



An Empirical Approach to Teacher Digital Competence in Compulsory Secondary Education in Spain

Una aproximación empírica a la competencia digital docente en la Educación Secundaria Obligatoria en España

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ABSTRACT

In a context in which digital competencies have become increasingly important, this study carries out a diagnostic analysis for Spain on the actions associated with teachers' digital competence in compulsory secondary education, as recognised by the teachers themselves. The methodology employs secondary analyses guided by the objectives of our research, based on responses to specific PISA 2018 questionnaires, with a quantitative, non-experimental, and descriptive design on a sample of 18,892 teachers, stratified by subnational jurisdictions. The results concerning teaching competencies to facilitate access to digital information for students, teaching competencies for the use of digital tools in teaching, and school policy in the digital field reveal mediocre figures, broadly homogeneous across territories and with a poor compensatory orientation. From the analysis and discussion of the data, we conclude that there is a need to substantially improve teacher training, promote the use of digital technologies as effective tools to advance educational equity, and support schools in defining their own policies. A subsequent analysis, associated with PISA 2022, will allow us to estimate the effect of the response induced by COVID-19.

Palabras clave

competencia digital, evaluación del profesorado, formación del profesorado, política educativa, igualdad de oportunidades.

RESUMEN

En un contexto en el que las competencias digitales han cobrado una importancia creciente, este estudio realiza un análisis diagnóstico de España sobre las acciones vinculadas a la competencia digital docente en educación secundaria obligatoria y reconocidas por los propios profesores. La metodología desarrolla análisis secundarios, orientados a los objetivos de nuestra investigación, a partir de las respuestas a cuestionarios específicos de PISA 2018, con un diseño cuantitativo, no experimental y descriptivo, sobre una muestra de 18.892 profesores, estratificada por jurisdicciones subnacionales. Los resultados referidos a competencias docentes para facilitar el acceso de los alumnos a la información digital, competencias docentes para el uso de herramientas digitales en la enseñanza y política de centro en materia digital revelan cifras mediocres, ampliamente homogéneas entre territorios y con una deficiente orientación compensatoria. Del análisis y discusión de los datos se concluye la necesidad de mejorar sustantivamente la formación del profesorado, promover el uso de las tecnologías digitales como instrumento efectivo para avanzar en materia de equidad educativa y apoyar a los centros docentes en la definición de sus propias políticas. Un análisis posterior, asociado a PISA 2022, nos permitirá estimar el efecto de la respuesta inducida por el COVID-19.

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1. Introduction

The UNESCO Delors Report (Delors et al., 1996) provided a broad vision - part prospective, part normative - on the direction of future education. This orientation has subsequently been reflected in various institutional frameworks for a competency-based curriculum. (European Commission, 2019; López Rupérez, 2020; OECD, 2018). Without prejudice to this necessary humanist vision of education, the link between the education of the present and the employment of the future is increasingly being assumed internationally (CSR Asia & Huawei, 2017; European Union, 2020; McKinsey & Co., 2017). Furthermore, there are multiple channels through which teaching digital competences (TDC) can influence student outcomes (European Union, 2020). All of this places these professional competencies as an object of analysis and diagnosis of increasing importance (Aydin & Yildirim, 2022; Castaño Muñoz & Weikert García, 2021; Rodríguez-García et al., 2018) in the formulation and implementation of training policies that are well aligned with the education challenges of the 21st century.

In this context, the notion of Digital Teaching Competence (DTC) has been aligned with the modern version of the concept of competence (López Rupérez, 2020) and has been defined by some authors as the “knowledge, skills, attitudes and strategies that the educator must activate, adopt and manage in real situations to facilitate learning” (Carrera & Coiduras, 2012, p. 5). These types of skills differ from those used in a purely domestic environment (Cabero-Almenara & Palacios-Rodríguez, 2020) and are specifically linked to the integration of digital technologies in teaching and learning processes (Hatlevik et al., 2018; Roig-Vila et al., 2015). This notion has, in fact, been incorporated into the European Framework for Digital Competence of Educators (DigCompEdu) (Redecker, 2017).

The widespread use of online education in response to COVID-19 confinement requirements has increased awareness among Governments, teachers, and society at large of the need for sufficient training in the use of digital devices and in the exploitation of their educational potential. The EU Digital Education Action Plan 2021-2027, aimed at adapting education and training to the digital age, has set as a strategic priority #1 “teachers and trainers should be better equipped and trained to participate more effectively in the digital transformation of education” (European Union, 2020, p.10).

The present research aims to conduct a diagnostic analysis, pre-COVID, of TDC in compulsory secondary education (ESO) in Spain and its autonomous communities and cities. The perspective of this study displaces the interest of the conceptual or even normative approach of the different models of TDC (Falloon, 2020; INTEF, 2018; Jiménez-Hernández et al., 2021; Kampylis et al., 2015; Redecker, 2017) towards another empirical one, concerning what teachers actually do in the ordinary context of the classroom.

Accordingly, the objectives of this research are to:

- a) Analyse ESO teachers’ self-reported TDC to facilitate students’ access to digital information.
- b) Analyse ESO teachers’ self-reported TDC for the use of digital tools in teaching.
- c) Explore, through regression analysis, the relationships between the two types of TDC and their consequences.
- d) Evaluate, in a systematic way, the compensatory dimension of the TDC of ESO teachers.
- e) Explore the importance of school policy for the use of digital tools in education.
- f) Reflect on the consequences of previous evidence for training policies in different jurisdictions.

Compared to previous research on the level of TDC in Spain (Pozo Sánchez et al., 2020; Castaño Muñoz & Weikert García, 2021), the present study is based on the PISA 2018 database, with a large sample size and statistical representativeness ensured at the level of the Spanish autonomous communities and cities; it analyses the use in teaching of a very wide range of digital tools and provides a systematic view from the point of view of educational compensation and equity in education.

2. Methods

For diagnostic purposes, this study adopts a quantitative, non-experimental methodology and a descriptive approach to secondary data from the PISA 2018 edition (OECD, 2019a).

2.1. Samples

Use has been made of a statistically representative sampling of the populations corresponding to ESO schools and their teachers (OECD, 2019a; 2019b), the extent of which is presented in Table 1. The sample was selected

Table 1. Sample size of surveyed teachers and schools by autonomous communities and cities.

