma de exclusión social, impidiendo el desarrollo de los países y el avance hacia una sociedad más equitativa. Esta investigación pretende evaluar la efectividad de un programa de intervención que permita el desarrollo de competencias digitales en estudiantes de Educación Media Básica. Se sigue una metodología cuasi-experimental con medidas de evaluación repetidas en tres grupos de control y tres grupos experimentales. La selección de los grupos se realizó a través de un muestreo no probabilístico intencional, alcanzando una participación de 204 estudiantes, de los cuales el 55.9% fueron hombres y el 44.1% mujeres, con edades comprendidas entre los 11 y 19 años (M = 14.1; DT = 2.24). La evaluación se realizó con el instrumento ECODIES en su institución educativa. Tras comprobar la ausencia de normalidad de los datos (prueba de Kolmogorov-Smirnov), se realizaron análisis descriptivos e inferenciales no paramétricos (prueba U de Mann-Whitney y Wilcoxon), así como el cálculo del tamaño del efecto mediante la d de Cohen. Los resultados mostraron la existencia de diferencias estadísticamente significativas en los grupos experimentales antes y después de la aplicación del programa, a diferencia de los grupos de control. Esto indica que los alumnos de los grupos experimentales alcanzaron un mayor grado de alfabetización digital que el grupo de control tras su participación en la intervención. Se concluye que los programas formativos que persiguen el desarrollo de competencias digitales integrados en el currículo escolar influyen positivamente en el grado de alfabetización TIC de la comunidad educativa, contribuyendo así a mitigar la brecha digital.

Palabras clave: Alfabetización digital; Educación Secundaria; Programa de intervención; Competencia digital.

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Correspondence: Carmen Pilar Gallardo-Montes, University of Granada, Spain
Email: cgallardo@ugr.es

Introduction

In recent decades, national and international educational policies have focused on the importance of integrating Information and Communication Technologies (ICT) into the educational curriculum. And, recently, in the need for students to develop digital competences, which can be acquired and developed in school through experience and instruction (Gonczi & Athanasou, 2009; Hager & Becket, 2009; Trujillo-Segoviano, 2014). Therefore, educational institutions play an important role in the development of these competencies from early stages (Aesaert, 2013; Munawaroh & Hernawan, 2022). Organizations such as the Organization for Economic Cooperation and Development (OECD, 2019), among the recommendations they offer to make lifelong learning accessible and relevant, highlight the development of high-quality basic skills and transversal skills such as digital, increasingly important, and fundamental for work and personal success, even for the same learning. However, beyond using technologies for teaching and learning, students, upon arriving at school, must acquire these skills and develop them through digital literacy programs (Casillas-Martín et al., 2022; Garcia et al., 2016; Kallas & Pedaste, 2022), product of a current educational curriculum and adjusted to the needs required by the knowledge society (Cabero-Almenara & Ruiz-Palmero, 2017).

Little by little, the myth of digital natives, synonymous with innately possessing the skills and knowledge necessary to face an increasingly digitized world, as opposed to that of digital immigrants, has become unfounded. This myth, for years, hid the need for planning and organizing specific learning processes in school for students to develop their digital competence (Sorrentino, 2018). During the COVID-19 pandemic, suffered during the years 2020-2021, the question of teachers at high school schools was very common: what happened to digital natives? Difficulties of these in the face of the change from face-to-face to virtuality. It was believed that it would be easy (Alonso-Ferreiro et al., 2020), but it was not. The fact of living in an increasingly digital environment does not necessarily imply the acquisition of the skills to make an appropriate, responsible, safe, critical, reflective, and profound use of ICTs (Iglesias et al., 2023; Kirschner & Bruyckere, 2017).

Digital literacy also occurs in spaces outside the school, a product of the constant interaction of young people with ICTs. De such a way, that students are acquiring and developing their digital skills, but evidencing shortcomings both intellectually and technically (Angulo et al., 2017; McDougall et al., 2018), due to the lack of guidance from their teachers, resulting in a low level of digital literacy. Therefore, for the acquisition and development of digital skills, a set of attitudes, knowledge and values are required, which converge in the creative, critical, ethical, responsible and safe use of ICT to achieve objectives related to employability, learning, leisure, professional and personal success, as well as social integration, facilitating adaptation to the new demands and changes brought about by the knowledge society (Fernández, 2018; Lucas, 2016). The formative processes in the school are indispensable to achieve this (López García et al., 2021).

Digital competence is essential for students. It allows them to participate actively and freely in a society surrounded by countless technologies, regardless of conditions such as gender, age or social status, in addition to favoring inclusion processes (European Commission, 2007; Cotino, 2020; Napal et al., 2018). Regardless of the disciplinary field, it is transversal and transferable to any context and field of knowledge (hence its denomination as basic, key, transversal competence, etc.), since it favors the acquisition of other specific competences and student performance (Sá & Serpa, 2018; Tapia, 2020). So, to obtain these benefits, it is necessary to change the objectives, methodology, evaluation, design of activities and incorporation of ICT in classroom practices, since digital literacy should not be summarized to a simple inclusion of these in the classroom (Higuera-Ruiz & Núñez-Delgado, 2022; Llorens & Alarcón, 2020; Pérez-Escoda et al., 2016). Those students who achieve this competence will have fewer difficulties and risks in digital environments. The benefits of digitalization are undeniable. In addition, countries and systems that fully embrace education that fosters the acquisition of digital skills will equip their students and future citizens with the skills needed to succeed personally and professionally (Lujan, 2016).

