Students' and teachers' digital competence in a Valencian network of cooperative schools

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Abstract. In the context of the increasingly digitalised modern society, the development of digital competence (DC) from early childhood is ever more essential. This situation represents a challenge for educational institutions at all levels, as they must ensure the development of students' DC, as well as train staff in teachers' digital competence (TDC). This study aims at measuring the self-perception of students' DC and TDC in a network of primary and secondary schools in the Valencian Community as a first step toward the detection of possible gaps and inequalities that may need to be addressed. The results show a high level of self-perceived DC among students and a medium-expert level of TDC among teachers. Additionally, differences in the self-assessed level of DC and TDC were found between the scores for the individual dimensions and types of literacy that make up these competencies, and there were significant differences in teachers' self-assessment as a function of age and educational level. These findings provide evidence for the need to develop training programs aimed at enhancing TDC in order to reduce the inequalities found.

Key words: students' digital competence; teachers' digital competence; preschool; primary education; secondary education

La competencia digital de alumnos y profesores en una red valenciana de escuelas cooperativas

Resumen. En el contexto de la sociedad moderna cada vez más digitalizada, el desarrollo de la competencia digital (CD) desde la primera infancia es cada vez más esencial. Esta situación representa un desafío para las instituciones educativas de todos los niveles, ya que deben velar por el desarrollo de la CD de los estudiantes, así como formar al personal en competencia digital docente (CDD). Este estudio tiene como objetivo medir la autopercepción de la CD y CDD del alumnado de una red de centros de educación primaria y secundaria de la Comunidad Valenciana como primer paso para la detección de posibles carencias y desigualdades que es necesario corregir. Los resultados muestran un alto nivel de CD autopercibido entre los estudiantes y un nivel medio-experto de CDD entre los profesores. Además, se encontraron diferencias en el nivel autoevaluado de CD y CDD entre las puntuaciones de las dimensiones individuales y tipos de alfabetización que componen estas competencias, y hubo diferencias significativas en la autoevaluación de los docentes en función de la edad y el nivel educativo. Estos hallazgos evidencian la necesidad de desarrollar programas de formación dirigidos a potenciar la CDD con el fin de reducir las desigualdades encontradas.

Palabras clave: competencia digital de los estudiantes; competencia digital docente; preescolar; educación primaria; educación Secundaria

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Introduction

Students' digital competence

Digital Competence (DC) has been defined by Larraz (2013, p. 118) as "the capacity to mobilise different literacies in order to manage information and communicate knowledge to resolve situations in a constantly evolving society". In recent decades, different theoretical attempts have been made internationally to identify the elements that make up this competence (ISTE, 2016; Martin, 2005; Vuorikari et al., 2016). The proliferation of these conceptual frameworks and of the assessment and self-assessment instruments developed to reflect them, including iDCA (Calvani et al., 2008) and Digitalis-ESO (Niño-Cortés et al., in press), are evidence of the relevance of DC development and certification.

Previous studies of primary and secondary students' DC have yielded some interesting results. In most of the reviewed references, although students were found to perceive themselves to have an overall moderate level of competence (Vila-Couñago et al., 2020), they tended to score higher for self-assessment of technical skills and lower for citizen participation, digital content creation, and legal and ethical issues (Vila-Couñago *et al*., 2020; Zhang & Zhu, 2016). The fact that students assess themselves differently in different dimensions of DC highlights the need to study these individual aspects in more detail, to further examine the factors that may cause these differences in perception.

In fact, some studies have pointed to age and academic level as factors that can influence students' perceptions about their DC. Specifically, the higher the age or academic level, the higher the level of the technical dimension (Zhang & Zhu, 2016). Moreover, some studies that evaluate students' DC have reported significant differences between girls and boys in secondary schools, with boys registering higher average DC scores than girls (Calvani et al., 2012). The opposite has been found in primary schools, where girls tend to record the highest scores (Martínez-Piñeiro *et al*., 2019). When the different DC dimensions are analysed in detail, both in evaluation and self-assessment, boys get higher scores when it comes to searching for, selecting and organising information, while girls tend to excel in content creation, communication and social relationships using digital technologies, and security (Amor & Serrano, 2019; Martínez-Piñeiro et al., 2019). Nonetheless, a smaller number of researchers examining primary and secondary schools have not found any gender differences (González et al., 2012; Zhang & Zhu, 2016). Therefore, findings as to the influence of age and/or gender on students' DC may be due to different factors such as the sample size and selection or the specific context of the study. That is why it is necessary to continue studying gender as an element that may influence students' DC, depending on the context.

As has been seen, although there are several studies about students' DC, each one assesses this competence in different contexts using different instruments and reference frameworks, which could explain the inconsistent findings in terms of the general DC results and the roles of other variables such as gender or age. Although some previous results are not yet conclusive, they bring to light the existence of inequalities which can only be reduced from the educational sphere. However, more research into students' DC need to be done, as teachers must be provided with the required abilities to meet their students' specific DC needs.

Teachers' digital competence

According to Gabarda et al. (2021), teachers have a dual role regarding the development of DC: to master their own development of these competences and to guide the development of students' DC. It is therefore necessary for teachers not only to expand their DC as users, but also their teachers' DC (TDC), which is what allows them to accompany the development of their students' DC.