	Schools	Teachers surveyed		
		Answers processed	Null answers	Total
Andalucía	53	923	113	1,036
Aragón	52	972	88	1,060
Asturias	55	1,014	46	1,060
Baleares	53	927	172	1,099
Canarias	54	900	134	1,034
Cantabria	56	897	199	1,096
Castilla y León	59	1,056	68	1,124
Castilla-La Mancha	53	960	53	1,013
Cataluña	50	843	111	954
Extremadura	54	932	106	1,038
Galicia	60	1,045	156	1,201
La Rioja	45	774	58	832
Madrid	143	2,399	551	2,950
Murcia	52	946	148	1,094
Navarra	49	941	123	1,064
Pais Vasco	128	2,062	424	2,486
Com. Valenciana	53	950	124	1,074
Ceuta	12	206	17	223
Melilla	8	145	38	183
Total	1,089	18,892	2,729	21,621

by stratified two-stage sampling. First, a representative sample of schools. was selected, considering stratification variables such as school location or funding. In the second stage, students were randomly selected from each school to sit the assessment (OECD, 2019b). For Spain, the total of all the extended partial samples corresponding to the different territories has been systematically taken as a reference.

2.2. Instruments

The main measuring instruments used in this study were three questionnaires addressed to teachers: TC166, TC169 and TC184 (see Box 1). It was a question of considering two substantive aspects, relating to the TDC and its main models (Jiménez-Hernández et al., 2021), and enriching them with those relating to the school policy for the use of digital devices in teaching.

2.3. Variables and analysis procedures

A set of variables corresponding to the Qj codes of the TC questionnaires (see Box 1) has been used. In addition, the territory variable, –which takes 19 values corresponding to the Spanish Autonomous Communities and Cities,– has been used, along with the ESCS variable. It is a normalised variable across the OECD countries, with a mean of 0 and a standard deviation of 1 (OECD, 2019a), calculated at the school level to assess the TDC compensatory orientation. The research's diagnostic approach has been accompanied by the systematic use of descriptive statistics, linear regression analysis, and Pearson chi-square independence tests, along with their contingency coefficient.

Box 1. Questionnaires for teachers used in this study.

Questionnaire TC166: Teaching competence to facilitate students' access to digital information
TC166Q01: How to use keywords when using a search engine such as <Google®>, <Yahoo®>, etc.
TC166Q02: How to decide whether to trust information from the Internet
TC166Q03: How to compare different web pages and decide what information is more relevant for students' school work
TC166Q04: To understand the consequences of making information publicly available online on <Facebook®>, <Instagram®>, etc..
TC166Q05: How to use the short description below the links in the list of results of a search
TC166Q06: How to detect whether the information is subjective or biased
TC166Q07: How to detect phishing or spam emails
Questionnaire TC169: Teaching competence for the use of digital tools in teaching
TC169Q01: Tutorial software or practice programmes
TC169Q02: Digital learning games
TC169Q03: Word-processors or presentation software (e.g. <Microsoft Word®>, <Microsoft PowerPoint®>)
TC169Q04: Spreadsheets (e.g. <Microsoft Excel®>)
TC169Q05: Multimedia production tools (e.g. media capture and editing, web production)
TC169Q06: Concept mapping software (e.g. <Inspiration®>, <Webspiration®>)
TC169Q07: Data logging and monitoring tools
TC169Q08: Simulations and modelling software
TC169Q09: Social media (e.g. <Facebook®>, <Twitter®>)
TC169Q10: Communication software (e.g. email, blogs)
TC169Q11: Computer-based information resources (e.g. websites, wikis, encyclopaedia)
TC169Q12: Interactive digital learning resources (e.g. learning objects)
TC169Q13: Graphing or drawing software
TC169Q14: E-portfolios
Questionnaire TC184: School policy concerning the use of digital devices for teaching
TC184Q01: Does your school have a policy concerning the use of digital devices for teaching?

Source: PISA 2018.

3. Results

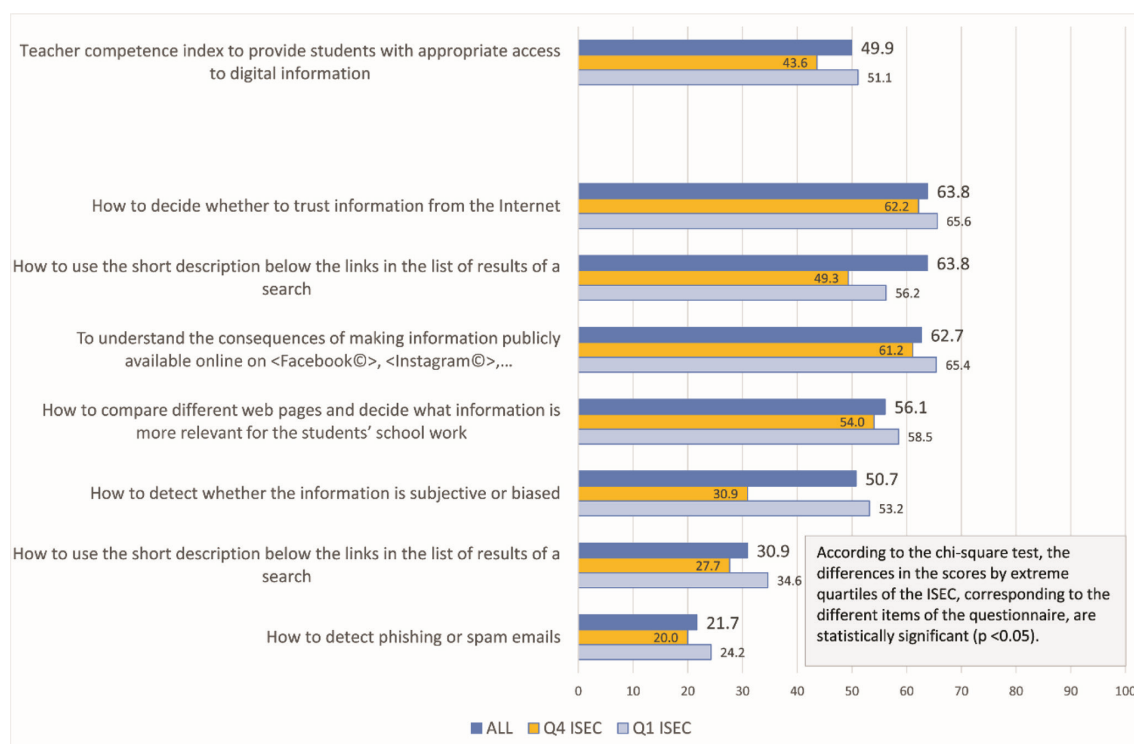
3.1. Teaching competence to facilitate students' access to digital information

The TC166 PISA 2018 questionnaire assesses the extent to which teachers have teaching competence and use it in their classes to facilitate students' appropriate or effective access to digital information, in safe conditions for themselves and for others (OECD, 2019a).