The school is considered as that ideal place where the different situations that affect, in one way or another, the academic performance of students and their personal development are detected (Raya & Escalona, 2013). One of those situations that currently contribute to inequality in society is the *digital divide*, not only because of access and lack of technological resources, but also because of the knowledge required. This was very noticeable in the confinement of the years 2020-2021. Thus, schools must play an important role in reducing this gap (Rodríguez, 2008).

Although there is little research related to the present, at the international level, from state policies, there are digital literacy plans for the population, in general, and for educational institutions according to needs, such as the Digital Education Action Plan (2021-2027), established by the European Commission (2020), with the firm intention of supporting all the educational systems of the member countries in training. of citizens' digital skills. As for Latin America, countries such as Mexico has the Federal Institute of Telecommunications (IFT, 2022), which developed the “Digital Literacy Program 2022", which continues to be implemented in 2023, whose objective is to provide digital skills to the community, in general, that allows them to participate in digital environments, in addition to contributing to the closing of the digital divide. All this through workshops, talks, courses and guides, tutorials. For its part, Peru has the "National Digital Literacy Plan" (PNAD), implemented in 2017 (Lapeyre, 2016) and complemented during the pandemic (2020-2022) with programs such as "Todos Conectados" and "Cultiva Talento Digital".

Finally, in Colombia, although the Ministry of National Education does not have guidelines for the acquisition and development of digital skills in the classroom, the Ministry of Information and Communication Technologies (MinTic, 2022) has been implementing a series of programs for some years such as: "Chicas Steam", "En TIC I trust", "Por TIC Mujer”, “With ICT senses", and "ICT training". All of them aimed at different social groups and with the firm intention of developing digital skills and allowing participation in different digital environments. At the local level, the city of Bogotá, its "Education Sector Plan 2020-2024", is committed to closing digital and scientific gaps, through the generation of processes that allow the development of digital skills in educational institutions (Sedbogotá, p. 67-68). Despite this, there is still room for improvement in this area, as evidenced by Betín et al. (2023).

Undoubtedly, the best programs will be those that are implemented from educational centers, even with external collaboration. An example of this is the DigiCraft program (Casillas-Martín et al., 2020), led by the Vodafone Foundation of Spain, which was evaluated by university professors and experts. This program was designed considering the DigCom 2.1 model, through the learning by doing methodology, whose objective was the training in the digital skills necessary for children and adolescents for social inclusion and thus address the problem of the digital divide that places them in a situation of *e-exclusion* (digital exclusion), affecting your personal and professional future. The program was implemented in educational institutions in seven Spanish provinces. In addition, it was integrated into the educational curriculum in another 50 educational institutions as a pilot project, evidencing an improvement in digital competences, especially in knowledge, in addition to developing other transversal competences, after the implementation of the program.

Based on the above, this research aims to assess the effectiveness of an intervention program for the improvement of digital skills, in the factors of *Knowledge* and *Attitudes*, in students at High school Basic Education. To do this, the results obtained before and after the program in the experimental groups that received the training are compared, in contrast to the control groups that did not receive it.

Method

The present study was framed within the quasi-experimental design, with repeated pre-test and post-test measures, for the equivalent control and experimental groups, applying a pretest (O) to all groups, then the treatment (X) only to the experimental group and, finally, a posttest (O) to all groups

(Montero and León, 2007). This method is justified since groups that are already integrated are taken into the classrooms; therefore, they are not randomly assigned (Campbell and Stanley, 1993).

Participants

The population under study was made up of 1081 students of High school Basic Education of a District Educational Institution (IED) of public character, located in the locality of Usme in the city of Bogotá (Colombia). A total of 204 students of Basic High school Education participated, obtaining a sufficiently representative sample size, with a sampling error of 1.9%, well below the 5% commonly accepted in educational research. The students belonged to the sixth, ninth and eleventh academic years. 44.1% (n = 90) were female, and 55.9% (n = 114) male. The ages of the students ranged from 11 to 19 years (M = 14.1; DT = 2.24). For the intervention and considering the learning levels of the DigCom 2.1 model (Carretero et al., 2017), the control (CG) and experimental (EG) groups were assigned in the levels: *Initial* (6th), *Intermediate* (9th) and *Advanced* (11th). The selection of the six groups was carried out by intentional non-probability sampling (Bisquerra & Alzina, 2012) (Table 1). During the academic year, the student population fluctuates in the educational institution, therefore, some were excluded since they did not complete the entire intervention, which is also known in this methodology as experimental mortality (Campbell & Stanley, 1993).

Therefore, inclusion criteria were: being enrolled in the educational institution being in the sixth, ninth, and eleventh grades, and having been present in all stages of the program (before, during, and after the intervention). Also, for students to access the post-test, they needed to have been present from the beginning.

In selecting the groups, the levels of learning according to the DigCom model (initial, intermediate, and advanced) were considered. For this reason, students from the sixth, ninth, and eleventh grades were selected.

Table 1

Students grouped according to learning level of the DigCom 2.1 model

Level of learning	Control group (CG)			Experimental group (EG)		
	n	**Girls (%)**	**Boys (%)**	***n***	**Girls (%)**	**Boys (%)**
Initial (6th) – Group 1	34	47.1	52.9	33	27.3	72.7
Intermediate (9th) – Group 2	33	39.4	60.6	33	48.5	51.5
Advanced (11º) – Group 3	36	52.8	47.2	35	48.6	51.4

Note: n = number of students in each group.