As is the case with DC, several national and international reference frameworks have been developed in order to identify the elements that make up TDC (INTEF, 2017; ISTE, 2017; Redecker, 2017; UNESCO, 2018). Additionally, in order to measure self-assessed TDC, many instruments have been created based on these frameworks (Verdú-Pina et al., 2021), although this variety makes it difficult to obtain comparable results. In this study, considering the contributions of the different frameworks, we describe TDC as a set of skills and attitudes that teachers need to develop in order to use digital technology in their professional practice (Lázaro et al., 2019).

Many of the reviewed studies of the TDC of primary and secondary education teachers show that they perceive themselves to have developed this competence to a medium or medium-high level (Moreno-Guerrero *et al*., 2021; Prieto-Ballester *et al*., 2021). There are also differences in how teachers perceive themselves in the various specific dimensions of TDC, with a lower level in the pedagogical dimension and a higher level in the technical dimension (Fernández et al., 2016; Suárez-Rodríguez et al., 2018). Furthermore, several studies show that the lowest levels of competence are found in the areas related to digital content creation, ethical, legal and safety aspects, and professional development (Palau et al., 2019; Pozo et al., 2020), whereas the highest levels appear in the areas of digital information and literacy, communication, and collaboration (Pozo et al., 2020; Prieto-Ballester et al., 2021). This coincides with the results for students' DC discussed above, since both teachers and students have a better self-perception of their technical skills and a lower opinion of their digital content creation abilities and their knowledge of legal and ethical aspects. It is therefore necessary to know where the weaknesses are in order to understand the teachers' needs.

Regarding the influence of age on TDC, and contrary to students' results, younger teachers generally

assess themselves at a higher level (Portillo et al., 2020), especially in areas such as content creation and problem solving (Pozo et al., 2020), although these differences are not always found (Falcó, 2017). Moreover, the educational stage in which teachers work has also been shown to have a significant effect on TDC. Specifically, teachers at higher stages tend to have a better self-perception (Portillo et al., 2020).

Another variable that has been shown to influence self-perception of TDC is gender. According to several studies, women perceive themselves to have a lower competence level than men (Portillo et al., 2020; Prieto-Ballester et al., 2021). When analysed in detail, men's self-perception levels are greater in the technological dimension, while women stand out in the pedagogical elements (Ortiz-Colón et al., 2020; Şimşek & Sarsar, 2019). Nevertheless, and similarly to gender differences in students' DC, other studies have failed to find such gender differences in TDC (Falcó, 2017).

Once again, the variability in the results of the reviewed studies was to be expected due to the variety of tools used. For this reason, it is necessary to consider teachers' self-perception in detail in order to be able to more definitively identify their strengths and weaknesses, as well as to address digital gaps that must be taken into consideration when analysing this competence.

Aim of the study

Previous research has focused on the study of students' DC or TDC separately, which makes it difficult to figure out if teachers have the necessary skills to address students' needs in their development of DC. This lack of information may impact the design of training, as teachers' needs might be different depending on those of their students.

It is therefore necessary to study students' DC and TDC jointly, in a large group of students and teachers. Hence, the aim of this study is to analyse the similarities and differences in the self-assessed level of students' DC in primary and lower- and upper-secondary education stages of a network of schools, and to examine TDC in the same stages and schools, also including early childhood education. Additionally, differences in terms of gender, age, and educational stage will be measured in order to detect possible digital gaps and inequalities.

Regarding primary education students, data from 1st, 2nd, 5th, and 6th grade were gathered in order to have a general view of the initial and final point in this stage. All the data used in this study was collected as a part of two Spanish research and innovation projects focused on the diagnosis of DC and TDC.

Method

The research aim has been addressed in this study through a quantitative approach, with a correlational design. Students and teachers' DC has been measured with different self-assessment instruments in order to detect their strengths and weaknesses, as well as to shed light on the different factors that could influence the development of their DC and TDC.

Context

To achieve the aim of this study, we needed to recruit a relatively large sample of participants from a small number of educational centres. However, as the simultaneous measurement of students' DC and TDC can be a burden for educational institutions, we decided to carry out this study within the schools of Akoe Educació Cooperative, a Valencian network of cooperative schools created in 2005 and made up of nine educational institutions with up to 11 schools. This context was considered appropriate in that it provided a relatively large sample of participants who were aware of the underlying need and perhaps likely to be keen to participate in the study.

Schools from Akoe Educació Cooperative share pedagogical principles, management systems and values, and they have a clear desire to improve their own educational projects. The core of all Akoe schools is innovation, as López et al. (2018) describe it, and the network's schools offer quality, efficiency and continuous training. These values are important for Akoe schools, which have been adapting to changes every year. For this reason, the promotion of digital skills for teachers and students has been and remains important. Akoe schools define themselves as active, placing the students at the centre of learning (Ortega & Rodrigo, 2022). This characteristic is based on a comprehensive pedagogical approach that promotes individualized learning, respect for each student's rhythms, and strong links between the schools and the community, all in order to ensure that students learn the skills they need for life. Regarding the sociocultural context, the families belonging to Akoe are middle and upper-middle class, with a low percentage of migrant students.