3.1.1. For all of Spain

Figure 1 shows, in decreasing order, the percentages of affirmative responses by ESO teachers to the different Qj items that make up the TC166 questionnaire. In addition, the results are disaggregated by the lower (Q1) and

Figure 1. Teacher competence indexes, by area, to facilitate students' access to digital information, for the first and fourth quartiles of the school's socioeconomic and cultural index (ESCS), in Spain.



Source: Authors, based on secondary analyses carried out by the authors based on PISA 2018 data.

upper (Q4) quartiles of the ESCS for the schools, and the statistical significance of the differences between the corresponding means is assessed using the Pearson chi-square test.

From a first analysis of the results, the following can be inferred: (a) Only half of the teachers consulted (49.95%) answered affirmatively, on average, to the different items of the questionnaire. (b) A wide variability between items was observed, ranging from 21.66% (Q07) to its triple (63.82%) for Q02, reflecting very different degrees of competence. (c) This frank variability could reflect an inadequate orientation of the training.

When the focus is on the distribution of these TDC by ESCS quartiles, there is a systematic advantage for lower quartile schools (Q1) (see Figure 1). That advantage is especially highlighted for item Q06 'How to detect whether information is subjective or biased'. Although it is a mere conjecture, these results are compatible with a spontaneous orientation in teaching, which compensates for differences in the socioeconomic and cultural levels of the schools and the handicap caused by deficiencies in their family and social environments.

3.1.2. For the Autonomous Communities and Cities

The territorial disaggregation of the above data, by Autonomous Community and Cities, is presented in Table 2, in which both the partial figures -or by item- can be seen as global figures relative to the corresponding composite index. From its analysis, the following results are inferred: (a) The presence of a thickly homogeneous territorial pattern for most of the items, except in particular for item Q07, related to how to detect fraudulent emails or spam. This is compatible with the existence of a generalised problem that, in general, goes beyond the circumstances of a particular territory. (b) A consistency of very low values for items Q05 and, in particular, Q07 was anticipated in the analyses covering the whole of Spain. (c) The Autonomous Communities of Aragon, Asturias, La Rioja and Castile-La Mancha stand out for their superior values of competence, and for their inferior values, the Community of Madrid, the Basque Country and Cantabria.

Figure 2 graphically represents the average values of a composite index of teacher competence to facilitate students' access to digital information, according to the first and fourth quartile of the school's socio-economic and cultural index (ESCS), by Autonomous Communities and Cities, in descending order of

Table 2. Index of teaching competence to facilitate students' access to digital information, by Autonomous Communities and Cities.

In your lessons, have you ever taught any of the following things? Percentage of teachers who answer affirmatively (TC166).

	Q01	Q02	Q03	Q04	Q05	Q06	Q07	Index of teaching competence to provide students appropriate access to digital information
Andalucía	70.2	65.6	58.0	69.0	33.2	53.4	26.0	53.6
Aragón	70.4	68.9	61.9	68.7	31.5	54.6	23.5	54.2
Asturias	71.6	73.5	65.7	70.8	38.7	61.0	25.1	58.0
Baleares	58.4	60.4	51.0	56.9	28.4	44.7	16.5	45.2
Canarias	67.7	68.2	63.7	65.8	35.2	50.0	21.9	53.2
Cantabria	58.2	59.9	49.8	56.9	26.5	44.4	19.5	45.0
Castilla y León	71.4	72.7	61.3	67.7	35.7	56.0	26.7	55.9
Castilla-La Mancha	68.5	67.4	59.5	68.0	32.9	57.5	25.9	54.2
Cataluña	56.8	67.1	56.8	62.5	29.2	50.2	16.8	48.5
Extremadura	67.5	68.5	62.1	70.9	38.6	54.3	28.7	55.8
Galicia	62.7	65.9	58.4	60.9	31.4	52.4	21.5	50.4
La Rioja	69.5	71.6	63.2	68.1	34.5	57.5	25.2	55.7
Madrid	58.8	59.1	50.4	57.6	26.2	47.0	20.5	45.6
Murcia	66.0	65.8	58.9	63.8	36.7	55.2	26.7	53.3
Navarra	62.4	59.7	52.3	59.1	25.0	49.2	16.9	46.4
País Vasco	57.2	51.5	48.3	53.7	25.5	42.3	14.5	41.9
Com. Valenciana	66.3	66.9	55.3	68.0	30.8	52.3	22.4	51.7
Ceuta	61.9	65.0	57.4	65.0	39.5	54.3	26.9	52.9
Melilla	60.7	56.3	48.6	61.2	30.1	48.6	29.0	47.8
España	63.8	63.8	56.1	62.7	30.9	50.7	21.7	49.9

Greater or equal than 75

Between 50 and 75

Between 25 and 50

Less or equal than 25

Q01: How to use keywords when using a search engine such as <Google>, <Yahoo>, etc.; Q02: How to decide whether to trust information from the Internet; Q03: How to compare different web pages and decide what information is more relevant for students' school work; Q04: To understand the consequences of making information publicly available online on <Facebook>, <Instagram>, etc.; Q05: How to use the short description below the links in the list of results of a search; Q06: How to detect whether the information is subjective or biased; Q07: How to detect phishing or spam emails.

magnitude. The aim is to show, in a descriptive way, the distribution by territory of this TDC in accordance with its compensatory orientation; that is reflected in significant differences in favour of schools of the lower quartile relative to the ESCS, compared to those of the upper quartile. The analysis highlights the following: (a) A certain prevalence of the compensatory orientation of this TDC in most territories. b) A clearly compensatory orientation in communities such as Navarre, Cantabria and Catalonia and the autonomous city of Ceuta.

3.2. Teaching competence for the use of digital tools in teaching

The TC169 questionnaire in PISA 2018 covers a wide range of digital tools and allows us to assess their degree or frequency of use in teaching, as perceived by teachers. For clarity, the data from the corresponding survey have been processed by focusing only on the negative, resounding response of 'never'.