Instrument

The instrument "Evaluation of the Digital Competence of Students - ECODIES" (Casillas-Martín et al., 2019), used in this work, had as a reference the DigCom model, composed of five areas, three levels and three areas. In 2016, an update called the European Framework for Citizens' Digital Competence (DigCom 2.0) was published (Vuorikari et al., 2016), which retained practically the same structure as DigCom 1.0. Then came version 2.1 presented by Carretero et al. (2017). Finally, Vuorikari et al. (2022) presented the latest update, which is now known as DigCom 2.2, which has 21 competencies grouped into five areas.

The instrument consisted of 108 items discriminated between knowledge and attitudes (Table 2). A variable was created that added the correct items of ability and knowledge to obtain the average of each area: the correct answers were coded with "1" and the incorrect ones with "0", for a total score of 78 points. As for the attitudinal items, they were assessed using a Likert scale from 1 to 5: (1) strongly disagree, (2) disagree, (3) indifferent, (4) agree, (5) strongly agree. The maximum possible score was 30 points to obtain in each competency area, and 150 points in the total of the test.

Table 2
Number of items that make up the "ECODIES"

Areas of competence	Knowledge	Attitudes	Total
A1: Problem solving	16	6	22
A2: Information	12	6	18
A3: Safety	16	6	22
A4: Communication	18	6	24
A5: Content creation	16	6	22
Total	**78**	**30**	**108**

Note: Own elaboration.

The "ECODIES" test was created to be applied in the Spanish student population; Therefore, to be used in a different sample it needed to be validated for the new context, in this case, the Colombian one. The values obtained in the validation showed the good psychometric properties of the questionnaire, guaranteeing its validity and reliability to apply it to Colombian students (Betín et al., 2023). In the exploratory factor analysis (EFA), using the rotation method Varimax normalization with Kaiser, two factors were obtained: Factor 1 - "*Knowledge*" and Factor 2 - "*Attitudes*". In the KMO coefficient (Kaiser Mayer-Olsen), each of the competence areas oscillated between 0.598 and 0.755, considered between low and acceptable (>0.50). In the "*Attitudes*" test, a coefficient of 0.950 (excellent) was obtained. Bartlett's sphericity test indicated that the test was highly significant ($p<0.05$). These values indicated that the EFA was appropriate. The values obtained in the goodness adjustments in the confirmatory factor analysis (CFA) for 2 factors, were also very favorable and significant. The values in the RMSEA in each area were less than 0.05, in the CFI and TLI, higher than 0.9. The factor load values obtained in the analysis confirmed the location of the items in the factors that the EFA yielded. These values ranged from 0.036 to 0.083, considered acceptable and significant. Finally, the reliability analysis of internal consistency was calculated, using the Omega McDonald coefficient and the Cronbach Alpha, both in the two components ("*Attitudes*" and "*Knowledge*") and in the *Total Test*. The results in the "*Attitudes*" component and the complete test indicated a good level of reliability (>0.80) in both statistics. However, in the "*Knowledge*" component, not so good values were presented, especially in the Omega McDonald statistic. All these values accounted for the good psychometric properties of the "ECODIES" questionnaire, being validated for the Colombian student population.

Procedure

For data collection, it was endorsed by the Human Research Ethics Committee of the XXXX (2982/CEIH/2022), from where the research process was directed, and with the permission of the rectory of the educational institution, where it was applied, as well as with the informed consent of the families of the participating minors. The research was organized in three phases. The pretest questionnaire (Phase 1) was presented in the form of an online questionnaire, carried out in *Google Forms* for this purpose, and was administered to the groups of the *Advanced* level (11th grade) during the virtual classes of "Mathematics and Technology and Computer Science ", during the first semester of the 2021 school year, when schools were still in lockdown due to the Covid-19 pandemic. Subsequently, starting the 2022 school year, the administration of the questionnaire was completed with the rest of the groups: *Initial* (6th) and *Middle* (9th) in person.

The training intervention (Phase 2) for the acquisition and development of digital skills lasted 14 sessions of 110 minutes each (stipulated by the educational institution) for the *Advanced* level group, in virtual mode. Subsequently, during the first semester of the 2022 school year, the intervention was carried out in parallel at the *Initial* and *Middle* levels with a duration of 13 and 14 sessions, respectively, in face-to-face mode. The experimental groups received the intervention without discarding the contents of the curriculum of the subject of Computer Science. Therefore, considering the areas, competences, knowledge, skills, and attitudes of the DigCom 2.1 model and the contents of the subject, work sessions were planned for the classroom and outside it (objectives, contents, activities, and evaluation) (Table 3). All the intervention was carried out from the areas of Mathematics and Technology and Information Technology and, more specifically, in the subject of Computer Science. This also allowed to articulate the contents of the s subject with the proposed guidelines, which for the future could represent changes in the curriculums of the areas and subjects to improve the level of digital skills of the students of the institution and, therefore, of the community. The control groups received the contents of the subject, however, some of these contents were updated (2022). Therefore, in one way or another these groups could improve their digital skills because of improved content and the maturation process (time, progress in the curriculum, processes of the student). After the intervention, the posttest was administered (Phase 3).

