Computers & Education 168 (2021) 104195

Contents lists available at ScienceDirect

Computers & Education

journal homepage: http://www.elsevier.com/locate/compedu

Digital inequality at home. The school as compensatory agent

Sara M. González-Betancor [a,*], Alexis J. López-Puig [b], M. Eugenia Cardenal [c]

[a] Universidad de Las Palmas de Gran Canaria, Departamento de Métodos Cuantitativos en Economía y Gestión, Facultad de Economía, Empresa y Turismo, 35017, Las Palmas de Gran Canaria, Spain
[b] Agencia Canaria de Calidad Universitaria y Evaluación Educativa (ACCUEE), Calle Granadera Canaria 2, Edificio Granadera Canaria Planta 3, 35071, Las Palmas de Gran Canaria, Spain
[c] Universidad de Las Palmas de Gran Canaria, Departamento de Psicología, Sociología y Trabajo Social, Facultad de Ciencias Jurídicas, 35017, Las Palmas de Gran Canaria, Spain

ARTICLE INFO

Keywords:
Cultural and social implications
Distance education and online learning
Media in education
Secondary education
Teaching/learning strategies
21st century skills

ABSTRACT

Following the lockdown caused by the COVID-19 crisis, the forced digitization of teaching at all levels of education has highlighted the social problem of digital inequality at home. The article addresses this issue by looking at the role of both social background, as measured by socio-economic-status (SES), in this inequality, and that of schools. A multidimensional approach to digital inequality is proposed, incorporating the frequency and quality of use of digital media, as well as ICT access. To this end, multiple structural equation models are estimated using data from the last PISA cycle (2018), for a total of 161,443 students from 6261 schools and 21 European countries, to check the influence on each of these three dimensions of both the SES and the integration of ICT in schools. The results confirm that for most European countries: (1) access to ICT at home is influenced to a greater extent by the family's SES than by the integration of ICT at school; (2) both the frequency and quality of use of ICT at home are influenced more by the integration of ICT at school than by the SES of the family, while in some countries the influence of the social aspect is practically irrelevant. Therefore, the integration of ICT in schools emerges as a compensatory measure for the social inequalities of students and may contribute to the reduction of digital inequality.

1. Introduction

The COVID19 crisis has had, among its many effects, a very drastic one on families and education systems. The lockdown imposed by governments has caused a forced digitization of teaching at all levels in the US and Europe (Iivari et al., 2020). The decision to confine the population and introduce teleworking wherever possible, and to move academic training to online platforms for an extended period, has meant relying exclusively on digital resources for education at all levels of teaching and learning. In turn, this has revealed the inadequacies of the educational model in place in each country, as well as the inequality of resources with regard to devices, connectivity, and the resulting work overload for families and teachers in their attempt to ensure the continuity of the academic course by telematic means (Ferguson, 2020; Schulze, 2020). These difficulties have accentuated the well-known relationship between digital inequality and social inequality (Robinson et al., 2015), bringing into the public debate the relationship between

* Corresponding author.
E-mail addresses: sara.gonzalez@ulpgc.es (S.M. González-Betancor), aloppui@gobiernodecanarias.org (A.J. López-Puig), mariaeugenia.cardenal@ulpgc.es (M.E. Cardenal).

https://doi.org/10.1016/j.compedu.2021.104195
Received 28 July 2020; Received in revised form 19 March 2021; Accepted 21 March 2021
Available online 27 March 2021

inequality of access to digital devices (so-called 'digital inequality') and educational opportunity.

The certainty that a return to classrooms will be mediated by the necessary hygiene measures to control infection implies that digital inequality at home will be a key issue in education planning at all levels. What can the education system, and in particular schools, do to improve this situation and prevent the widening of the digital divide between children's home settings? The debate is open, and will be necessary in order to optimize the use of resources for education, in a context of economic crisis, rising unemployment and families facing significant economic and social risks (Beaunoyer et al., 2020).

This article addresses the question by analyzing, on one hand, the relationship between social background and ICT integration at home, and on the other, the relationship between ICT integration at school and ICT integration at home, by estimating structural equations, using PISA 2018 data for 21 European countries (6261 schools and 161,443 students).

2. Background

2.1. Digital inequality

The expression 'digital divide' has been and remains popular in the media; however, current analyses invite more nuances than the term suggests. 'Divide' implies a binary division between those who 'have' and those who 'have not', while the reality of the ICT use is multidimensional and polyhedral. Selwyn (2004) argues that, in the face of the duality of having or not having, it is necessary to distinguish the mere contact with information technology (access), from its use, and from significant utilization or involvement (engagement). Warschauer, stresses that discussions on digital inequality make sense to the extent that different forms of access allow the acquisition of positions of greater power and prestige, and that this is most likely when technological devices are used profitably (Warschauer, 2002). The challenge for the author is not only to generalize the use of digital technologies, but to democratize knowledge and competencies.

Research supports this approach, emphasizing that while inequalities in access are still a major factor in digital inequality (Erdogdu & Erdogdu, 2015; Hohlfeld et al., 2017), access, frequency and significant use are not linked. Thus, the distinction between frequency of use and type of use on the Internet leads to the identification that the length of time of use is higher in lower status users, while a more profitable web use is more common among higher socioeconomic level users (Dimaggio et al., 2004; Livingstone & Helsper, 2007; Ragnedda et al., 2020; van Deursen & van Dijk, 2014). The analysis of ICT activities using PISA data also reveals less frequency of general use in students of higher social status, but a higher use for educational purposes (Manzano & Fernández-Mellizo, 2019). The *Students, Computers and Learning Report. Making the connection,* based on PISA surveys, echoes these discussions, pointing out the relevance of analyzing material and non-material resources that allow maximum use of ICT, thus distinguishing between access, frequency of use and quality of use. The document states that:

> *Digital inequality refers to differences in the material, cultural and cognitive resources required to make good use of ICT. Traditionally, research on digital inequality has focused on differences in physical access to and possession of ICT tools, while emphasising that access is only one of the many factors required to make good use of technology. (…) Equal access, however, does not imply equal opportunities (equity). Indeed, even when opportunities to learn about the world, practice new skills, participate in online communities or develop a career plan are only a few clicks away, students from socio-economically disadvantaged backgrounds may not be aware of how technology can help to raise one's social status. They may not have the knowledge and skills required to engage with massive open online courses (MOOCs), e-government websites, open educational resources, etc.* (OECD, 2015, p. 125, p. 125).

2.2. Social inequalities, digital inequalities, and schools

Contexts are equally important in order to investigate digital practices (Warschauer, 2002). It is therefore necessary to analyze the systemic dimension of digital inclusion. This article will focus on two key aspects in determining digital inequality: the role of social inequalities, which will be explored through the relationship between socio-economic-status (SES) and digital integration at home; and the role of the teaching system, which will be examined through a study of the relationship between digital integration at school and digital integration at home.