Figure 2. Teacher competence indices to facilitate students' access to digital information, according to the first and fourth quartile of the school's socio-economic and cultural index (ESCS), by Autonomous Communities and Cities.



Source: Authors, based on secondary analyses carried out by the authors based on PISA 2018 data.

3.2.1. For the whole of Spain

Figure 3 graphically represents the percentages of the corresponding “never” responses to the different Qj items that make up the TC169 questionnaire (see Box 1), arranged in decreasing order. Also shown here is the disaggregation of the results by the lower (Q1) and upper (Q4) quartiles of the ESCS for the schools, along with the statistical significance of the differences between the corresponding means, calculated using the Pearson chi-square test.

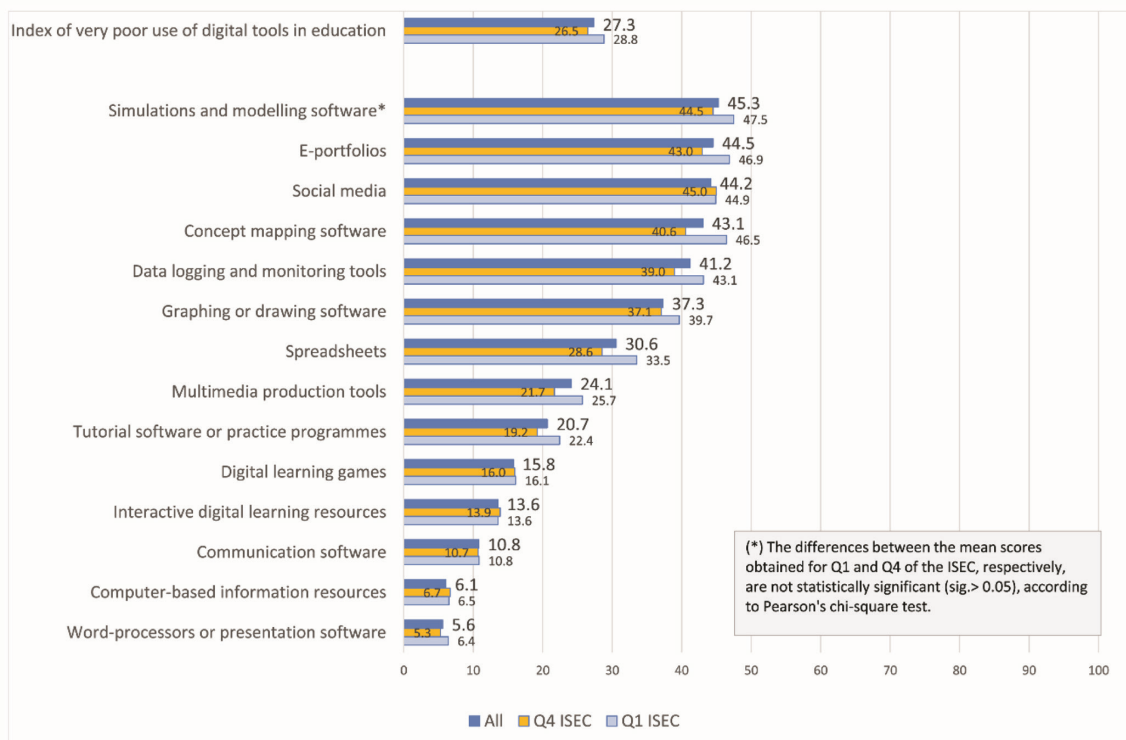
From the analysis of this information, the following results are inferred: (a) The global index of very deficient use of digital tools in the classroom shows a value of 27.34%, which indicates that more than a quarter of teachers, on average, never use such tools in the context of teaching. (b) A very wide variability between items is observed, which is situated in a range between 5.60% for word processors or programs to make presentations (Q03), and its eightfold (45.28%) for simulations and modelling programs (Q08), reflecting very different degrees of teaching competence, depending on the tool considered. c) it is apparent how, in general, as the objective difficulty in using the tool -or the conceptual or methodological basis that supports it- increases, its frequency decreases, which could be evidence of a training problem that would concern both one aspect and the other.

From the analysis of the distribution of this TDC by tools and by quartiles of the **ESCS**, the following should be highlighted: (a) A lack of compensatory orientation of this TDC that reaches more than half of the tools described. (b) A prevalence of this situation for tools, in general, of greater difficulty, which, having a greater potential as teaching aids, are less used in disadvantaged environments than in advantaged ones.

3.2.2. For the Autonomous Communities and Cities

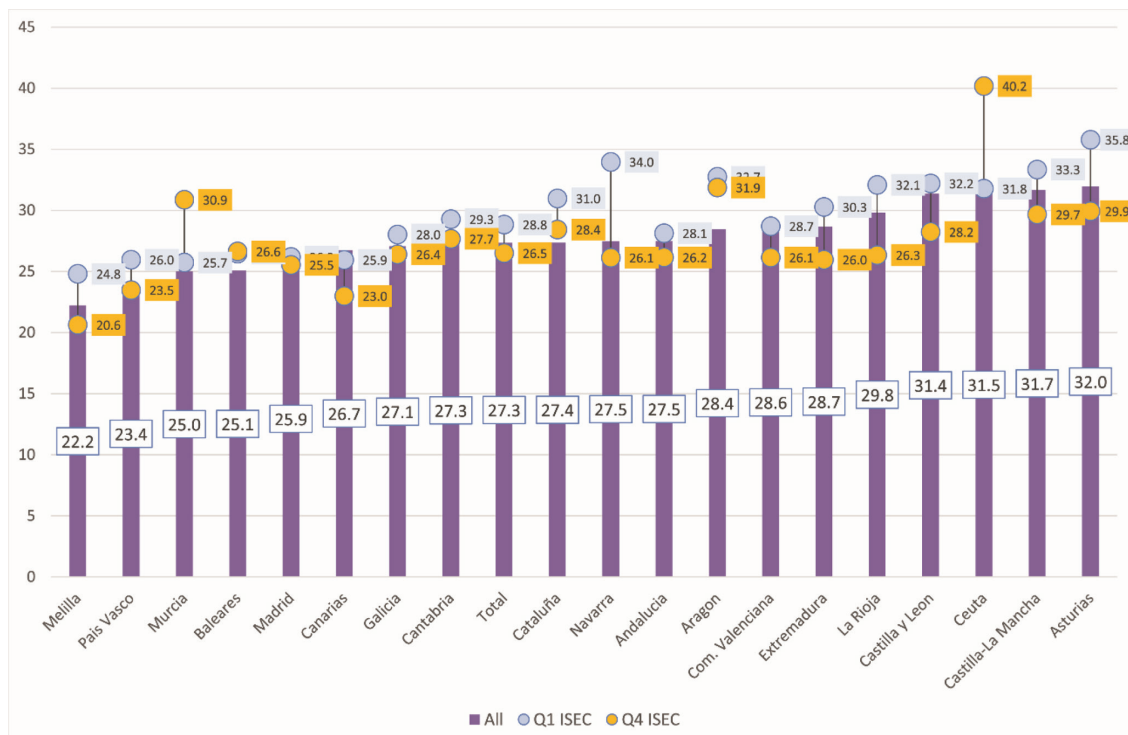
Table 3 shows the disaggregation of the previous data by Autonomous Communities and Cities. Figure 4 makes it easy to identify the positions of the different territories, ordered by the magnitude of their composite index of very deficient use of digital tools.