Participants

A total of 1779 students and 166 teachers from 11 schools participated in this study. Among the students, 114 (6%) were in upper-secondary education (16-18 years old), 1294 (73%) in lower-secondary education (12-16 years old), 265 (15%) in 5th and 6th grade of primary education (10-12 years old), and 106 (6%) in 1st and 2nd grade of primary education (6-8 years old). 834 students (47%) identified themselves as girls, 856 (48%) as boys, 25 (1%) as non-binary, and 64 (4%) did not answer this question (the details of gender distribution by grades are available in Table 1). Concerning teachers, 116 (70%) taught in secondary education, 37 (22%) in primary education, and 13 (8%) in preschool. Their average age was 42.3 (SD = 10.19), and 96 (58%) identified themselves as women, 62 (37%) as men, 4 (2.5%) as non-binary, and the remaining 4 (2.5%) did not answer.

Table 1. Gender distribution among grades

Grade	Participants	Girls	Boys	Non-binary	No answer
1st and 2nd Primary (6-8 years old)	106	54%	41%	5%	–
5th and 6th Primary (10-12 years old)	265	47%	49%	1%	3%
1st and 2nd Lower-Secondary (12-14 years old)	679	45%	52%	1%	3%
3rd and 4th Lower-Secondary (14-16 years old)	615	46%	46%	3%	5%
1st and 2nd Upper-Secondary (16-18 years old)	114	55%	41%	1%	3%

Note. Due to the low percentages of "non-binary" and "no answer", these answers were not considered in the analysis of gender differences.

Instruments

Students' DC was measured with three versions of the same questionnaire: Digitalis-1P measures the level of DC for students in the 1st and 2nd grade of primary education. It consists of seven items answered on a 3-point Likert scale (no, yes, a lot), and distributed into three factors, one related to students' self-perception in mathematics (F1: $\alpha = 0.68$; 2 items), another to digital technology (F2: $\alpha = 0.63$; 3 items), and the last to the gender gap (F3: $\alpha = 0.64$; 2 items). The design and validation of this instrument is available at Usart *et al.* (2021). Digitalis-6P measures 5th and 6th grade of primary education students' DC, and it was adapted from the original Digitalis-ESO (Niño-Cortés *et al.*, in press) for secondary education students. These diagnostic tests are based on the DC model defined by Larraz (2013), which includes four literacies in DC: informational, technological, multimedia and communicative. Cronbach's alpha values for both questionnaires are available in Table 2.

Digitalis-ESO and Digitalis-6P measure the students' self-perception of their DC, which is closely related with the competence itself and is easier to evaluate, allowing researchers to obtain an initial diagnosis. In the questionnaires, students' DC is measured with 19 items (Digitalis-ESO) or 15 items (Digitalis-6P), answered using a 5-point Likert scale, where students self-evaluate their capacity level from 1 (I do not feel capable) to 5 (I feel totally capable).

Meanwhile, the COMDID-A questionnaire (Lázaro & Gisbert, 2015) was used to assess TDC. This questionnaire is based on the COMDID rubric, designed to measure TDC based on the most commonly used national and international models of the construct. Teachers self-assess their TDC through 22 items, divided into four dimensions.

– D1. Didactic, curricular, and methodological (five items);
– D2. Planning, organisation and management of digital technological spaces and resources (six items);

– D3. Relational, ethics and safety (six items);
– D4. Personal and professional (five items).

To complete the questionnaire, for each item teachers must choose the answer that best describes their level of competence from among five options, corresponding to four levels of development (initial, medium, expert, transformative) and a baseline (not yet started). The validation and reliability analysis of COMDID-A is available in Salgado (2019). For the sample of this study, an analysis of reliability with the Cronbach's Alfa coefficient was also carried out, yielding values between 0.844 and 0.906 for the four different dimensions, indicating good levels of internal reliability.

Complementary demographic data was gathered in both questionnaires, including gender (male, female, non-binary, NR/DK) based on The GenIUSS Group (2014), educational level, and also age in the case of teachers. Data were gathered between February and November of 2021 and were hosted on the university's server. The participation of students and teachers was voluntary, and contact was made through the school management teams. An informed consent form with a description of the data gathering procedure and the participants' rights was used to gather teachers and students' consent at the beginning of the questionnaire. Answers were anonymised and transferred to a spreadsheet database, and the whole process strictly met the ethical guidelines for educational research established by the British Educational Research Association (2018). This protocol was also approved by the ethics committee of Rovira i Virgili University (Ref: CEIPSA-2021-PR-0046).

Procedure and data analysis

First, a descriptive analysis of both students' and teachers' dimensions of DC levels was made. The overall level of DC for each factor of Digitalis-1P was calculated by adding the partial scores of each item and it was categorised intro three levels of development (low: 0-1 points; medium: 2-3 points; high 4 points), except for F2 (low: 0-2 points; medium: 3-4 points; high: 5-6 points). Regarding Digitalis-6P, Digitalis-ESO and COMDID-A, DC and TDC development levels were calculated by averaging the scores of the items. For Digitalis-6P, the DC development was categorised into three levels: low (1-3.3 points), medium (3.4-4 points), and high (4.1-5 points), except for communicative literacy (low: 1-3.5 points; medium: 3.6-4.5 points; high: 4.6-5 points). For Digitalis-ESO the ranges were low (1-3.1 points), medium (3.2-3.8 points), and high (3.9-5 points). Regarding TDC, it was categorised into five levels of develop-

Table 2. Cronbach's Alpha values for Digitalis-6P and Digitalis-ESO

Questionnaire	Informational literacy	Technological literacy	Multimedia literacy	Communicative literacy
Digitalis-6P	$\alpha = .68$	$\alpha = .57$	$\alpha = .64$	$\alpha = .60$
Digitalis-ESO	$\alpha = .71$	$\alpha = .62$	$\alpha = .66$	$\alpha = .78$

ment: "not yet started" (0-10 points), initial (11-25 points), medium (26-50 points), expert (51-75 points), and transformative (76-100 points), as in Lázaro & Gisbert (2015).