Social inequality can be measured exclusively by economic income indicators such as the Gini index (Trapeznikova, 2019) or by constructs that reflect the mutidimensionality of inequality, incorporating status, and its effects on inequality of opportunity (Weber, 2008). Bourdieu and Passeron's analysis of capital types in transmitting privilege in the meritocratic school career has a major influence on the study of digital inequality. The authors point out the importance of the specific contexts of language learning, habits, preferences and behaviors, which enable students to take advantage of their passage through the education system, building a cultural capital equivalent to the economic one in terms of its role in social reproduction (Bourdieu & Passeron, 2008). Research on digital inequality confirms this approach, underlining the importance not only of economic resources (Ragnedda et al., 2020), but also of a favorable social environment, including informal learning at home, which enriches the social experience and contributes to more profitable digital experiences (Azzolini & Schizzerotto, 2017; Dimaggio et al., 2004; Hargittai et al., 2019; Lutz, 2019). The SES, used in the PISA reports, is in this sense a good indicator, since it incorporates important elements of that capital, such as the educational level of parents and their occupation, as well as personal possessions, such as the number of books at home, which can play a significant role in the passage through school (Lutz, 2019).

The education system may play a significant role in reproducing these inequalities, or it may have a compensatory effect. It is important to remember that the use of ICT is rooted in digital practices that can be learned in day to day family life (Facer & Furlong, 2001; Stevenson, 2011), but also in schools (Warschauer et al., 2010). Studies in this field are scarce and the results are inconclusive. The OECD report mentioned above underlines that in 11 countries of those studied, the least advantaged young people make more use of computers at school than the most advantaged, but in another 10 that trend is reversed (OECD, 2015). Meneses & Mominó's analysis of the learning of basic digital skills in different scenarios concludes that the role of the school is minor, but it does not incorporate the SES as a differentiating element (Meneses & Mominó, 2010). Other papers analyze the relationship with ICT in schools and attempt to identify the influence of the family background, but they do not include the effect of different school features, nor the role of the school itself (Hatlevik & Christophersen, 2013). However, for a more complete picture of educational inequality, the role of the school in countering students' low SES must be taken into account. As Warschauer et al. point out, through an inclusive approach, experimental programs in some schools with lower social status have allowed students with a lower SES to achieve greater digital inclusion and, therefore, more opportunities to succeed (Warschauer et al., 2010).

Our study therefore fills an important gap in the analysis of digital inequality and digital inclusion by analyzing the separate effects of social inequality and the education system on digital inclusion at home. If we can identify the influence of the school on digital integration in the home, and on which aspects of this integration it is more relevant, it should be possible to determine more specifically what kind of educational actions are necessary to facilitate the digital inclusion of students from all social classes and ultimately to correct digital inequality. In a public health scenario such as the current one, this analysis becomes central, since governments will have to develop hybrid models of teaching and learning in order to guarantee the continuity of education in the event of a new situation which prevents face-to-face education.

2.3. Research hypotheses

What effect does social inequality have on students' digital inequality at home? What effect do schools have? These are the two questions that guide this research. To this end, two categories of analysis have been constructed that bring together the three dimensions of digital inequality highlighted as relevant in section 2.1. and which we have come to call ICT integration at home and ICT integration at school.

Our analysis focuses on a scenario where home is replacing the formal education setting and therefore students must have the necessary material and digital resources in order to continue their academic learning. This leads us to the important question of the role of the school in relation to digital inequality.

Before establishing the hypotheses for our study, it is helpful to give a brief definition for the following concepts that we will use repeatedly throughout the article:

- ICT access: refers to the provision of ICT resources (e.g. computers, tablets, laptops, internet connection, interactive whiteboards, storage servers …) and their availability for student use.
- ICT frequency of use: refers to the variety of use of digital devices, as well as the time spent using them.
- ICT quality of use: refers to the autonomy and development of students' digital competences, as well as their teachers' skill in using digital devices. We are not referring to the quality of the ICT itself (i.e. the equipment and its functioning), but to the quality of its use (i.e. the competence of students and teachers).
- ICT integration: refers to the integration of the three previous concepts, i.e., the mode of access, frequency of use and quality of use of ICT -either at home or at school.

We will define all these concepts in more detail in sections 3.2.2 and 3.2.3 taking into account the PISA ICT framework (OECD, 2019), as the data source for this study is PISA, as explained in section 3.1.

Fig. 1 shows the relationship between ICT integration at home (HOME_ICT) and SES, through H1, and between ICT integration at home and at school (SCH_ICT), through H2.

According to the literature reviewed above, HOME_ICT can be divided into three different elements (access, frequency of use and quality of use), in order to make it possible to analyze the influence of both, the SES and the ICT integration at school (SCH_ICT) on each of them. Thus, the two hypotheses are expanded into the following six:

H1. : The socio-economic and cultural environment influences the integration of ICT at home:

- **H1a:** SES influences ICT <u>access</u> at home
- **H1b:** SES influences ICT <u>frequency of use</u> at home
- **H1c:** SES influences ICT <u>quality of use</u> at home

Fig. 1. *The influence of socio-economic status (*SES*) and school ICT integration (*SCH_ICT*) on ICT integration at home (*HOME_ICT*).* Hypothesis 1 (H1): The socio-economic and cultural environment (SES) influences the integration of ICT at home (HOME_ICT); Hypothesis 2 (H2): The integration of ICT at school (SCH_ICT) influences the integration of ICT at home (HOME_ICT).

H2. : The integration of ICT at school influences the integration of ICT at home:

- **H2a:** SCH_ICT influences ICT access at home
- **H2b:** SCH_ICT influences ICT frequency of use at home
- **H2c:** SCH_ICT influences ICT quality of use at home

3. Methodology

3.1. Sample

The data source for this study is PISA 2018, a large-scale international assessment which focused that year on the language competence of 15-year-old students in 37 OECD countries and 42 partner countries and economies. Of all the countries that participated in this cycle, our work focuses on the European Union countries.

The PISA tests consist of a series of cognitive tests, along with contextual questionnaires, which collect information from schools and teachers, as well as students and their families. The information that we have used in our analysis comes from these contextual questionnaires.

In 2018, PISA tests were applied to students in a total of 26 European Union countries. However, since the computer familiarity questionnaire was optional for participating countries, five of these chose either not to take it (Netherlands, Portugal and Romania) or to take a simplified version with fewer questions (Austria and Germany). As a consequence, these five countries do not have some of the key indicators for this study, and they have therefore been excluded from our study which was conducted with the remaining 21 European Union countries. For this reason, when we refer to 'Europe' in this study, we refer to these 21 countries of the European Union (Eur-21). A total of 161,443 students from 6261 schools were retained in the sample (see Appendix A).

3.2. Method

In order to be able to test the above-mentioned hypotheses, it was necessary to generate some indicators that were not directly calculated in the PISA 2018 database. These indicators were all obtained by means of factorial analyses from the corresponding variables in the different questionnaires. Once all the indicators were obtained, the structural equation model (SEM), described in a following section, was estimated. The statistical and econometric analysis was performed with StataSE 15 employing all PISA recommended practices related to final student weights and balanced repeated replications (OECD, 2020).