Figure 3. Index of very deficient use of digital tools in education, according to the first and fourth quartile of the school's socioeconomic and cultural index (ESCS), in Spain.



Source: Authors, based on secondary analyses carried out by the authors based on PISA 2018 data.

Figure 4. Indices of very deficient use of digital tools in education, according to the first and fourth quartile of the school's socio-economic and cultural index (ESCS), by Autonomous Communities and Cities.



Source: Authors, based on secondary analyses carried out by the authors based on PISA 2018 data.

Table 3. Index of very deficient use of digital tools in education, by Autonomous Communities and Cities.
How often did you use the following tools in your teaching this school year? Percentage of teachers who answered 'never' (TC169).

	Q01	Q02	Q03	Q04	Q05	Q06	Q07	Q08	Q09	Q10	Q11	Q12	Q13	Q14	Index of very deficient use of digital tools in education
Andalucía	20.6	16.8	6.9	31.3	22.4	44.1	40.6	46.3	42.4	11.4	6.4	13.0	36.8	45.9	27.5
Aragón	22.8	15.4	4.8	28.0	23.9	45.6	44.2	49.3	47.2	8.7	6.4	13.3	37.6	50.9	28.4
Asturias	26.3	19.4	5.3	37.4	27.6	51.8	46.7	52.9	53.7	13.4	5.8	14.4	41.1	51.6	32.0
Baleares	20.7	12.1	4.6	26.5	25.2	40.1	38.8	42.2	41.8	9.4	5.0	11.8	38.1	34.6	25.1
Canarias	17.9	14.5	4.5	34.9	21.0	41.8	40.7	45.4	43.9	11.0	3.9	10.8	37.8	46.3	26.7
Cantabria	22.0	17.3	6.2	30.3	24.3	41.7	40.3	42.9	42.9	11.3	6.8	15.2	34.5	45.9	27.3
Castilla y León	22.6	17.6	6.7	38.2	27.9	48.5	47.7	50.1	48.4	14.4	7.3	15.2	42.5	52.0	31.4
Castilla-La Mancha	25.5	19.2	7.2	34.4	28.7	50.0	44.7	51.8	49.1	12.6	7.8	15.4	43.1	53.6	31.7
Cataluña	21.3	14.0	3.7	27.7	26.2	45.8	45.8	45.5	48.3	8.5	5.1	12.8	44.7	33.6	27.4
Extremadura	23.7	13.4	5.6	34.4	24.4	47.3	45.0	49.1	44.7	10.7	4.6	10.2	40.4	48.2	28.7
Galicia	21.9	15.5	5.9	31.9	24.6	43.5	41.4	44.6	44.7	12.4	5.2	12.6	34.7	40.0	27.1
La Rioja	22.5	16.6	3.5	32.1	27.5	48.8	46.4	50.0	44.6	12.7	6.4	14.3	40.0	52.2	29.8
Madrid	18.3	15.6	6.4	27.2	22.9	40.3	38.0	42.2	41.3	12.4	7.7	14.4	33.7	42.0	25.9
Murcia	19.1	15.2	4.7	29.0	20.9	40.2	39.4	44.1	38.0	7.2	3.7	11.2	35.6	41.7	25.0
Navarra	20.8	16.4	4.9	27.6	24.4	43.0	39.8	44.9	45.1	10.0	7.3	15.9	38.1	46.3	27.5
Pais Vasco	16.3	13.8	4.7	26.2	20.0	34.7	34.8	38.4	41.6	6.5	4.6	13.5	32.1	40.8	23.4
Com. Valenciana	20.6	18.9	7.1	32.5	26.7	43.4	43.7	46.4	45.5	12.8	6.8	14.4	39.3	42.1	28.6
Ceuta	20.6	17.0	10.8	41.3	28.3	45.7	42.6	49.3	43.5	18.8	13.9	17.9	41.3	49.3	31.5
Melilla	15.3	11.5	9.8	30.1	17.5	37.2	32.8	38.3	31.7	7.1	4.4	9.8	27.9	37.7	22.2
España	20.7	15.8	5.6	30.6	24.1	43.1	41.2	45.3	44.2	10.8	6.1	13.6	37.3	44.5	27.3

Between 0 and 15	Between 15 and 30	Between 30 and 45	Between 45 and 60
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Q01: Tutorial software or practice programmes; Q02: Digital learning games; Q03: Word-processors or presentation software (e.g. <Microsoft Word @>, <Microsoft PowerPoint @>); Q04: Spread-sheets (e.g. <Microsoft Excel@>); Q05: Multimedia production tools (e.g. media capture and editing, web production); Q06: Concept mapping software (e.g. <Inspiration @>, <Webspiration @>); Q07: Data logging and monitoring tools; Q08: Simulations and modelling software; Q09: Social media (e.g. <Facebook>, <Twitter>); Q10: Communication software (e.g. email, blogs); Q11: Computer-based information resources (e.g. websites, wikis, encyclopaedia); Q12: Interactive digital learning resources (e.g. learning objects); Q13: Graphing or drawing software; Q14: E-portfolios.