Table 3

Summary of the intervention program

Session	Area	Competence	Thematic content	Indicators (Know, Do, Attitude)
1-2	Information	Browsing, searching, and filtering information Evaluating Information Storing and retrieving information	▪ On-line information search ▪ File and folder management ▪ Storage	• Is aware of different search engines • Understands how search engines classify information • Has a proactive attitude towards looking for information? • Understands how information is stored on different devices/services
3-4	Safety and Content creation	Protecting data and digital identity Protecting health Developing content	▪ Risks and care when surfing the net ▪ Privacy and protection of personal data ▪ Presentations	• Knows how to protect other people data that apply to his/her own context (as a worker, a parent, a teacher, etc.) • Knows how data about his/her digital identity can or cannot be used by third parties • Knows the effect of prolonged use of technologies • Can use basic packages to create content in different forms
5-6	Communication and collaboration	Collaboration through technologies Netiquette	▪ Digital tools for collaborative work ▪ Netiquette	• Understands the dynamics of collaborative work and of giving and receiving feedback • Can work at a distance with others Understands the consequences of own behavior
7-8	Problem solving, Content creation and Safety	Developing content Integrating and re-elaborating Protecting the environment	▪ Tools for content creation ▪ Environmental impact of digital technology. Digital consumerism	• Can use basic packages to create content in different forms. Can create knowledge representations (e.g., mind maps, diagrams) using digital media • Is aware of environmental issues related to the use of digital technologies
9-10	Information	Evaluating Information	▪ Search strategies: commands to filter information	• Recognizes that not all information can be found on the Internet • Is critical about information found. • Can analyze retrieved information

For a better understanding of the process, attention has been given to the Template for Intervention Description and Replication (TIDieR) checklist (Table 4). This resource is a useful tool for other researchers to replicate interventions in different contexts or leverage the findings from this study (Hoffman et al., 2014).

Table 4
Template for intervention description and replication (TIDieR) checklist

Brief name	Implementation of Training Activities for Developing Digital Competencies in Secondary Basic Education Students.
Why	Through a digital literacy program consisting of organized and planned activities, the aim is to promote the holistic development of digital competencies among Secondary Education students, rather than only instrumental skills. Thus students can engage in a safe, critical, collaborative, and reflective use of ICT, meeting the current Information Society's needs.
What	*Materials*: During the intervention period, digital resources available at the educational institution (computers and Tablets) and owned by students (Smartphones) were used. Another type of resource utilized were academic guides created by the educational institution itself. The thematic axes and intervention activities were presented through these guides. The guides were shared via links through instant messaging applications like WhatsApp. These guides were hosted on the institution's Google Drive, accessed by students through the provided link for downloading. In addition to this, some online applications were used, especially for content creation. Also, the Education Department provided a username and password for the use of Microsoft software. *Procedure:* Each session was conducted with a strong emphasis on promoting the development of digital competence among students. Therefore, the entire process was meticulously planned. Firstly, at the beginning of each session, time was dedicated to familiarize students with the topic through questions about a given situation to encourage analysis and reflection. Secondly, the different thematic lines were developed by the teacher, introducing new knowledge at both the cognitive and attitudinal levels. Thirdly, a series of activities (in groups and individuals) were outlined for each session, both in and out of classroom. This aimed to strengthen collaborative work and communication among students. Finally, the activities were evaluated to provide feedback and enrich the experiences exchange.
Who provided	The intervention was conducted by a teacher from the Technology and Informatics area. She had experience in the IT sector and a master's degree in ICT applied to education. All of this ensured that she could guide the students towards achieving the intervention's objectives.
How	With the initial and intermediate groups, in-person sessions were conducted. However, due to the lockdown, the advanced group participated online.
Where	For the initial and intermediate groups, the intervention took place in the computer lab. The advanced group received the intervention through the Teams platform.
When and how much	The intervention was conducted over an academic semester, in sessions lasting 110 minutes (approximately 13 to 15 sessions), once a week, following the designated schedules for the Technology and Informatics area, and occasionally in the mathematics area.
Tailoring	It has been proposed to adapt the literacy program for the teaching staff, as equipping them with digital competencies will positively impact the students. Sessions with the faculty would be conducted during faculty meetings and institutional development weeks. Changes would be implemented compared to the student intervention, as the availability of time is more limited.
Modifications	Modifications were made, particularly in extending content. This prioritized competencies, as some of them demanded more time than initially planned. Additionally, due to the institution's educational recreational activities, flag ceremonies, cultural events, talks from external organizations, or the celebration of festivities, the initial proposed schedule was altered.
How well	To assess the program, rubrics were developed for teachers and for each student session. However, these were not used, as the entire program was implemented using the approved guides, which fulfilled all the institution's requirements. Regarding the students' rubric, it was also not administered. Instead, at the end of each semester, for each subject area, a general self-assessment and peer assessment rubric was used. Furthermore, using the rubric for each session would have reduced the time available for guide development, activities, and peer interaction. However, all activities were evaluated and provided feedback based on evaluation criteria (knowing, doing, and being) from the DigCom 2.1 learning levels model. Consequently, quantitative grades were assigned to the learning process, as mandated by the institutional evaluation system. Overall, the intervention program was fulfilled at an 80% completion rate. Some content was prioritized due to time restrictions .