3.2.1. SES

Starting with hypothesis 1, which seeks to analyze the relationship between the socio-economic and cultural environment and the integration of ICT at home, it is necessary to incorporate a SES variable. Although there is a SES variable in the PISA database, it includes - among other components - information related to household possessions (including digital devices). Therefore, it was not appropriate to use the original PISA SES variable, since using it, would explain ICT integration at home by one of its components, namely ICT access at home, which would lead to endogeneity problems. For this reason, instead of using the existing SES variable of the PISA 2018 dataset, we derived a new latent variable composed of three indicators directly available in the PISA 2018 databases (*Books, HISEI* and *HISCED)*. All the variables that have been used to obtain SES for this study come from questions in the student questionnaire.[1]

Books is a categorical variable, that refers to the number of books available at home, obtained from question ST013Q01TA.

HISEI (highest parental occupational status) is an index that refers to the highest ISEI (international socio-economic index of occupational status) score of either parent, or to the only available parent's ISEI score, and was obtained from questions ST014 and ST015.

Finally, *HISCED* (highest parental education level) is an index, that refers to the highest ISCED (international standard classification of education) level of either parent, or to the only available parent's ISCED level, and was obtained from questions starting with ST005 to ST008.

These three indexes are the observable variables used for estimating the latent variable SES that allowed us to check H1a, H1b and H1c via the SEM model (Fig. 2).

3.2.2. SCH_ICT

In order to test the relationship between school ICT integration and home ICT integration (H2), it is necessary to have an indicator for the former as another latent variable of the SEM. This indicator, which we have called SCH_ICT, is composed of three other variables - *S_access*, *S_use*, *S_quality* - which have been generated from indicators and variables in the PISA2018 database.

The *S_access* index refers to the access to ICT resources at school. It was obtained from the combination by factor analysis of two indicators directly available from PISA 2018, *Ratcmp1* - number of available computers per student at modal grade - and *Ictsch* - ICT availability at school index. The former is derived from the question starting with SC004 of the school questionnaire administered to

[1] All variables in the study have been refined by imputing as missing the observations that contain INVALID or NO RESPONSE.

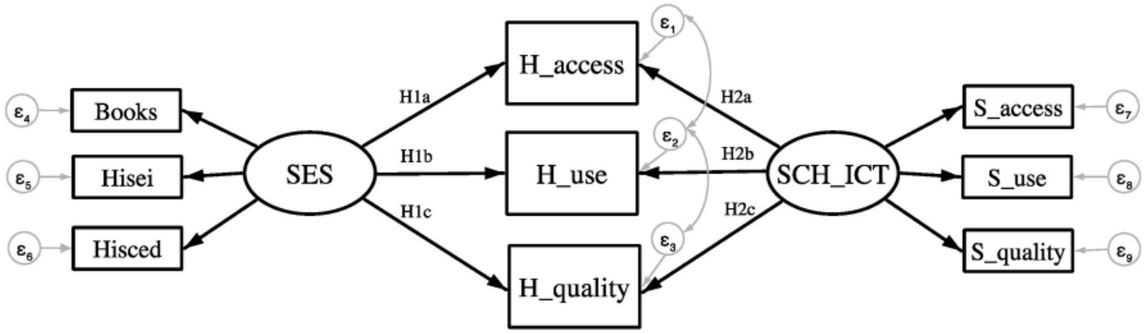

Fig. 2. *The influence of Socio-economic status (*SES*) and school ICT integration (*SCH_ICT*) on ICT access at home (H_access), ICT frequency of use at home (H_use), and ICT quality of use at home (H_quality).* Notes: Socio-economic status (SES) is a latent variable composed of three PISA indicators: Number of books available at home (*Books*), Highest parental occupational status (*HISEI*) and Highest parental education level (*HISCED*). School ICT integration (SCH_ICT) is a latent variable composed of three indicators: access to ICT resources at school (*S_access*), frequency of use of ICT at school (*S_use*) and quality of use of ICT at school (*S_quality*). Hypothesis 1a (H1a): Socio-economic status (SES) influences the access to ICT resources at home (*H_access*). Hypothesis 1b (H1b): Socio-economic status (SES) influences the frequency of use of ICT at home (*H_use*). Hypothesis 1c (H1c): Socio-economic status (SES) influences the quality of use of ICT at home (*H_quality*). Hypothesis 2a (H2a): The integration of ICT at school (SCH_ICT) influences access to ICT resources at home (*H_access*). Hypothesis 2b (H2b): The integration of ICT at school (SCH_ICT) influences the frequency of use of ICT at home (*H_use*). Hypothesis 2c (H2c): The integration of ICT at school (SCH_ICT) influences the quality of use of ICT at home (*H_quality*). The curved arrows represent the covariances between the endogenous variables in the SEM.

principals, and the latter from the question starting with IC009 of the ICT familiarity questionnaire administered to students. The index therefore not only measures the ratio of computers in the school to students aged 15, but also the availability of other digital devices for use by students in the school, such as laptops, tablets, internet connection, WI-FI, storage devices, electronic books, interactive whiteboards, etc.

S_use is another index that refers to the frequency of use of ICT at school. It was obtained from the combination by factor analysis of two other indicators available from PISA 2018, *Usesch* and *Ictclass*. Both indicators come from the familiarity questionnaire administered to students. *Usesch* comes from the questions starting with IC011 and is an index which measures the frequency of use of ICT at school in general. *Ictclass* comes from the question starting with IC150, and is an index showing the time spent using digital devices during classroom lessons. Hence, this index measures the use of digital devices at school (for on-line chatting, sending emails, browsing the Internet for schoolwork, uploading, posting or browsing material from the school's website, playing simulation games, practising foreign language learning or math, doing homework, using school computers for group work and communication with other students, using learning apps or learning websites) as well as the time spent using these digital devices in all subjects in a typical school week.

Finally, *S_quality* is an index that refers to the quality of use of ICT at school. It is a combination by factor analysis of two other indicators that were not directly available in the PISA dataset and that were derived initially from factor analysis. These indicators are *Qualict*, related to the quality of ICT training at school - derived from questions starting with ST158 from the student questionnaire -, and *Tqualict*, another indicator related to ICT teaching quality - derived from question starting with SC155 from the ICT familiarity questionnaire. The index, therefore, synthesizes what students indicate they have learned about how to use Internet (use keywords when using a search engine, decide whether to trust information from the Internet, compare different web pages and decide what information is more relevant, understand the consequences of making information publicly available online, use the short description below the links in the list of results of a search, detect whether the information is subjective or biased and detect phishing or spam emails), and what they observe about the teacher's capacity using digital devices (whether teachers have the skills to integrate digital devices in instruction, or have sufficient time to prepare lessons integrating digital devices; whether there are effective professional resources for teachers to learn how to use digital devices; whether the school has sufficient qualified technical assistant staff).