From the analysis of Table 3, the following can be inferred: (a) The presence of a roughly homogeneous territorial pattern by items, with the exception of some items, such as Q06, on conceptual mapping programs, or Q14 related to the digital portfolio, for example. Again, this territorial homogeneity is compatible with the existence of a generalised problem that goes beyond the circumstances of a specific territory. (b) The consistency of very high values for items Q08, Q14, and Q09 is consistent with the analyses for the whole of Spain. (c) The autonomous communities of Asturias, Castile-La Mancha, Castile and León and the autonomous city of Ceuta stand out due to their higher values of very deficient use of digital tools, and due to their lower values, the Basque Country and Melilla.

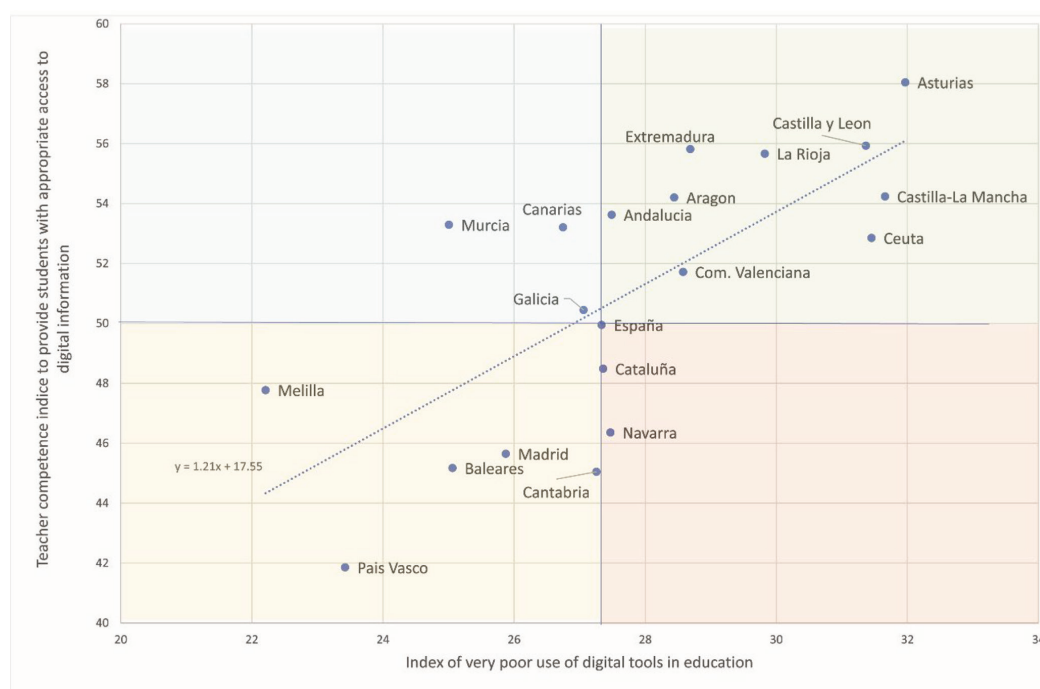
On the other hand, from Figure 4, the following results are inferred: (a) A prevalence of non-compensatory orientation in most of the territories. (b) A clearly compensatory orientation for the autonomous city of Ceuta and the Region of Murcia. At the opposite extreme are Navarre, Asturias and La Rioja.

3.3. The relationship between the two teaching competences

Figure 5 shows a linear regression analysis conducted on the collective of Spanish autonomous communities and cities, using the indices of very deficient use of digital tools and teacher competence to facilitate students' access to digital information.

From the statistical parameters obtained (see Table 4), the following can be inferred: (a) There is a positive association between the two indices, which means that the greater the deficiency in the use of digital tools in teaching, the greater, on the contrary, the frequency with which the teacher facilitates students' access to digital information. (b) This relationship is relatively intense ($R^2 = 0.52$) and statistically significant ($\text{sig.} = 0.00$). (c) The seemingly contradictory character of these results will be analysed in the Discussion.

Figure 5. Linear regression between the index of very deficient use of digital tools in teaching and the index of teacher competence to facilitate students' access to digital information.



Source: Authors, based on secondary analyses carried out by the authors based on PISA 2018 data.

3.4. The importance of digital policy in schools

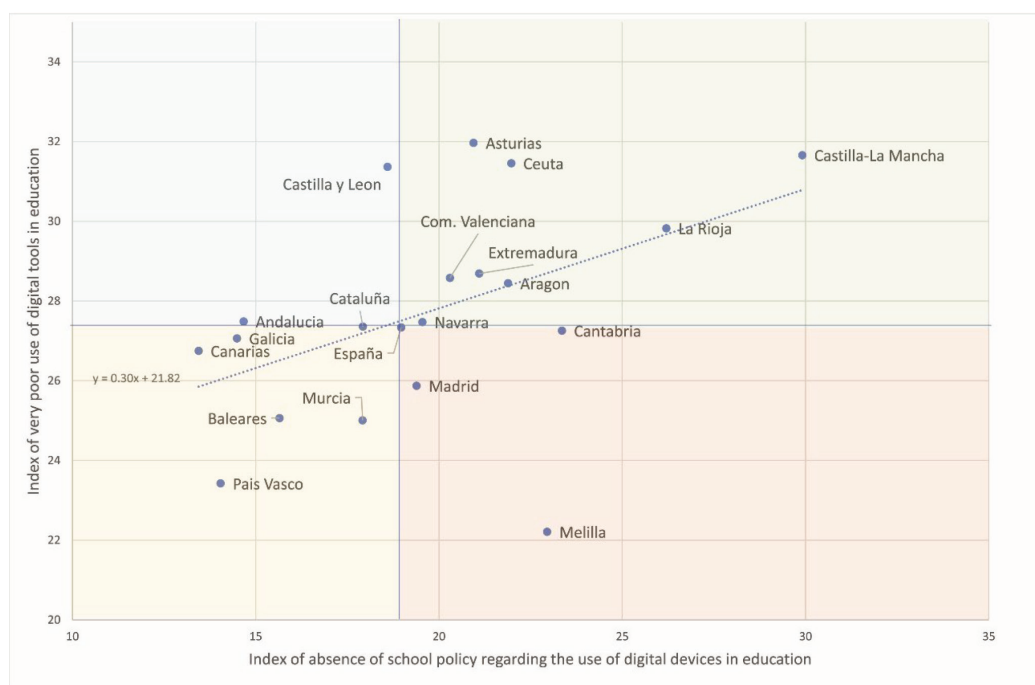
Finally, the role of a school policy on the use of digital devices in education in the development of TDC can be explored. Other studies have identified Spain as having, among other factors, the inadequacy of a digital strategy in schools and the involvement of teachers in such a strategy (Castaño Muñoz & Weikert García, 2021). It is therefore plausible to conjecture that in an educational institution with a defined policy for the use of digital devices in teaching, its teachers will be more likely to align to use digital tools with their students more often.