Data Analysis

Data were analyzed with IBM SPSS 22 and Jamovi 2.2 statistical packages. After verifying the absence of normality of the data, using the Kolmogorov-Smirnov test, non-parametric descriptive and inferential analyses were performed, to identify if there were significant differences by competence areas, by factors (*Knowledge* and *Attitudes)*, as well as in the score obtained in the pretest and posttest after the intervention. Consequently, for the intergroup analysis, the Mann-Whitney *U* test was used and for the intragroup analysis, the Wilcoxon test. In addition, the size of Cohen's d-effect was calculated for nonparametric samples. All analyses were performed with a significance level of $p < 0.05$.

Results

Inferential Intergroup Analysis

Pretest-Postest Differences in the Knowledge Factor

Regarding the intergroup analysis of the pretest between the *Control* and *Experimental* groups (Table 5), the data obtained showed that no statistically significant differences were found in any of the competence areas or in the *Total Test of the Knowledge* factor in the Middle and Advancing groups (p>0.05). In the groups of the *Initial* level there were statistically significant differences in all the competence areas of the Knowledge factor ($p<0.05$), although the researchers tried not to jeopardize the internal validity of the design (groups as similar as possible), these groups are distributed by the educational institution considering their own criteria and there was no possibility of raising them.

Subsequently, the data obtained in the analysis of the differences in the posttest between the *Control* and *Experimental* groups (Table 5) showed that they were statistically significant (p<0.05), in all competence areas and in the Total *Test* of the *Knowledge factor* at all levels. Being the students of the *Experimental* groups those who obtained better results compared to those of the *Control* groups, with a very high effect size (*Cohen's d*), greater than 0.80 in all competence areas and in the *Total Test*, except for the *Advanced* level that in three areas, *Problem solving*, *Communication and collaboration* and *Content creation*, resulted in medium size, between 0.50 and 0.80.

Table 5

Analysis of differences in the pretest – postest, Knowledge factor (Mann-Whitney U test)

Area	Group	Pretest				Postest				
		M	***DT***	***U***	***p***	***M***	***DT***	***U***	***p***	***d***
PS	CG1	7.26	2.49	267.0	**.001*****	7.41	1.89	39.0	**.001*****	2.67
	EG1	9.81	2.60			12.5	1.92			
	CG2	9.72	2.54	502.5	.588	9.03	2.21	182.0	**.001*****	1.52
	EG2	9.45	2.80			11.57	2.20			
	CG3	10.1	2.53	544.0	.318	11.05	2.34	370.0	**.003****	0.79
	EG3	10.7	2.50			12.82	2.12			
I	CG1	4.29	2.02	366.5	**.014***	4.50	1.46	105.5	**.001***	2.03
	EG1	5.66	2.14			8.21	2.13			
	CG2	5.66	2.52	489.0	.472	6.09	2.09	203.0	**.001**	1.22
	EG2	6.12	2.49			8.42	1.71			
	CG3	7.19	2.51	500.0	.131	7.08	2.15	329.5	**.001*****	0.96
	EG3	6.42	2.27			8.80	1.32			
SA	CG1	6.97	2.49	254.5	**.001*****	7.41	3.07	228.5	**.001*****	1,14
	EG1	9.51	2.34			10.9	3.04			
	CG2	8.57	2.90	514.5	.699	8.96	3.13	297.0	**.001**	0.84
	EG2	8.72	2.74			11.30	2.39			
	CG3	10.1	2.84	570.0	.486	10.41	2.34	336.0	**.001****	0.96
	EG3	9.77	2.65			12.25	1.31			
CO	CG1	7.23	3.70	207.5	**.001*****	8.05	3.21	183.0	**.001*****	1.39
	EG1	11.5	2.71			12.81	3.59			

	CG2	10.2	4.33	441.5	.185	10.72	3.37	160.0	**.001*****	1.27
	EG2	11.5	3.69			14.63	2.75			
	CG3	11.2	4.30	548.5	.346	13.02	3.42	449.0	**.034***	.70
	EG3	12.2	3.46			14.88	1.45			
CC	CG1	4.47	1.98	254.5	**.001*****	4.82	2.13	152.0	**.001*****	1.55
	EG1	6.96	2.50			9.27	3.46			
	CG2	7.66	2.45	528.0	.831	7.81	2.18	310.5	**.002****	0.71
	EG2	7.30	2.57			9.48	2.48			
	CG3	7.58	3.36	599.0	.720	9.25	3.05	455.0	**.043***	0.55
	EG3	7.57	2.64			10.74	2.30			
TT	CG1	30.2	8.39	156.0	**.001*****	**32.20**	8.53	72.50	**.001*****	2.23
	EG1	43.4	8.90			**53.75**	10.7			
	CG2	41.8	11.8	488.5	.472	42.63	9.72	100.5	**.001*****	1.40
	EG2	43.1	11.1			55.42	8.45			
	CG3	46.2	11.8	612.5	.840	50.83	10.3	279.0	**.001*****	1.06
	EG3	46.8	10.8			59.51	5.03			

Note: PS= Problem solving; *I* = Information; *SA* = Safety; *CO* = Communication; *CC* = Content creation*;* *TT* = Total test; *CG1* = Control group 1; *EG1* = Experimental group 1; *CG2* = Control group 2; *EG2* = Experimental group 2; *CG3* = Control group 3; *EG3* = Experimental group 3; *M* = Mean; *SD* = standard deviation; *U* = Mann-Whitney U test; Significance level: $*p<.05$ $**p<.01$ $***p<.001$; *d* = size of Cohen's effect.