These three indexes are the observable variables used for estimating the latent variable SCH_ICT (school ICT integration) that allows us to check H2a, H2b and H2c via the SEM model (Fig. 2).

3.2.3. HOME_ICT

The three endogenous variables included in HOME_ICT (*H_access*, *H_use*, *H_quality*) - to check hypotheses a, b, and c - have also been generated from indicators available from PISA 2018 by means of factor analysis.

H_access is an index that refers to the access to ICT resources at home. It was obtained from the combination by factor analysis of two indicators directly available from PISA 2018, *Ictres* - ICT resources at home - and *Icthome* - index of ICT availability to students at home. The former is derived from the questions starting with ST011 and ST012 of the student questionnaire, and the latter from the question starting with IC001 of the ICT familiarity questionnaire administered to students. Thus, *H_access* synthesizes not only whether there are digital devices at home, such as: laptops, tablets, internet connection, WIFI, storage devices, electronic books, interactive whiteboards, etc., but also whether they are available for the students to use.

H_use is another index that refers to the frequency of use of ICT at home. It was obtained from the combination by factor analysis of two other indicators available from PISA 2018, *Entuse* and *Homesch*. Both indicators come from the familiarity questionnaire administered to students. *Entuse* comes from the question starting with IC008, and is an index showing the frequency of use of ICT outside of school for leisure. *Homesch* comes from the question starting with IC010 and is an index about the frequency of use of ICT outside school for schoolwork activities. Thus, *H_use* synthesizes the frequency of use of digital devices for leisure (e.g. playing one-player or collaborative online games, using email, chatting online, participating or playing in social networks, browsing the Internet for fun, reading news, obtaining practical information, downloading music, films, games or software, uploading self-created content for sharing, downloading new apps on a mobile device, etc.) as well as for schoolwork (e.g. browsing the Internet for schoolwork or to follow up lessons, using email for communication with other students or teachers about schoolwork or for submission of homework, using social networks for communication with other students or teachers about schoolwork, downloading, uploading or browsing material from the school's website, checking the school's website for announcements, doing homework on a computer or a mobile device, using learning apps or learning websites on a computer or a mobile device, etc.).

Finally, *H_quality*, is an index that refers to the quality of use of ICT at home. It is a combination by factor analysis of two other indicators available from PISA 2018, *Autict* and *Compict*. Both indicators come from the familiarity questionnaire administered to students. *Autict* is derived from the question starting with IC015, and is an index showing perceived autonomy related to ICT use. *Compict* comes from the questions starting with IC014 and is an index that refers to perceived ICT competence. Thus, *H_quality* synthesizes what students think about their ICT autonomy (ability to install the software they need, to read and understand information about digital devices, to use digital devices for self-defined purposes, to solve problems with digital devices on their own, and to choose new applications by themselves), as well as their perceived ICT competence (feel comfortable using their digital devices at home, or using other devices they are less familiar with, ability to give advice to friends and relatives about new digital devices or applications, feel able to solve problems with digital devices, as well as to help friends and relatives with digital devices, …).

3.2.4. Model

Using all these latent and observable variables we estimated the following model for the whole sample (Eur-21), as well as for each of the 21 countries that it comprises, in order to test the significance of the estimated parameters in all 22 estimated SEMs that allow us to check whether our hypotheses are true or not for Eur-21 and for each individual country (Fig. 2).

4. Results

4.1. Descriptive statistics

Table 1 includes a description of the indicators used to generate all the latent variables and indexes in the model in Fig. 2. In it we can observe different measures of dispersion and the different average values for the different indicators, both those that generate the latent variable SES, and those that generate the latent variables related to ICT (at school and at home). These data show that access, frequency of use and quality of use of ICT is very heterogeneous among students and their schools, as is the socio-economic and cultural composition of families.

The following maps represent the average values of indexes of ICT access, frequency of use and quality of use by students at home

Table 1
Means, standard deviations (SD), minimums (Min) and maximums (Max) of observed variables (Indicators) for the 21 European countries.

Latent variables	Indexes	Indicators	Mean	SD	Min	Max
SES		*Books*	3.24	1.46	1	6
		HISEI	50.45	22.09	11.01	88.96
		HISCED	4.77	1.37	0	6
SCH_ICT	*S_access*	*Ratcmp1*	0.69	0.72	0	25
		Ictsch	6.03	2.37	0	10
	S_use	*Usesch*	0.02	0.98	−2.54	3.35
		Ictclass	−0.10	0.95	−1.22	2.44
	S_quality	*Qualict*	0.66	0.39	0	1.21
		Tqualict	2.87	0.56	1.10	4.39
HOME_ICT	*H_access*	*Ictres*	−0.10	0.87	−3.97	3.61
		Icthome	8.51	2.01	0	11
	H_use	*Entuse*	0.10	1.00	−3.59	4.31
		Homesch	0.01	0.99	−2.70	3.32
	H_quality	*Autict*	0.05	0.97	−2.51	2.03
		Compict	0.09	0.99	−2.62	2.58

Source: Authors' own calculations, using final student weights, from PISA 2018.
Legend: SES: Socio-economic-status; SCH_ICT: ICT integration at school; HOME_ICT: ICT integration at home; *S_access*: Access to ICT resources at school; *S_use*: Frequency of use of ICT at school; *S_quality*: Quality of use of ICT at school; *H_access*: Access to ICT resources at home; *H_use*: Frequency of use of ICT at home; *H_quality*: Quality of use of ICT at home; *Books*: Number of books available at home; *HISEI*: Highest parental occupational status; *HISCED*: Highest parental education level; *Ratcmp1*: Number of available computers per student at modal grade; *Ictsch*: ICT availability at school index; *Usesch*: General use of ICT at school index; *Ictclass*: Time spent using digital devices during classroom lessons index; *Qualict*: Quality of ICT training at school; *Tqualict*: ICT teaching quality index; *Ictres*: ICT resources at home; *Icthome*: Index of ICT availability to students at home; *Entuse*: Index measuring the frequency of use of ICT outside school for leisure; *Homesch*: Index measuring the frequency of use of ICT outside school for school work activities; *Autict*: Index measuring perceived autonomy related to ICT use; *Compict*: Index measuring perceived ICT competence.

(Fig. 3) and in their schools (Fig. 4). The darker the color of a country, the higher the value for the index it represents. It is clear from the maps that there are important differences between the 21 European countries. On the one hand, there are countries where the variation between access, frequency of use and quality of use within the household hardly varies, such as Finland or Spain (Fig. 3). On the other hand, there are other countries where the differences between these aspects are more pronounced, such as Estonia, France or Italy (Fig. 3). As far as ICT at school is concerned, in most countries there are differences between access, frequency of use and quality of use, and there is no pattern of stability in any particular country (Fig. 4).

Finally, comparing Figs. 3 and 4, it can be seen that the range of colors in the maps of access, use and quality have a number of similarities - although with some exceptions in certain countries - so that a possible relationship between ICT at school and ICT at home can be inferred.