Table 4. Statistical parameters of the corresponding regression and variance analysis.

Regression statistics	
Multiple correlation coefficient	0.72
Determination coefficient R ²	0.52
R ² adjusted	0.49
Typical error	3.20
Observations	20

	Variance analysis				
	Degrees of freedom	Sum of squares	Average of squares	F	Sig.
Regression	1	197.84	197.84	19.34	0.00
Residuals	18	184.18	10.23		
Total	19	382.01			

Figure 6. Linear regression between the index of absence of school policy regarding the use of digital devices in education and the index of very deficient use of digital tools, by Autonomous Communities and Cities.



Source: Authors, based on secondary analyses carried out by the authors based on PISA 2018 data.

The linear regression analysis, graphically represented in Figure 6, provides results compatible with this conjecture, as discussed in the Discussion.

4. Discussion

4.1. Competence to facilitate students' access to digital information

In relation to the first of these two TDC groups analysed, and in the light of the results presented above, what draws attention strongly, on the one hand, is the fact that half of ESO teachers in Spain do not consider themselves competent in this set of items; and, on the other hand, that this lack of competence reaches much higher values for the most difficult tasks.

These results point to a real training problem. However, when the results obtained after processing the data on teacher training in general are considered (López Rupérez et al. 2021), it is noted that 25% of those teachers surveyed recognise training needs in the field of ICT skills applied to education, although this area is the priority for education administrations, with a frequency of 45%.

This apparent incoherence is twofold: on the one hand, between the level of recognised incompetence (50.1% of teachers, on average, never taught these elements) and the level of declared training needs (25%); and, on the other hand, by the existence of a frequency of in-service training in this field (45%), which, despite almost doubling the level of the declared needs (25%), seems, in practice and according to the perceptions of the teachers on its use, either not very effective or insufficient.

The first of these two inconsistencies indicates a lack of alignment –with a ratio of 2 to 1– that could reflect a fundamental professional disagreement: the teachers, to a large extent, would not consider themselves competent, but they would not give it enough importance and would believe they do not need training in this regard.

However, there could also be some confusion, or interpretative ambiguity, in the sense that for a significant fraction of teachers the competence to facilitate students' access to digital information would not be considered associated - at least so far- with ICT skills strictly considered, but rather with more general skills related to the analysis and processing of information that can be acquired outside the classroom. If this were the case, there would not have to be any correspondence between incompetence and ICT training needs, as can be seen, because they would be considered spontaneously in the teacher's mind as differentiated realities.

About the second of the above-mentioned contradictions, it seems to reveal either an overestimation by the education administrations of teachers' ICT training needs, or an underestimation by teachers, or both at the same time. The following analyses will enable us to shed some light on this.

4.2. Competence for the use of digital tools in education

When the results obtained on the degree of habitual use of digital tools in the classroom are considered, it can be seen that, on average, just over a quarter of practising teachers never use them. That fraction is close to half for the most difficult tools. In this case, it is much clearer that if a teacher does not use them, it is because they do not know how to or does not value their usefulness in the classroom. This appeals to training needs in the field of ICT applied to teaching. It should be noted here that when the results of recognised training needs (25%) are compared with those of the declared lack of use of digital tools (27%), the corresponding figures are of the same order of magnitude. This suggests that, when the aforementioned ambiguity is eliminated, a level of coincidence emerges, indicating remarkable consistency among teachers in their responses.

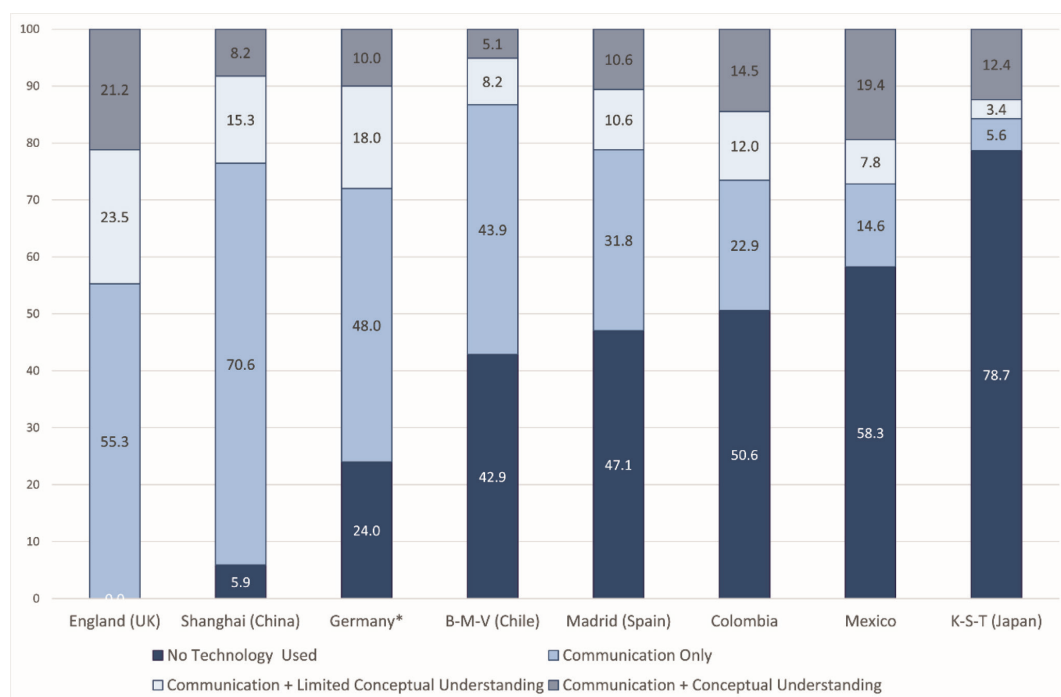
The fact is that as the difficulty of the tool increases, the proportion of teachers who never use it in the classroom also increases, clearly indicating the need to modulate the provision of ICT-oriented training according to the objective difficulty of the tools. The aim would be to better match in-service training to teachers' needs and the learning potential of digital tools, with a view to the learner and their future.