To analyse the differences on students' DC and TDC according to their gender and educational level, chi-square tests (χ^2) were used (Cohen *et al.*, 2018). Additionally, a correlation analysis was made with Spearman's rho due to the non-parametric data to examine the relationship between age and TDC level. Data was analysed using IBM SPSS Statistics 27.

Results

The results obtained in the study about students' DC and TDC are shown below. Note that students' results are presented separately by educational level due to the use of different questionnaires (Digitalis-1P, Digitalis-6P, and Digitalis-ESO).

Primary education students' DC: 1st and 2nd grade

Among the students from 1st and 2nd grade of primary education (N = 106), and regarding mathematics self-perception (F1), 63% of students perceived themselves at a medium level (Figure 1), 26% at a high level, and 10% at a low level. In digital technology (F2), 49% of the students perceived themselves at a medium level, 31% at a low level, and 20% at a high level. Finally, about the gender gap awareness (F3), 92% of the students did not perceive it, 7% did perceive it, and only 2% perceived it a lot.

Significant differences emerged in the different items of gender gap awareness (F3), where boys were more aware of the gap than girls ($\chi^2 = 4.1$; df = 1; $p = .043$). As well, a higher percentage of boys considered themselves to be better than girls in mathematics ($\chi^2 = 37.04$; df = 4; $p < .001$) and digital technology use ($\chi^2 = 28.45$; df = 4; $p < .001$). Furthermore, when analysed in detail, there were gender differences in individual items from F1 and F2, where boys expressed more interest than girls in mathematics ($\chi^2 = 13.11$; df = 4; $p = 0.011$) and digital technology ($\chi^2 = 15.04$; df = 4; $p = .005$).

Primary education students' DC: 5th and 6th grade

Students from the higher grades of primary education (N=265) mainly self-assessed their global level of DC at a high level (46%) and, to a lesser extent, at a medium level (29%), and at a low level (25%). Generally, students showed a better self-assessment in communicative and informational literacy, and lower in technological and multimedia literacies (Figure 2).

No significant gender differences were found in general DC. They emerged only in technological literacy, where boys self-assessed themselves better than girls ($\chi^2 = 8.2$; df = 2; $p = .017$). Regarding grade, significant differences were also found in technological ($\chi^2 = 8.59$; df = 2; $p = .014$) and multimedia ($\chi^2 = 14.45$; df = 2; $p = .001$) literacies, where 6th grade students self-assessed themselves better than 5th grade students.

Secondary education students' DC

Among secondary education students (N=1408), 46% showed a high level of self-assessed DC, 34% a medium level, and 20% a low level. Overall, students showed the highest levels in multimedia and technological literacy, and the lowest levels in informational and communicative literacy (Figure 3).

Differences in DC self-assessment were also analysed among 1st/2nd grade, 4th/5th grade (lower-secondary) and 1st/2nd grade (upper-secondary), which proved to be significant in general DC ($\chi^2 = 21.6$; df = 4; $p < .001$), and in informational ($\chi^2 = 19.15$; df = 4; $p = .001$), multimedia ($\chi^2 = 23.31$; df = 4; $p < .001$), and communicative ($\chi^2 = 24.19$; df = 4; $p < .001$) literacies. For all cases, the higher the grade, the higher the level of competence.

In this case, significant differences in gender were found in general DC level ($\chi^2 = 6.42$; df = 2; $p = .04$), that come from the technological ($\chi^2 = 19.1$; df = 2; $p < .001$) and communicative ($\chi^2 = 11.83$; df = 2; $p = .003$) literacies. In particular, boys perceived themselves as more competent than girls. Nevertheless, when analysed by grade, the results are slightly different. Boys in 1st/2nd grade (lower-secondary) perceived themselves
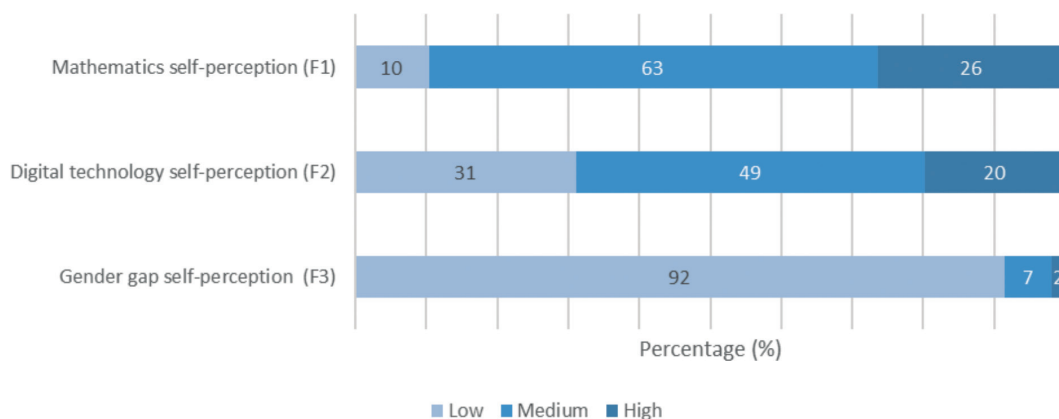