4.2. *H1: The socio-economic and cultural environment influences the integration of ICT at home*

The direct effects between SES and the three aspects of ICT at home *(H_access, H_use, H_quality*) are presented in Table 2. All three effects are statistically significant for Eur-21, so our three hypotheses are confirmed for these countries as a whole.

As can be seen in the first results column of Table 2, SES influences access at home to ICT in all European countries. However, this influence is not totally homogeneous between countries, as the estimated coefficients vary between 0.203 in Sweden and 0.446 in Spain, the average being 0.325.

On the contrary, the second and third results columns of Table 2 show that the influence of SES on the frequency and quality of ICT use at home is not statistically significant in all countries. In fact, there are 9 countries where SES is not related to the frequency of ICT use, and 5 where it is not related to the quality of ICT use.

Finally, it should be noted that in those countries where the SES is related to the three aspects of ICT, the influence it has on access (H1a) is far greater than that on frequency of use (H1b) or quality of use (H1c).

4.3. *H2: The integration of ICT at school influences the integration of ICT at home*

The direct effects between the integration of ICT at school (SCH_ICT) and the three aspects of ICT at home *(H_access, H_use, H_quality*) are presented in Table 3. All three effects are also statistically significant for Eur-21, as well as for each of the countries it comprises, so our other three hypotheses are confirmed for all individual countries, and also for Eur-21 as a whole.

Therefore, the integration of ICT at school is significantly related to access, frequency of use and quality of use of ICT at home. Furthermore, in general the influence of SCH_ICT is stronger firstly on the frequency of use, secondly on access and thirdly on the quality of use (except in some countries such as Denmark or Sweden). The value of this influence varies between the countries analyzed: in access, it ranges from 0.178 in Denmark to 0.398 in Croatia; in frequency of use, it ranges from 0.385 in Malta to 0.711 in Finland; and finally, in quality of use, it ranges from 0.056 in Belgium to 0.362 in Denmark.

5. Discussion

Our results confirm the need for multi-dimensional studies on the use of ICT at home, as pointed out by Stevenson (2011), when she stated that, beyond focusing on access to ICT, studies that focus on the messy realities of ICT usage in the home should be carried out.

5.1. *ICT access at home*

From the results presented in the previous section, it can be seen that ICT access at home is influenced to a greater extent by the family's SES (H1a) than by ICT integration at school (H2a). This is the case in most of the countries analyzed, although there are

Fig. 3. Mean values for ICT access, frequency of use and quality of use at home in 21 European countries. Source: Authors' own calculations, using final student weights, with PISA 2018.

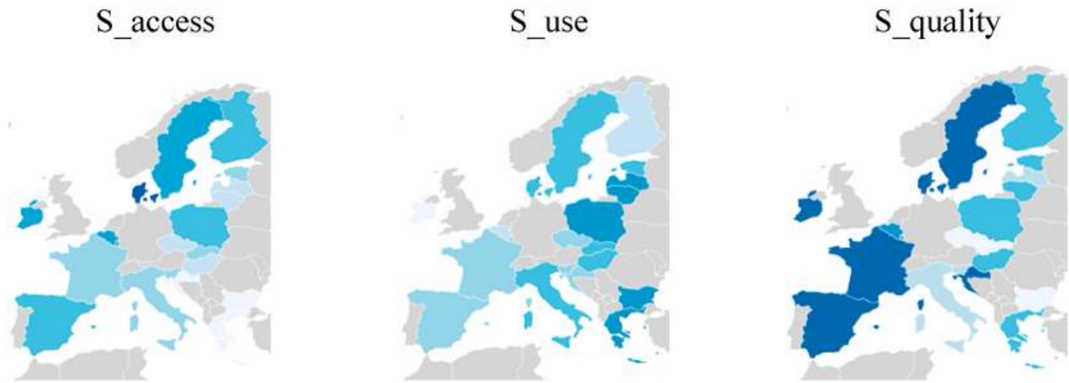

Fig. 4. Mean values for ICT access, frequency of use and quality of use at school in 21 European countries. Source: Authors' own calculations, using final student weights, with PISA 2018.

Table 2
Standard direct effects for H1: The socio-economic and cultural environment influences the integration of ICT at home.

	H1a	z	Sig.	H1b	z	Sig.	H1c	z	Sig.
Belgium	0.332	20.53	***	−0.008	−0.50		0.000	−0.01	
Bulgaria	0.417	19.28	***	0.166	7.58	***	0.225	10.14	***
Croatia	0.292	17.92	***	0.029	2.00	**	0.102	6.14	***
Czech Republic	0.316	17.73	***	−0.013	−0.70		0.029	1.46	
Denmark	0.232	10.30	***	−0.010	−0.50		0.014	0.64	
Estonia	0.276	13.90	***	0.021	1.11		0.093	4.54	***
Finland	0.232	12.60	***	0.069	4.09	***	0.064	3.44	***
France	0.261	13.45	***	−0.036	−1.79	*	0.030	1.47	
Greece	0.390	21.94	***	0.018	0.94		0.116	5.79	***
Hungary	0.414	23.22	***	0.054	2.80	***	0.162	8.53	***
Ireland	0.332	16.93	***	0.017	0.94		0.085	4.21	***
Italy	0.395	21.23	***	0.048	2.41	**	0.029	1.42	
Latvia	0.271	12.40	***	0.049	2.56	**	0.121	5.48	***
Lithuania	0.299	17.05	***	0.051	2.90	***	0.174	9.66	***
Luxembourg	0.416	23.21	***	−0.040	−2.32	***	0.056	2.79	***
Malta	0.271	11.06	***	0.041	1.76	*	0.128	5.17	***
Poland	0.263	14.89	***	−0.008	−0.48		0.109	6.21	***
Slovakia	0.325	17.15	***	0.078	4.07	***	0.150	7.47	***
Slovenia	0.271	12.65	***	0.045	2.38	**	0.045	1.90	**
Spain	0.446	39.14	***	0.015	1.20		0.056	4.51	***
Sweden	0.203	8.94	***	0.024	1.21		0.037	1.67	*
Eur-21	0.325	48.88	***	−0.020	−2.98	**	0.073	10.29	***

Legend: H1a: Coefficient for each country for H1a (socio-economic status influences access to ICT resources at home); H1b: Coefficient for each country for H1b (socio-economic status influences the frequency of use of ICT at home); H1c: Coefficient for each country for H1c (socio-economic status influences the quality of use of ICT at home); z: test statistic; Sig.: significance level (*** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$).
Note: If the significance level has at least one asterisk (*), the hypothesis for the given country is accepted. The higher the coefficient, the greSource: Authors' own calculations, using final student weights, from PISA 2018.

differences among them. For example, in Slovakia, Sweden or Estonia the influence of SES and that of ICT integration at school are almost equally important. On the other hand, in Luxembourg, Spain or Ireland there are differences in their influence, in favor of a greater SES influence. This relationship between SES and the integration of ICT at home has already been shown by Scherer and Siddiq (2019), whose meta-analysis suggest that students' ICT literacy differs between socioeconomic status groups. Zilka (2020), in the case of Israel, highlights the differences in access to technology between schools and homes and indicates that ICT in schools is sometimes outdated. However, as Bati and Workneh (2020) point out, it is important to integrate ICT resources within and outside the school, because of the effect that the improved use of ICT has on student learning, and also because of the influence that technology has on the collaborative problem-solving skills of young people (Shin & Kim, 2019).