Pretest-Postest Differences in the Attitudes Factor

Regarding the *Attitudes* factor (Table 6), in the pretest no significant differences were found in any of the competence areas, nor in the *Total Test* of the Advanced level groups (*CG3)* ($p>0.05$). As for the groups of the *Middle* level (CG2), no significant differences were found in almost all the competence areas and the Total Test ($p>0.05$), except for the competence area of *Information Literacy* ($p<0.05$). Again, at the Initial level (CG1) significant differences were found in most of the competence areas and in the Total Test, except for the Security and *Content Creation* area ($p>0.05$).

On the other hand, in the posttest the significance was varied. In the *total test* and in the areas of *Information Literacy* and *Communication* there were statistically significant differences ($p<0.05$) in the Initial (EG1) and Middle (EG2) levels. Likewise, there were significant differences in the area *of Problem Solving* ($p<0.05$) at the Intermediate level (EG2). However, in the area of competence of *Security and Content Creation*, there were no statistically significant differences at any of the levels ($p>0.05$). As for the size of the effect, it was located between small and medium, except in the area of competence of *Information Literacy* in the initial and medium groups, which turned out to be high, as well as in the *Total Test* of the *Medium* level, for being higher than 0.80.

Table 6

Analysis of pretest-postest differences. Attitudes factor (Mann-Whitney U test)

Area	Group	Pretest				Postest				
		M	***DT***	***U***	***p***	***M***	***DT***	***U***	***p***	***d***
SP	CG1	23.38	5.08	380.00	**.023***	23.94	3.95	415.50	.066	.490
	EG1	24.78	6.33			25.66	2.89			
	CG2	25.42	2.26	398.50	.059	24.93	1.80	337.0	**.01****	.665
	EG2	22.51	5.79			26.42	2.61			
	CG3	23.02	6.14	611.00	.826	25.19	3.70	581.00	.570	.091
	EG3	23.60	5.41			25.54	4.02			
I	CG1	22.91	4.87	399.00	**.05***	22.14	4.26	267.50	**.001*****	**.886**
	EG1	24.21	6.53			25.60	3.40			
	CG2	24.75	3.77	386.00	**.05***	25.03	2.93	246.00	**.001*****	**1.12**
	EG2	22.21	5.12			27.75	1.78			
	CG3	23.33	6.04	549.00	.348	25.30	3.54	557.50	.400	.229
	EG3	24.77	4.34			26.02	2.67			

SA	CG1	23.05	4.94	432.00	.104	23.44	5.12	447.50	.153	.484
	EG1	23.96	7.16			25.48	3.01			
	CG2	22.72	3.67	535.50	.908	24.12	2.90	408.00	.078	.373
	EG2	22.21	5.12			25.33	3.55			
	CG3	22.77	5.98	574.50	.521	23.88	3.21	549.50	.352	.244
	EG3	22.82	4.30			24.65	3.11			
CO	CG1	23.97	3.98	360.00	**.05***	22.85	5.87	355.00	**.01***	.714
	EG1	25.63	5.80			26.33	3.56			
	CG2	24.48	3.60	456.50	.256	25.66	2.64	365.00	**.05***	.764
	EG2	22.51	6.08			27.57	2.35			
	CG3	23.58	5.55	595.50	.690	25.00	4.15	527.00	.233	.413
	EG3	24.51	3.88			26.45	2.71			
CC	CG1	22.94	4.59	410.50	.057	22.61	5.81	450.00	.162	.619
	EG1	24.63	5.52			25.45	2.81			
	CG2	24.69	2.98	414.50	.090	25.87	2.79	414.50	.090	.588
	EG2	22.36	5.88			27.42	2.47			
	CG3	23.83	5.00	575.50	.529	24.36	3.65	575.50	.529	.293
	EG3	23.37	4.43			25.34	3.01			
TT	CG1	116.2	20.02	375.00	**.05***	115.00	20.94	336.50	**.01****	.770
	EG1	123.2	28.9			128.54	13.29			
	CG2	122.0	11.2	450.00	.225	125.63	10.18	291.50	**.001**	**.894**
	EG2	111.8	26.2			134.51	9.67			
	CG3	116.5	25.6	620.00	.908	123.75	15.81	526.50	.233	.304
	EG3	119.1	20.1			128.02	11.94			

Note: PS= Problem solving; *I* =Information; *SA* = Safety; *CO* = Communication; *CC* = Content creation; *TT* = Total test; *CG1* = Control group 1; *EG1* = Experimental group 1; *CG2* = Control group 2; *EG2* = Experimental group 2; *CG3* = Control group 3; *EG3* = Experimental group 3; *M* = Mean; *SD* = standard deviation; *U* = Mann-Whitney U test; Significance level: *p<.05 **p<.01 ***p<.001; *d* = size of Cohen's effect.

Intragroup Inferential Analysis

Differences in the Pretest and Postest of the control groups and experimental groups

Table 7 shows the result of the intragroup analysis (related samples), to know the level of significance considering the pretest and posttest values of the *Control* and *Experimental* groups, at the end of the intervention, as well as to determine the size of the effect. It can be observed that in the students of the experimental groups there were statistically significant differences (p<0.05) in all areas and the *Total Test of the Intermediate and Advanced levels;* except in the areas of *Security* and *Communication* in the Initial group (EG1), where there were no significant results(p>0. 05). The effect size (*Cohen's d*) for the *Knowledge* factor in the *Total Test* was 0. 737 – 0. 883 and 1,067, respectively for each of the levels.