Figure 1. Rates of 1st and 2nd grade students (primary education) in each level of mathematics, digital technology, and gender gap self-perception
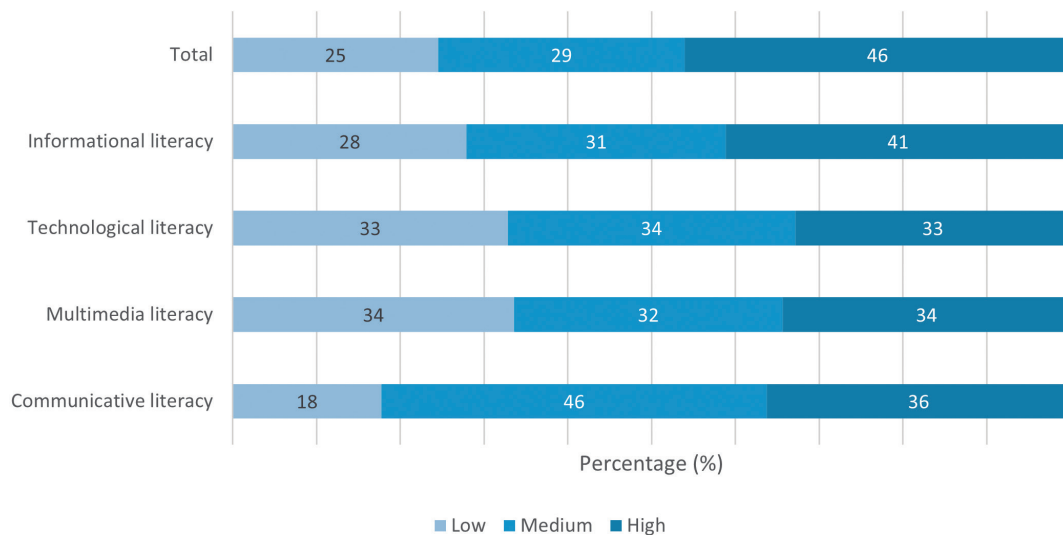
Figure 2. Percentage of 5th and 6th grade students (primary education) in each level of DC self-perception
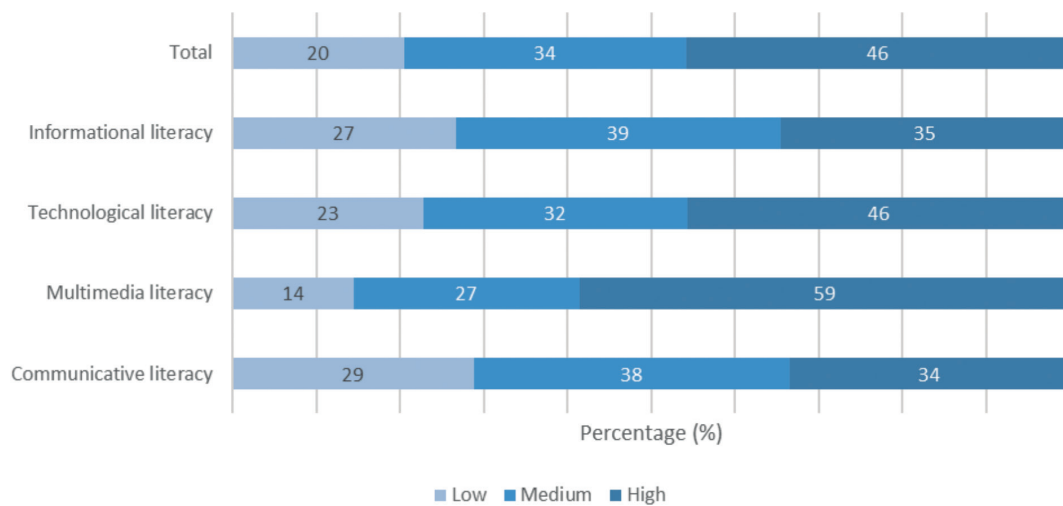

Figure 3. Percentage of secondary education students in each level of DC self-perception

as more competent in general DC ($\chi^2 = 6.27$; df = 2; $p = .043$) and in technological literacy ($\chi^2 = 15.4$; df = 2; $p < .001$), and in 3rd/4th grade they perceived themselves as more competent in technological ($\chi^2 = 7.29$; df = 2; $p = .026$) and communicative ($\chi^2 = 8.43$; df = 2; $p = .015$) literacies. Finally, no gender differences were found among upper-secondary education students.