On the other hand, the observed correlation between the index of very deficient use of digital tools and that of teacher competence to facilitate students' access to digital information could be interpreted, tentatively, as an expression of a tendency of teachers to compensate for deficits in those skills that are more intellectually demanding with actions that derive from the user experience itself or that present a lower level of difficulty.

To place Spain's position on the international scene, Figure 7 presents the key results, in terms of TDC, from the GTI (Global Teaching InSights) study by the OECD (OECD, 2020; 2021). Thus, in terms of the percentage of mathematics teachers -or of classes analysed- who frequently used digital technologies for communication purposes -at least-, England (United Kingdom) is in first place with 100%, Shanghai (China) holds second place with 94.1% and Madrid (Spain) is in fifth with 52.9%, ahead of K-S-T (Japan) (21.3%), Mexico (41.7%) and Colombia (49.4%). Regarding the fuller use of digital technologies in the classroom (communication + conceptual understanding), England (United Kingdom) is also in the lead, with 21.2%. In comparison, Madrid (Spain) with 10.6% occupies fifth position, ahead of Germany (10.0%), Shanghai (China) (8.2%) and B-M-V (Chile) (5.1%).

Although the research methodologies used in PISA and GTI are different, and the degree of familiarity with digital technologies of mathematics teachers would, in principle, be higher than average, according to our data in the Community of Madrid, 45.6 % of teachers have ever taught, on average, aspects related to appropriate access to digital information, compared with 54 % of mathematics teachers who frequently used digital technologies, at least for communication purposes (see Figure 7). On the other hand, according to our study, 25.9% of ESO teachers in the Community of Madrid never used digital tools in teaching, compared to 46% of mathematics teachers who, according to direct observation, did not use digital technologies in their classes.

Figure 7. Percentages of classes according to the use of digital technologies in them.



Note: *Germany refers to a convenience sample of volunteer schools.

Source: OECD, 2020; Table 5.1. Use of technology in the classroom.

In addition to the methodological differences between the two empirical studies, there is the bias associated with “social desirability” in surveys, which limits the strict comparability of the two groups of data. However, when the heterogeneity of the PISA 2018 items is reduced by focusing on those closer to the philosophy of the GTI study (Q06, Q07, Q08, and Q12), the average figures between the two studies approximate considerably (33.7% vs 46%). In any case, and in the light of some other data groups, there is a long way ahead for Spain to improve the use of digital technologies in teaching.

4.3. On the relationship between the levels of use of both teaching competences

According to objective c), it is worth noting the observed correlation between the index of very poor use of digital tools and the index of teaching competence to facilitate students’ appropriate access to digital information. With a coefficient $R^2=0.52$ and a statistical significance of 0.00, this apparently contradictory fact could be interpreted, tentatively, as the expression of a tendency of the teachers to compensate the deficits in those competences of greater intellectual demand -which, therefore, require systematic training-, with actions that derive from one’s own experience as a user or that present a lower level of difficulty.

4.4. Territoriality, educational compensation and digital policy at the school level

For both groups of TDC items, the territorial pattern is approximately homogeneous, which can be interpreted as derived from the existence of analogous bases, in terms of the orientation of in-service training. However, for the first group of items (TC166), there is a compensatory orientation of teaching practice. Although the results of the previous empirical analyses do not allow for establishing a causal attribution of the observed compensation to teachers’ deliberate behaviour, they can still be useful for diagnosis. However, this compensatory orientation is not appreciated for the second group of items (TC169). Given the greater level of both difficulty and utility of the second group approach, the above result could reveal a lower level of possibilities or expectations of the use of digital tools in the classroom, in schools with socially disadvantaged pupils and which would be associated with significant deficits in teacher training.

Even if the behaviour of the different territories in terms of educational compensation is heterogeneous, the prevalence of socially disadvantaged schools, in terms of their deficit in the use of digital tools in teaching, clearly highlights the need for education administrations to correct this inequality factor, which has obvious consequences for the equity of the education system.

Table 5. Statistical parameters of the corresponding regression and variance analyses.

Regression statistics	
Multiple correlation coefficient	0.47
Determination coefficient R ²	0.22
R ² adjusted	0.18
Typical error	2.43
Observations	20

Variance analysis					
	Sum of squares	Sum of squares	Sum of squares	F	Sig.
Regression	1	29.85	29.85	5.06	0.04
Residuals	18	106.25	5.90		
Total	19	136.10			

Finally, it is worth noting the relationship observed between the index of absence of school policy regarding the use of digital devices in teaching and the index of very deficient use of digital tools in the classroom. Thus, a statistically significant relationship (sig. = 0.04) and a coefficient of determination (R^2) of 0.22 have been established (see Table 5). In other words, 22% of the differences in the rate of very deficient use of digital tools in teaching can be explained by the absence of a digital policy in schools.

Other factors will be mediating in that relationship, but, according to the above findings and the nature of the underlying mechanisms, the encouragement and support of education administrations on the schools to define policies for the use of digital tools in teaching, together with initiatives in this regard by the schools themselves, would make it possible to correct, with high probability, the shortcomings noted in our study. And this favourable institutional context will most likely contribute to improving students' learning (Tondeur et al., 2012; Voogt et al., 2011).

Despite the limitations of these association figures in establishing a causal relationship, especially given that the two senses of connection are plausible, the above results are compatible with the defence of greater support from education administrations for this type of policy at the school level.

Even if the validity of subjective indicators based on questionnaires has some empirical support (Kaufmann et al., 2003), there are limitations to survey methodology for teachers. Because of biases, teachers' responses may differ somewhat from what they actually do in practice. However, as Ainley and Carstens (2018) have warned, this procedure provides information on issues that would otherwise be difficult and costly to obtain.

On the other hand, the fact that, in this study, priority has been given to the extension of the sample, the soundness of its statistical representativeness by territories and the usual relevance of the PISA questionnaires, against the use of some of the theoretical models established for TDC (Falloon, 2020; INTEF, 2018; Jiménez-Hernández et al., 20219), constitute both a strength and a weakness of our work.

A further analysis of the data from the next edition of PISA (in 2022 year) will allow us to estimate, by differences, the effect of the integrated response of teachers, schools, and educational administrations induced by the COVID-19 emergency.

Author's Contribution

Francisco López Rupérez: Conceptualisation, Methodology, Supervision, Writing-review and Editing.

Isabel García García: Research, Methodology, Formal Analysis, Writing-review, and Editing.

Eva Expósito Casas: Research, Formal Analysis, Writing-review, and Editing.

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