5.2. ICT frequency of use at home

The analysis for these 21 European countries also shows that, in the frequency of use of ICT at home, the integration of ICT at school is fundamental (H2b), while the influence of the social aspect is practically irrelevant (H1b), and even non-existent in countries such as Belgium, the Czech Republic, Denmark, Estonia, Greece, Ireland, Poland, Spain and Sweden. This relationship between ICT at home

Table 3
Standard direct effects for H2: The integration of ICT at school influences the integration of ICT at home.

	H2a	Z	Sig.	H2b	z	Sig.	H2c	z	Sig.
Belgium	0.378	21.86	***	0.461	19.84	***	0.056	2.72	***
Bulgaria	0.321	6.18	***	0.534	19.62	***	0.251	7.95	***
Croatia	0.398	17.24	***	0.662	29.53	***	0.329	15.58	***
Czech Republic	0.268	7.93	***	0.644	14.26	***	0.258	7.78	***
Denmark	0.178	4.66	***	0.647	11.76	***	0.362	9.44	***
Estonia	0.296	9.94	***	0.677	22.50	***	0.216	7.98	***
Finland	0.312	13.64	***	0.711	33.33	***	0.270	11.14	***
France	0.353	8.39	***	0.653	15.55	***	0.198	6.04	***
Greece	0.359	12.32	***	0.493	17.77	***	0.129	5.02	***
Hungary	0.334	12.98	***	0.592	21.66	***	0.236	9.77	***
Ireland	0.216	9.46	***	0.579	26.40	***	0.081	3.49	***
Italy	0.296	8.73	***	0.546	18.91	***	0.211	7.55	***
Latvia	0.233	7.09	***	0.559	14.92	***	0.182	6.64	***
Lithuania	0.257	10.04	***	0.552	23.30	***	0.087	3.89	***
Luxembourg	0.171	8.13	***	0.552	19.55	***	0.119	5.18	***
Malta	0.298	9.07	***	0.385	9.60	***	0.091	2.56	**
Poland	0.220	7.15	***	0.506	18.95	***	0.200	8.82	***
Slovakia	0.329	11.32	***	0.566	21.59	***	0.230	8.49	***
Slovenia	0.334	11.81	***	0.571	20.12	***	0.220	7.17	***
Spain	0.217	12.69	***	0.456	26.23	***	0.108	6.51	***
Sweden	0.190	6.69	***	0.617	21.83	***	0.268	10.58	***
Eur-21	**0.279**	**27.06**	***	**0.494**	**58.34**	***	**0.169**	**19.80**	***

Legend: H2a: Coefficient for each country for H2a (The integration of ICT at school influences access to ICT resources at home); H2b: Coefficient for each country for H2b (The integration of ICT at school influences the frequency of use of ICT at home); H2c: Coefficient for each country for H2c (The integration of ICT at school influences the quality of use of ICT at home); z: test statistic; Sig.: significance level (***$p < 0.01$; **$p < 0.05$; *$p < 0.10$).
Note: If the significance level has at least one asterisk (*), the hypothesis for the given country is accepted. The higher the coefficient, the greater the influence.
Source: Authors' own calculations, using final student weights, from PISA 2018

and in school is consistent with that detected by Pullen (2015) for Australia. Furthermore, Eickelmann et al. (2017) highlight that the integration of ICT into teaching (at school) and learning (at school and at home) is relevant across the educational systems and correlated to characteristics at school. However, the frequency of use should be moderated, as excessive access to ICT resources, excessive use of ICT, and excessive interest in ICT can be associated with lower digitally assessed reading performance (Gubbels et al., 2020).

5.3. *ICT quality of use at home*

Finally, in terms of the quality of use of ICT at home, although the study by Hohlfeld et al. (2017) identified a differentiated use of ICT according to students' socioeconomic environment, our study shows that the influence of the integration of ICT at school (H2c) is more relevant than that of the family's SES (H1c). In fact, in some countries the influence of the latter aspect is not even significant, as is the case in Belgium, the Czech Republic, Denmark, France and Italy. Our result is in line with one of the conclusions of the work of Petko et al. (2017), who indicate that, controlling for influential sociodemographic factors, it might be quality instead of quantity of educational technology use that matters. In addition, quality use of ICT in households should begin at an early age in order to develop higher ICT competence and autonomy at later ages (Juhaňák et al., 2019).

Consequently, as previous studies have indicated, increasing and improving the integration of ICT in the teaching and learning process improves the educational performance of students (Skryabin et al., 2015; Xiao et al., 2019; Zhang & Liu, 2016), although sometimes it does so for some subjects and not for others (Fernández-Gutiérrez et al., 2020). Sometimes, the mere fact of having ICT access at home (Alderete et al., 2017; Formichella et al., 2020) or an internet connection at home or school (Erdogdu & Erdogdu, 2015) in itself improves student performance, especially when it is used for educational proposes (Srijamdee & Pholphirul, 2020). However, it is worth differentiating what exactly the ICT integration consists of, since Hu et al. (2018) find a greater effect on student academic performance of ICT skills than of ICT access and use. Moreover, our results show that when ICT integration is present in schools, it also contributes as a measure of compensation for the effect of the family's SES on digital inequalities at home, which in turn could moderate student achievement (Xiao & Hu, 2019). Finally, it should also be noted that this compensatory action of ICT integration via the education system, and particularly via schools, is particularly relevant in situations where it is necessary to adapt teaching to a forced distance learning mode (Adam & Tatnall, 2017).

6. Conclusions

The main objective of this study was to contribute to a better understanding of the digital inequalities that occur in students' households and the extent to which SES and the school influence them. Based on the SEM analyses carried out using PISA 2018 data for 21 European countries, we found that ICT integration at home is influenced by the SES of the family - H1 - as well as by the integration of ICT at school (access, frequency of use and quality of use) - H2. However, we have also been able to show that this influence differs when we analyze separately access, frequency of use and quality of use of ICT at home. Specifically, regarding access, SES has slightly more influence than the integration of ICT at school, while regarding use, SES has practically no influence, and finally, regarding quality of use, the integration of ICT at school has a slightly greater influence than the family's SES.