Teachers' digital competence

Among the participating teachers 45% (N=166) considered themselves to be at a "medium" level of TDC, 42% at "expert" level, 11% at "transformative" level, and 2% at an "initial" level. A closer analysis showed that teachers perceived themselves as the most competent in the didactic, curricular, and methodological dimension (D1) and the least competent in the relational, ethics and safety (D3) and personal-professional dimensions (D4) (Figure 4). Significant differences were found between preschool-primary education and secondary teachers in the general level of DC

($\chi^2 = 10.14$; df = 3; $p = .017$) with secondary teachers assessing themselves more highly.

Regarding gender, there were significant differences between women and men only in D4 ($\chi^2 = 11.12$; df = 3; $p = .011$), where men considered themselves to be more competent than women did. No other gender differences were found in general TDC or in any of the other dimensions. The analysis by educational stage and gender did not find any gender differences in any of the dimensions among preschool and primary education teachers. Finally, significant correlations were identified between TDC level and age for general TDC, D2, D3, and D4 (Table 3). In all cases, and inversely to students, younger teachers tended to assess their TDC more highly.

Discussion

The aim of this study was to assess the self-perception of students' DC and TDC in primary and secondary schools of Akoe Educació Cooperative, as well as to
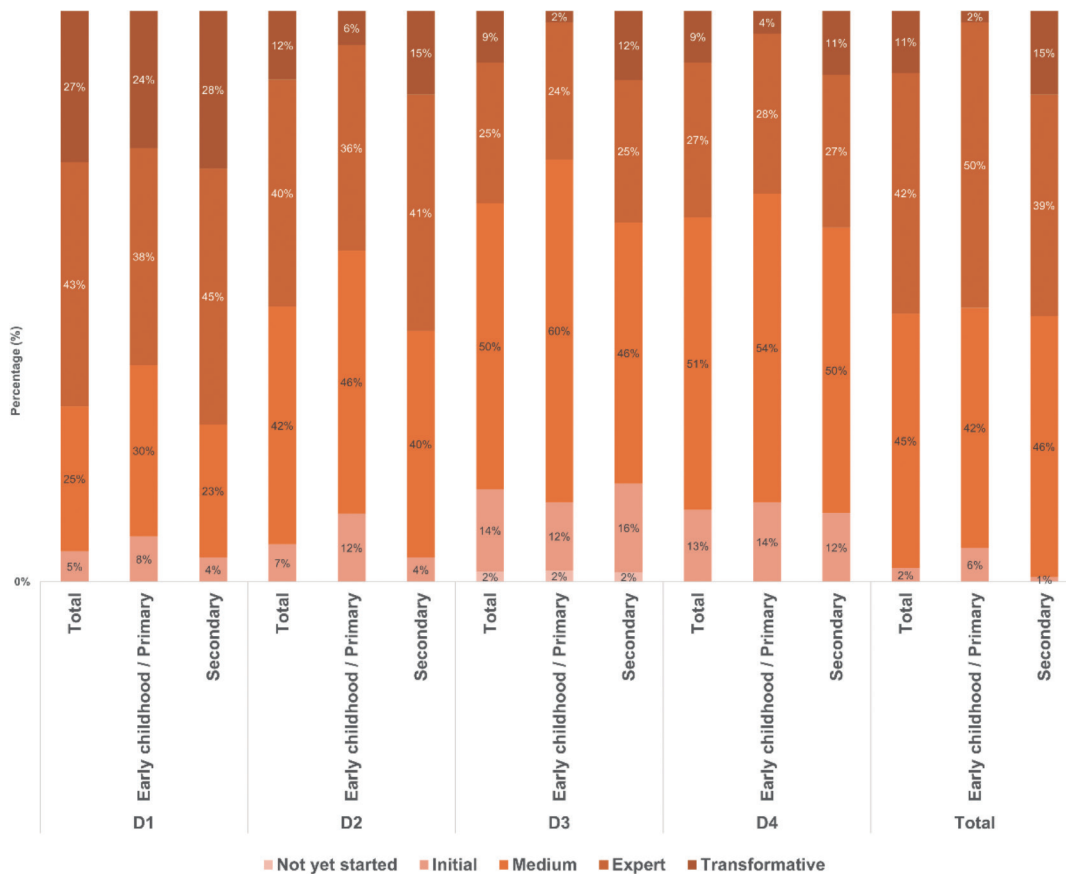
Figure 4. Percentage of teachers in each level of TDC self-perception

Table 3. Correlations between teachers' age and their self-assessed level of TDC

Spearman's Rho			
	D1	Correlation coefficient	-.129
		Sig. (2-tailed)	.097
	D2	Correlation coefficient	-.166*
		Sig. (2-tailed)	.033
	D3	Correlation coefficient	-.225**
		Sig. (2-tailed)	.004
	D4	Correlation coefficient	-.262**
		Sig. (2-tailed)	.001
	TOTAL	Correlation coefficient	-.228**
		Sig. (2-tailed)	.003

** Correlation is significant at the .01 level (2-tailed).
 * Correlation is significant at the .05 level (2-tailed).

examine the differences in self-perception in terms of gender, age and educational stage.