Regarding the significance in the *Attitudes* factor, the constant variation between the levels is still presented, there are no statistically significant differences in the Initial level (EG1) and practically in all the competence areas and the total test of the Advanced group (EG3), only significant difference was found in the Communication area. On the other hand, in the medium level (EG2) statistically significant differences were found in all areas and the *Total Test.* In this factor, the effect size (Cohen's *d*) of the *Total Test* was calculated, considered small for the Initial level (EG1) of 0.167 and the Advanced level (EG3) of 0.382, as for the medium level (EG2) the effect size is considered large (0.813).

Table 7

Analysis of pretest – posttest differences (Wilcoxon test)

Area	**CONTROL GROUP**					**EXPERIMENTAL GROUP**				
		Knowledge Factor		**Attitudes Factor**			**Knowledge Factor**		**Attitudes Factor**	
	Group	***Z***	***p***	***Z***	***p***	**Group**	***Z***	***p***	***Z***	***p***
PS	CG1PRET CG1POST	-.05	.959	-.31	.751	EG1PRET EG1POST	-3.78	.001***	-.64	**.522**
I	CG1PRET CG1POST	-.52	.602	-.69	.488	EG1PRET EG1POST	-3.42	.01**	-.48	**.628**
SA	CG1PRET CG1POST	-.72	.471	-.70	.482	EG1PRET EG1POST	-1.94	**.052**	-.40	**.687**
CO	CG1PRET CG1POST	-1.1	.261	-.92	.354	EG1PRET EG1POST	-1.51	**.130**	-.21	**.829**
CC	CG1PRET CG1POST	-.58	.556	-.04	.963	EG1PRET EG1POST	-2.54	.05*	-.21	**.829**
TTEST	**CG1PRET CG1POST**	-1.2	.220	-.25	.79	**EG1PRET EG1POST**	-3.15	.01**	-.15	**.879**
PS	CG2PRET CG2POST	-1,3	.185	-1.0	.301	EG2PRET EG2POST	-3.30	.01**	-3.2	.001***
I	CG2PRET CG2POST	-.84	.397	-.12	.990	EG2PRET EG2POST	-3.89	.001***	-4.2	.001***
SA	CG2PRET CG2POST	-.41	.680	-1.8	.066	EG2PRET EG2POST	-3.73	.001***	-2.5	.05*
CO	CG2PRET CG2POST	-.40	.688	-1.6	.104	EG2PRET EG2POST	-4.02	.001***	-3.56	.001***
CC	CG2PRET CG2POST	-.64	.521	-1.8	.058	EG2PRET EG2POST	-3.04	.01**	-3.60	.001***
TTEST	**CG2PRET CG2POST**	-.28	.775	-1.5	.130	**EG2PRET EG2POST**	-4.44	.001***	-3.93	.001***
PS	CG3PRET CG3POST	-1.2	.216	-1.6	.103	EG3PRET EG3POST	-2.99	.01**	-1.5	**.126**
I	CG3PRET CG3POST	-.25	.801	-1.4	.135	EG3PRET EG3POST	-4.30	.001***	-1.0	**.314**
SA	CG3PRET CG3POST	-.49	.618	-.36	.715	EG3PRET EG3POST	-3.77	.001***	-1.6	**.094**
CO	CG3PRET CG3POST	-2.0	**.05***	-.77	.436	EG3PRET EG3POST	-3.80	.001***	-2.1	.05*
CC	CG3PRET CG3POST	-2.0	**.05***	-.19	.844	EG3PRET EG3POST	-4.15	.001***	-1.1	**.081**
TTEST	**CG3PRET CG3POST**	-1.5	.111	-1.0	.313	**EG3PRET EG3POST**	-4.45	.001***	-1.8	**.063**

Note: PS= Problem solving; *I* =Information; *SA* = Safety; *CO* = Communication; *CC* = Content creation; *TTEST* = Total test; *CG1PRET* = Control group 1 pretest; *CG1POST* = Control group 1 postest; *EG1PRET* = Experimental group 1 pretest; *EG1POST* = Experimental group 1 posttest; *Z* = Wilcoxon test; Level of significance *p<.05 **p<.01 ***p<.001.

Discussion

The student population of the basic level of Primary Education and High School is immersed in a constant and daily use of ICT. This has allowed them to become digitally literate and, therefore, develop digital skills, mostly autonomously, either for leisure, to acquire knowledge and/or for other tasks (Fernández, 2017; Orosco et al., 2020). Digital literacy in students should not be limited only to the instrumental or functional part of the devices but should be expanded. This means that the acquisition and development of skills that allow them to perform individually and collectively in various activities is encouraged, making use of ICT responsibly (Cano, 2018; Sacristan, 2013). In addition, this literacy should not be limited to a specific content and subject but should be transversal in all areas of the school curriculum (Balladares et al., 2016). This has been the aim of this study: to develop the digital competence of Colombian high school students through an *ex-pot facto program.*

The results obtained, before and after the intervention, indicated that teacher-oriented digital competence training was necessary for an optimal and effective use of ICT, as pointed out by Barbudo et al. (2021). When analyzing the differences found in the posttest, between the *Control* and Experimental groups, the effectiveness of the program was confirmed, since they were statistically significant in each of the competence areas and in the total test of the *Knowledge* factor, due to the improvement experienced by the students of the *Experimental* groups at all levels, including the *Initial group.* Although it cannot be said that at this level the intervention program has been decisive in the difference between the *Experimental* group and the *Control* group in the posttest, given the non-equivalence between these groups. And the same, form, can be seen that there was an improvement in learning when comparing the means obtained in the posttest, which exceed up to 20 points (total test) to the means obtained in the Control group. These results are like those obtained by Fernández-Montalvo et al. (2017), in which, through a brief intervention program, whose objective was digital literacy they found statistically significant differences in the comparison between the control and experimental groups in the posttest. The experimental group achieved a higher degree of digital literacy (conceptual – procedural and attitudinal) than the control group.