Therefore, in a situation such as the one experienced by the global health crisis caused by COVID-19, in order to ensure that students have equal opportunities in access, use and quality of ICT at home, thus reducing digital inequalities, it is essential for public institutions to establish measures to compensate for the SES of families. However, we have seen that this alone is not enough, as it is also necessary to carry out specific actions to improve the integration of ICT in schools, which will in turn lead to an improved integration of ICT at home. Based on the indicators we have used to analyze school ICT integration (Table 1), and on the results of the estimated structural equation models (Table 3), our proposals for action are:

- To improve ICT access at school:
  - o increase the availability of computer equipment in schools
  - o prioritize the use of devices that are autonomous in their operation, i.e. that include Internet connectivity
- To improve frequency of use of ICT at school:
  - o promote a generalized use of ICT in schools in all subjects
- To improve quality of use of ICT at school:
  - o establish common criteria within the school to ensure a responsible and critical use of ICT
  - o improve teacher training in ICT, providing the necessary time and resources for this purpose

Furthermore, in those schools where the SES is lower, it will be necessary to invest more in the integration of ICT at school.

Our proposals reinforce the need to continue along the lines of what some OECD countries are already doing. As Van der Vlies (2020) argues, many OECD countries have generic strategies on digital innovation (which often focus on economic growth and modernization), though not all have digital education strategies (which aim at education and visualize how digital innovation can benefit education). In his study, he states that most OECD countries have focused mainly on aspects such as ICT infrastructure (e.g. Internet connectivity and access to digital devices) and advances in existing ICT technologies (e.g. digital learning environments or access to resources). But he also recognizes that there are still challenges related to the development of skills and competences of students and teachers, not least the digital divide that can be generated (Van der Vlies, 2020), which is also in line with our proposals. However, we include some original ones - which are not among the digital strategies in education -, such as those referring to the type of device and its connectivity, the general use in all subjects, and the common criteria within schools for a responsible and critical use of ICT.

The main limitation of this study comes from the use of PISA 2018 data for the European countries that participated in that cycle, which limits our findings exclusively to this geographical area, and to the students that participated in these tests. Therefore, it would still be interesting to analyze these same associations for other countries, as well as for other educational levels.

Credit author statement

Sara M. González Betancor: Conceptualization; Formal analysis; Funding acquisition; Methodology; Project administration; Resources; Supervision; Visualization; Writing - original draft; Writing - review & editing Alexis J. López Puig: Conceptualization; Data curation; Formal analysis; Methodology; Resources; Writing - original draft; Writing - review & editing; M. Eugenia Cardenal: Conceptualization; Resources; Writing - original draft; Writing - review & editing.

Appendix A Number of students and schools of the sample

	Students	Schools
Belgium	8475	288
Bulgaria	5294	197
Croatia	6609	183
Czech Republic	7019	333
Denmark	7657	348
Estonia	5316	230
Finland	5649	214
France	6308	252
Greece	6403	242
Hungary	5132	238
Ireland	5577	157
Italy	11,785	542
Latvia	5303	308
Lithuania	6885	362
Luxembourg	5230	44
Malta	3363	50

(*continued on next page*)

(*continued*)

	Students	Schools
Poland	5625	240
Slovakia	5965	376
Slovenia	6401	345
Spain	35,943	1089
Sweden	5504	223
Eur-21	**161,443**	**6261**

References

Adam, T., & Tatnall, A. (2017). The value of using ICT in the education of school students with learning difficulties. *Education and Information Technologies, 22*(6), 2711–2726. https://doi.org/10.1007/s10639-017-9605-2

Alderete, M. V., Di Meglio, G., & Formichella, M. M. (2017). Acceso a las TIC y rendimiento educativo: ¿una relación potenciada por su uso? Un análisis para españa. *Revista de Educación, 377*(Julio-Septiembre), 54–79. https://doi.org/10.4438/1988-592X-RE-2017-377-353

Azzolini, D., & Schizzerotto, A. (2017). The second digital divide in Europe. A cross- national study on students' digital reading and navigation skills. In *Research institute for the evaluation of public policies (No. 2017–02; FBK-IRVAPP working paper series)*.

Bati, T. B., & Workneh, A. W. (2020). Evaluating integrated use of information technologies in secondary schools of Ethiopia using design-reality gap analysis: A school-level study. In *The electronic journal of information systems in developing countries*. https://doi.org/10.1002/isd2.12148

Beaunoyer, E., Dupéré, S., & Guitton, M. J. (2020). COVID-19 and digital inequalities: Reciprocal impacts and mitigation strategies. *Computers in Human Behavior, 111* (April), 106424. https://doi.org/10.1016/j.chb.2020.106424

Bourdieu, P., & Passeron, J. C. (2008). *La Reproducción. Elementos para una teoría del sistema educativo* (2nd ed.) Popular.

van Deursen, A. J., & van Dijk, J. A. (2014). The digital divide shifts to differences in usage. *New Media & Society, 16*(3), 507–526. https://doi.org/10.1177/1461444813487959

Dimaggio, P., Hargittai, E., Celeste, C., & Shafer, S. (2004). Digital inequality: From unequal access to differentiated use. In K. M. Neckerman (Ed.), *Social inequality* (pp. 355–400). Russell Sage Foundation.

Eickelmann, B., Gerick, J., & Koop, C. (2017). ICT use in mathematics lessons and the mathematics achievement of secondary school students by international comparison: Which role do school level factors play? *Education and Information Technologies, 22*(4), 1527–1551. https://doi.org/10.1007/s10639-016-9498-5

Erdogdu, F., & Erdogdu, E. (2015). The impact of access to ICT, student background and school/home environment on academic success of students in Turkey: An international comparative analysis. *Computers & Education, 82*, 26–49. https://doi.org/10.1016/j.compedu.2014.10.023

Facer, K., & Furlong, R. (2001). Beyond the myth of the "cyberkid": Young people at the margins of the information revolution. *Journal of Youth Studies, 4*(4), 451–469. https://doi.org/10.1080/13676260120101905

Ferguson, D. (2020). *July 26). Anxious middle-classes look to private schools after coronavirus disruption*. The Guardian.

Fernández-Gutiérrez, M., Gimenez, G., & Calero, J. (2020). Is the use of ICT in education leading to higher student outcomes? Analysis from the Spanish autonomous communities. *Computers & Education*, 103969. https://doi.org/10.1016/j.compedu.2020.103969

Formichella, M. M., Alderete, M. V., & Di Meglio, G. (2020). Nuevas tecnologías en los hogares: ¿Hay una recompensa educativa? Evidencias para Argentina. *Education in the Knowledge Society (EKS), 21*, 14. https://doi.org/10.14201/eks.23553

Gubbels, J., Swart, N. M., & Groen, M. A. (2020). Everything in moderation: ICT and reading performance of Dutch 15-year-olds. *Large-Scale Assessments in Education, 8*(1), 1–17. https://doi.org/10.1186/s40536-020-0079-0

Hargittai, E., Piper, A. M., & Morris, M. R. (2019). From internet access to internet skills: Digital inequality among older adults. *Universal Access in the Information Society, 18*(4), 881–890. https://doi.org/10.1007/s10209-018-0617-5

Hatlevik, O. E., & Christophersen, K. A. (2013). Digital competence at the beginning of upper secondary school: Identifying factors explaining digital inclusion. *Computers & Education, 63*, 240–247. https://doi.org/10.1016/j.compedu.2012.11.015