Primary education students' DC: 1ˢᵗ and 2ⁿᵈ grade

Overall, students from the lower grades of primary education (6-8 years old) perceived themselves to have a medium level in mathematics and digital technology. The gender gap awareness was low, as most of the students did not perceive a gender gap in mathematics and digital technology. Nevertheless, a more detailed analysis showed significant gender differences in some of the items. Specifically, boys were more interested than girls in learning about mathematics and digital technology, and they were more likely than girls to believe that they were skilled in these areas. These re-

sults suggest that the gender gap in digital competence becomes noticeable externally from the early stages of primary education, but students in these courses are not aware of it. These results complement the findings of Bian et al. (2017) where girls aged 6 and 7 were less likely than boys to believe that people of their gender were very intelligent, which could explain why girls are less interested in these areas that are traditionally liked to "brilliance".

Primary education students' DC: 5ᵗʰ and 6ᵗʰ grade

Most of the students from the higher grades of primary education (10-12 years old), perceived themselves to have high DC level, in contrast with previous studies (Vila-Couñago et al., 2020), where students considered themselves to be at a medium level. On this matter, there are different factors that may have influenced the results, such as the innovative type of schools included in the study and the COVID-19 lockdown. Specifically, students perceived themselves to be the most proficient in communicative literacy, followed by informational literacy, and to be less proficient in technological and multimedia literacies. These results are consistent with those of previous studies that have found high levels of self-perception in aspects related to communication and information and lower degrees of self-perception in multimedia literacy and technical problem-solving (Amor & Serrano, 2019; García-Ruiz et al., 2020).

In terms of gender, significant differences were found only with regard to technological literacy, with boys perceiving themselves as more competent than girls. Previous studies evaluating and measuring self-assessed DC of students in Spain at the same educational level did not find gender differences (Colás-Bravo et al., 2017), or even sometimes found higher scores or self-assessment levels among girls in general DC and communicative, multimedia and security literacies (Amor & Serrano, 2019; Martínez-Piñeiro et al., 2019). For this reason, it is necessary to consider the different literacies that make up students' DC rather than only considering overall DC in order to be able to find these differences. Thus, gender gap perceptions may differ depending on the context and the instrument used, and it is necessary to further study the factors that are likely to influence them.

With regard to grade level, no significant differences were found in general DC between 5th and 6th grade students. However, differences were found in technical and multimedia literacies, with 6th grade students perceiving themselves as more competent. Again, this reinforces the need to analyse the various kinds of DC literacies individually. In the European context, no studies have been found comparing students' DC among different grades in primary education. Nevertheless, in a study carried out in Beijing, Zhang and Zhu (2016) found out that 6th grade students assessed their technical skills with higher scores than 5th grade students. However, it must be considered that most of the studies of DC in primary schools have been carried out in the 5th and 6th grade, and it might be hard to find differences in DC self-perception between two consecutive grades. For this reason, this issue could be more effectively analysed among secondary education students.

Secondary education students' DC

The analysis of lower- and upper-secondary education students' (12-18 years old) DC indicated that most of them perceived themselves to have a high level of competence. These results also contrast with those of other studies measuring DC self-perception and assessment in Spanish secondary schools (Colás-Bravo et al., 2017; González, 2012), where students tended to place themselves at a medium level. Again, this higher self-perception of students in Akoe schools could be due to the importance given to the training in DC in this cooperative, as well as to the fact that the study was carried out after the COVID-19 lockdown, during which students' DC might have improved.

A more detailed analysis showed that students perceived themselves as the most competent in multimedia and technological literacies and less competent in informational and communicative literacies, a finding that echoes previous studies in Spanish secondary schools that have shown higher levels of self-perception in some technical skills and lower levels in informational and communicative literacies (González, 2012).

In contrast with primary education students, more significant gender differences were found among secondary education students. Specifically, boys perceived themselves to have a higher competence than girls in general DC and in technological and communicative literacies. These results support the study of Calvani et al. (2012), where boys performed better than girls in DC assessment, and they demonstrate the importance of the context to identify gender differences, as they might vary. On this point, Colás-Bravo et al. (2017) did not find any gender differences, while in the study by Hatlevik et al. (2015) girls in fact obtained higher scores for general DC and technological literacy. In our study, the gender gap appears to be more evident in lower-secondary education students than in primary education. However, the gap seems to be smaller at the upper-secondary education level, since no differences were found between boys and girls in any of the dimensions. Digitalis questionnaires have been shown to be useful in identifying these inequalities as a first step toward developing actions aimed at reducing the gender gap.

Finally, it was found that the higher the grade, the higher the level of general DC self-perception and the higher the scores for each of the different literacies, except for the technological domain. In this regard, Li and Ranieri (2010) also found a correlation between DC and age. Nonetheless, Colás-Bravo et al. (2017) did not find any correlation between students' age and their assessed DC. The results of our study suggest that students' DC is enhanced as they progress through the educational stages, and, although students might overvalue or undervalue their competence, they are consistent with their self-assessment depending on the grade.

Teachers' digital competence

Teachers in Akoe schools generally perceived themselves with a medium-expert level of TDC, along the lines of the findings of previous studies (Prieto-Ballester et al., 2021). The analysis of the individual dimensions of TDC showed that teachers perceived themselves as most competent in the didactic, curricular and methodological dimension (D1) and least competent in the relational, ethics and safety (D3) and personal-professional (D4) dimensions, also coinciding with previous studies (Palau *et al*., 2019; Pozo et al., 2020). These results support the reliability of COMDID and provide guidance for the development of training actions to meet teachers' needs in order to improve their TDC levels.