On the other hand, the results obtained in the Wilcoxon test at the end of the intervention confirmed that digital competence increased with respect to the beginning in the *Experimental* groups, which agrees with the research of López et al. (2021), where, through the implementation of an educational intervention program to improve digital competence in three dimensions such as technological fluency, Learning-knowledge and digital citizenship, conclude that digital competence increased significantly with respect to the beginning in the experimental group.

Along the same lines, the results coincided with the research of Ferrada (2021), whose intervention program developed digital competences in primary and early school students, through STEM activities. The results were positive, the experimental group achieved relatively high values compared to the control group and statistically significant. Similarly, they are related to the positive results obtained in the research of García-Valcárcel and Caballero-González (2019), through a robotics intervention program for primary school students, which aimed to develop digital skills. Students in the experimental group demonstrated greater learning than students in the control group.

It should be noted that the *control* groups presented a higher mean in the posttest with respect to the pretest, during the intervention period, due to the maturation effect. This could be related to the progress in the curriculum during the time of the intervention or other factors specific to the student. However, although there was a gain, it was not statistically significant for these groups (p <0.05), with respect to baseline; on the contrary, with the *Experimental* groups. In the area of *Communication* and *Content Creation*, the difference was significant, product of the need that arose when interacting in virtual classes during the pandemic, which means that students developed and made constant use of the skills they used most in their daily lives. Thus, most digital skills are being acquired outside of school (McDougall et al., 2018).

Another important aspect to highlight is the virtual modality, equally successful implementation of the intervention program at the *Advancing level.* This implies that the intervention program turned out to be a very valuable instrument for the development of digital skills both in the face-to-face and virtual environment, since it can be adapted and made more flexible in the face of the challenges presented by today's society, in addition to encouraging the use of electronic devices for educational purposes (Spanish & Pantoja, 2017). The results of the intervention were satisfactory despite the limitations that were presented at that time: connection, access to devices, confinement.

Although the purpose of the investment program mainly revolved around improving the level of digital competence, it also allowed to reinforce other transversal competences such as autonomous and collaborative work, creativity, social skills, and oral and written expression, coinciding with Casillas-Martín et al. (2020), also confirming the afore mentioned about the importance of this competence in the development of others.

However, the results for the *Attitudes* factor were not as satisfactory. Significant differences were varied. Therefore, it is concluded that the intervention program did not improve the overall perception that students have towards ICT. This is no argument to doubt the effectiveness of the program, since attitudes were measured with a Likert scale and students commonly tend to overestimate their digital competence, and the results may be biased (Tao, 2022).

However, although the results of the intervention are generally satisfactory, the present research has some limitations. An example of this is the sample used. Although it has been representative and broad, the intervention was carried out in a single educational institution. It would be ideal to extend it to more educational centers in different contexts, both rural urban, as well as to the private sector. In this way, the results are broader and richer, so that they are considered as a first step towards the inclusion of literacy programs in Colombian schools, that is, to know the influence that different social variables can have on the acquisition and development of digital competence (Casillas-Martín et al., 2022). Other limitations presented by this research revolve around the preparation of teachers, the infrastructure of the educational institution, the participation of the family and, not least, the little transversality between the curriculum areas.

For future research it is recommended to overcome the previous limitations, as well as to consider the threats to internal validity and try to make the groups similar, in the results of the pretest, which did not happen in the present research with the initial groups. Similar, complement with qualitative and longitudinal studies.

Given the findings of this research, it can be concluded that this training program in digital competence is effective, and the objective is achieved: to increase digital literacy in knowledge and skill of the population under study, given that after the implemented intervention high levels of improvement in their digital competence were shown. Intervention programs in primary and high school education students related to ICT turn out to be successful for the advancement of digital competence, through the design and planning of activities, students are always willing and motivated to participate in training activities related to the use of ICT (Fernández-Montalvo et al., 2017).

Based on the obtained results, several practical implications derived from this study are inherently linked to the improvement of digital skills. The developed intervention program has enabled students to improve competencies closely associated with their academic performance and readiness for the workforce, considering that ICT (Information and Communication Technologies) are part of the Knowledge Society in which we currently operate. Similarly, efforts have been made to bridge the digital divide caused by the lack of familiarity with the applications that technological resources offer, going beyond a merely instrumental use.

Conclusions

School must assume the challenge of digitally literate its students to face the digital culture and the changes that ICT entails in all areas of daily life (Peñalva & Irazabal, 2016). Countries are joining forces to promote digital literacy in their citizens, however, despite this, literacy plans are not yet fully articulated with the training processes, from all subjects of the curriculum and at all educational levels. Itis also clear that leaving the acquisition and development of digital skills in the hands of the environment becomes a risk factor for the digital divide to continue widening. Finally, the participation of all actors involved in the training of the younger population is also required, such as teachers and families, who also need to become digitally literate (Navarrete & Mendieta, 2018).

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