Hohlfeld, T. N., Ritzhaupt, A. D., Dawson, K., & Wilson, M. L. (2017). An examination of seven years of technology integration in Florida schools: Through the lens of the Levels of Digital Divide in Schools. *Computers & Education, 113*, 135–161. https://doi.org/10.1016/j.compedu.2017.05.017

Hu, X., Gong, Y., Lai, C., & Leung, F. K. S. (2018). The relationship between ICT and student literacy in mathematics, reading, and science across 44 countries: A multilevel analysis. *Computers & Education, 125*(September 2017), 1–13. https://doi.org/10.1016/j.compedu.2018.05.021

Iivari, N., Sharma, S., & Ventä-Olkkonen, L. (2020). Digital transformation of everyday life – how COVID-19 pandemic transformed the basic education of the young generation and why information management research should care? *International Journal of Information Management*. https://doi.org/10.1016/j.ijinfomgt.2020.102183 (in press). Corrected proof, 102183.

Juhaňák, L., Zounek, J., Záleská, K., Bárta, O., & Vlčková, K. (2019). The relationship between the age at first computer use and students' perceived competence and autonomy in ICT usage: A mediation analysis. *Computers & Education, 141*(February). https://doi.org/10.1016/j.compedu.2019.103614

Livingstone, S., & Helsper, E. (2007). Gradations in digital inclusion: Children, young people and the digital divide. *New Media & Society, 9*(4), 671–696. https://doi.org/10.1177/1461444807080335

Lutz, C. (2019). Digital inequalities in the age of artificial intelligence and big data. *Human Behavior and Emerging Technologies, 1*(2), 141–148. https://doi.org/10.1002/hbe2.140

Manzano, D., & Fernández-Mellizo, M. (2019). Origen familiar, uso del tiempo y de las tecnologías de la información. *Revista Internacional de Sociología, 77*(3), e136. https://doi.org/10.3989/ris.2019.77.3.17.165

Meneses, J., & Mominó, J. M. (2010). The information society putting digital literacy in practice: How schools contribute to digital inclusion in the network society. *The Information Society, 26*(3), 197–208. https://doi.org/10.1080/01972241003712231

OECD. (2015). *Students, computers and learning: Making the connection*. OECD Publishing. https://doi.org/10.1787/9789264239555-en

OECD. (2019). *PISA 2021 ICT framework*. OECD Publishing.

OECD. (2020). *PISA 2018 technical report*. OECD Publishing.

Petko, D., Cantieni, A., & Prasse, D. (2017). Perceived quality of educational technology matters. *Journal of Educational Computing Research, 54*(8), 1070–1091. https://doi.org/10.1177/0735633116649373

Pullen, D. (2015). The influence of the home learning environment on middle school students' use of ICT at school. *Australian Educational Computing, 30*(1).

Ragnedda, M., Ruiu, M. L., & Addeo, F. (2020). Measuring digital capital: An empirical investigation. *New Media & Society, 22*(5), 793–816. https://doi.org/10.1177/1461444819869604

Robinson, L., Cotten, S. R., Ono, H., Quan-Haase, A., Mesch, G., Chen, W., Schulz, J., Hale, T. M., & Stern, M. J. (2015). Digital inequalities and why they matter. *Information, Communication & Society, 18*(5), 569–582. https://doi.org/10.1080/1369118X.2015.1012532

Scherer, R., & Siddiq, F. (2019). The relation between students' socioeconomic status and ICT literacy: Findings from a meta-analysis. *Computers & Education, 138*, 13–32. https://doi.org/10.1016/j.compedu.2019.04.011

Schulze, L. (2020). June 30). Corona-krise und schulschließungen: "Wir haben viel fernsehen geschaut. *Der Spiegel*.

Selwyn, N. (2004). Reconsidering political and popular understandings of the digital divide. *New Media & Society, 6*(3), 341–362. https://doi.org/10.1177/1461444804042519

Shin, H. S., & Kim, S. H. (2019). Do ICT related factors make a difference in the collaborative problem-solving skills of the youth?: A cross-level analysis of ICT resources at home and school. *The Journal of Korean Education, 46*(1), 137–160.

Skryabin, M., Zhang, J., Liu, L., & Zhang, D. (2015). How the ICT development level and usage influence student achievement in reading, mathematics, and science. *Computers & Education, 85*, 49–58. https://doi.org/10.1016/j.compedu.2015.02.004

Srijamdee, K., & Pholphirul, P. (2020). Does ICT familiarity always help promote educational outcomes? Empirical evidence from PISA-Thailand. *Education and Information Technologies, 25*(4), 2933–2970. https://doi.org/10.1007/s10639-019-10089-z

Stevenson, O. (2011). From public policy to family practices: Researching the everyday realities of families' technology use at home. *Journal of Computer Assisted Learning, 27*(4), 336–346. https://doi.org/10.1111/j.1365-2729.2011.00430.x

Trapeznikova, I. (2019). *Measuring income inequality. IZA World of Labor*. https://doi.org/10.15185/izawol.462

Van der Vlies, R. (2020). *Digital strategies in education across OECD countries: Exploring education policies on digital technologies (No. 226*. OECD Education Working Papers. https://doi.org/doi.org/10.1787/33dd4c26-en.

Warschauer, M. (2002). Reconceptualizing the digital divide. *First Monday, 7*(7). https://doi.org/10.5210/fm.v7i7.967

Warschauer, M., Matuchniak, T., Pinkard, N., & Gadsden, V. (2010). New technology and digital worlds: Analyzing evidence of equity in access, use, and outcomes. *Review of Research in Education, 34*, 179–225. https://doi.org/10.3102/0091732X09349791

Weber, M. (2008). *Economía y sociedad. Esbozo de sociología comprensiva* (3rd ed.). Fondo de Cultura Económica.

Xiao, Y., & Hu, J. (2019). The moderation examination of ICT use on the association between Chinese mainland students' socioeconomic status and reading achievement. *International Journal of Emerging Technologies in Learning (IJET), 14*(15), 107. https://doi.org/10.3991/ijet.v14i15.10494

Xiao, Y., Liu, Y., & Hu, J. (2019). Regression analysis of ICT impact factors on early adolescents' reading proficiency in five high-performing countries. *Frontiers in Psychology, 10*(JULY). https://doi.org/10.3389/fpsyg.2019.01646

Zhang, D., & Liu, L. (2016). How does ICT use influence students' achievements in math and science over time? Evidence from PISA 2000 to 2012. *Eurasia Journal of Mathematics, Science and Technology Education, 12*(9), 2431–2449. https://doi.org/10.12973/eurasia.2016.1297a

Zilka, G. C. (2020). Teenagers connected to digital environments – what happens when they get to school? Commonalities, similarities and differences from their perspective. *Education and Information Technologies, 25*(3), 1743–1758. https://doi.org/10.1007/s10639-019-10052-y