In terms of gender, significant differences were only found in the personal-professional dimension (D4), where men perceived themselves at a higher level than women. Additionally, these differences in D4 were only found among secondary teachers when they were analysed by educational stage. Previous studies have found gender differences in TDC self-perception (Portillo et al., 2020; Prieto-Ballester et al., 2021). However, in other studies, men have not always shown a higher self-perception than women. In several cases, no sig-

nificant gender differences have been found (Falcó, 2017), or women have even sometimes assessed themselves more highly for general DC (Krumsvik et al., 2016) or in individual areas such as content creation or communication and collaboration (López et al., 2019; Pozo et al., 2020).

Age turns out to be negatively correlated with general TDC and three of the four TDC dimensions in COMDID. This inverse association has also been found in previous studies (Portillo et al., 2020) and might be related to Prensky's (2001) theory of digital natives, according to which younger generations would have better digital skills, also necessary in order to develop TDC. Finally, regarding educational level, teachers from preschool and primary schools have shown lower levels of TDC self-perception than teachers from secondary schools, coinciding with previous studies in Spanish schools (Fernández-Cruz & Fernández-Díaz, 2016).

It is worth noting that both teachers and students perceived themselves as less competent in dimensions related to communication, ethics, and copyright use (D3 and D4 in TDC, communication literacy in DC). This would mean that the areas where teachers feel less competent are also where they experience the most difficulties in helping their students to develop, which seems logical. Consequently, it is necessary to train teachers and students in these areas, especially considering the large number of digital tools that are used in education.

There were, however, some differences between the self-perception of teachers and students regarding the development of informational literacy (part of D1 in TDC), where teachers assessed themselves with a high level of competence in the development of their students' informational literacy, while students perceived themselves to have a low level regarding this literacy. This fact should be further explored to find out the reason for this disparity of perceptions, since one of the areas where teachers feel the most confident is not being successfully developed among their students.

Therefore, although TDC and students' DC are measured through different instruments, these dimension equivalences point out that TDC is related to DC. As a matter of fact, according to the different TDC frameworks such as DigCompEdu (Redecker, 2017), the development of students' DC is a part of TDC. Nevertheless, only a few studies have examined these competencies together, focusing on the stage of higher education (Kuzminska et al., 2019; Zambrano et al., 2016), and they have not studied their relationship in depth. No previous studies have been found to confirm this relationship, and, therefore, our study represents a first step towards investigating these connections.

Conclusions

The results of this study of the Akoe cooperative show that students from primary and secondary schools mostly believed themselves to have a high level of DC, while teachers assessed themselves with a medium-

expert level of TDC. Nevertheless, some differences in self-assessment levels were found among the dimensions and literacies, a fact that must be considered for future training plans.

Despite the difficulty involved in comparing the TDC dimensions and students' DC literacies due to their specific nature, both groups of participants showed low levels of self-assessment in items related to ethics and to the use of open licenses (D3 and D4 of TDC and communicative literacy of DC). Meanwhile, some items of D1 where teachers had a good level of self-perception are related to the development of students' informational literacy, while students self-assessed lower for this area than for other literacies. These preliminary results open a path for future research on the relation between DC and TDC constructs and measures, studies that could lead to a better understanding of the influence of TDC on the development of students' DC.

The instruments COMDID-A, Digitalis-1P, Digitalis-6P, and Digitalis-ESO have also made it possible to identify differences in TDC and students' DC in terms of gender, educational level and age. The gender gap is more evident among students, especially when literacies are considered. The gap is larger in lower-secondary education but, as discussed, it decreases in upper-secondary education.

Concerning educational level, students' DC self-perception improves as they progress through the educational stages, suggesting that the training in aspects related to DC has a positive impact on their self-perception. However, this improvement does not happen with all the literacies, since technological literacy remains stable at a medium-high level throughout the stages. In the case of teachers, age has a negative association with their TDC self-perception, and therefore it is necessary to offer continuous training to help minimise these inequalities among teachers. These results reaffirm the importance of reducing the inequalities found beginning with teacher training in TDC, which would provide them with the necessary abilities to accomplish the development of their students' DC.

Based on the results presented here, a report was delivered to each of the participating schools, and different improvement actions could be carried out as a result. These reports served as a preliminary diagnosis for the creation of the Akoe schools' digital plan, the planning of training actions to improve TDC, and the decision-making process with regard to the use of digital devices by students.

One of the limitations of this research is related to the study of a specific case, which can affect the generalisability of results, as well as the lack of data from 3rd and 4th grade of primary education. However, at the present time these questionnaires have been answered by a larger number of teachers and students, which will make it possible to continue working in this research line and gain a more detailed view of the results in terms of grades and educational stages. Secondly, it

would be necessary to improve the instrument Digital-is-6P in future research, since the Cronbach's Alpha values are slightly low and, consequently, the dimensions used in the analysis are theoretical. Lastly, the difficulty of comparing TDC and students' DC has also been a major constraint due to the different nature of the dimensions and literacies measured by COMDID and Digitalis.

Author Disclosure Statement

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