The social process of internet appropriation: living in a digitally advanced country benefits less well-educated Europeans

Abstract

We generalize and extend the sequential model proposed by the resources and appropriation theory to explain the digital divide in the European Union plus the United Kingdom (EU27+UK). We measure the theoretical constructs of the model with data provided by the EU and test the theoretical predictions using a partial least squares structural equation model. We find support for the hypothesized relationships but find that the effects vary depending on the digital development level of countries. While education overall is the primary determinant of the social production of digital inequalities, a country's digital development level is crucial for less well-educated Europeans. These findings have theoretical and practical implications: (1) they call into question the homogeneity of the effect of causal relationships and the assumption that individuals differ only in terms of motivation, access, and digital skills, and (2) they indicate that socially disadvantaged Europeans benefit from living in more digitally developed countries.

Keywords: digital divide; internet use; physical access; country digital development; digital skills; PLS-SEM.

Accepted version published in:

Lamberti, G., Lopez-Sintas, J., & Sukphan, J. (2021). The social process of internet appropriation: Living in a digitally advanced country benefits less well-educated Europeans. *Telecommunications Policy*, *45*(1), 102055.

https://doi.org/10.1016/j.telpol.2020.102055

1. Introduction

People use the internet for entertainment but also to increase their chances of social and economic advancement, e.g., to improve their education using distance learning, to work from home or start their own business, to make better-informed health decisions, to find lower-priced goods and services, etc. Digital competence is becoming increasingly important for individuals to improve their position in the social hierarchy and for firms to enhance the quality of their human resources and increase their productivity and competitiveness. However, evidence from the literature suggests that physical possibilities for accessing the internet, digital skills, and uses of the internet are not equally distributed in society.

The resources and appropriation (RA) theory (van Dijk 2005, 2012, 2020; van Deursen & van Dijk 2015) proposes a sequential model to explain how social inequalities are produced in internet appropriation. The sequential model covers attitudes (i.e., motivations to use the internet), physical access to devices and connections, digital skills, and internet use (van Dijk 2020). The complete sequential model has only been tested on a sample of Dutch citizens (van Deursen & van Dijk 2015), although partial tests have been conducted in several countries (Hargittai 2002; Scheerder, van Deursen, & van Dijk 2017; van Deursen, Helsper, & Eynon 2016; van Deursen & van Dijk 2015); as for comparative studies (Cueto, Felipe, & León 2018), none have as yet been implemented using the complete model.

The relational view of inequality adopted by the RA theory (Bourdieu 1984; Tilly 1998; van Dijk 2020) is based on Bourdieu's (1984) theory of consumption and Tilly's (1998) theory of durable inequality. Both theories, together with the RA theory, direct our attention to the social positioning of people within and between countries and to the fact that individuals temporarily occupy positions based on their resources, according to

Bourdieu's theory (called autonomous goods by Tilly). In all cases, therefore, practices will be related to positions and social categories occupied temporarily by individuals in clusters. What interests social researchers is the relationship between resources (i.e., autonomous goods) and practices (i.e., relational goods) and the social categories in which resources and practices are unequally distributed (Tilly 1998:26). The RA theory, then, suggests that theoretical relationships between attitudes, physical access, digital skills, and internet use may vary across countries, resources, and social categories. Furthermore, inequalities in internet appropriation produced by country-specific resources may operate in ways that reduce any disadvantages accruing to privileged individuals, although, according to van Dijk (2020), this proposition is an empirical one.

The aim of this research was to identify the relative importance of between-country and within-country resources and social categories in producing inequalities in the process of internet appropriation. We first tested the sequential model of digital technology appropriation in the 27 countries of the European Union plus the United Kingdom (EU27+UK),[1] and we then checked to what extent the proposed theoretical relationships in the model differed depending on the digital development of countries and other indivdiual-specific drivers of inequality.

We contribute to the development of the RA theory in two ways: first, by describing the different ways in which the relationships hypothesized by the sequential model differ between countries depending on their level of digital development; and second, by identifying the relative importance of country-specific and individual-specific resources and social categories in the social production of digital inequalities. The latter

[1] The list of EU27+ UK countries is available at: https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:EU_enlargements

issue is of paramount importance, because public material resources, like the digital development of countries, positively affect the possibilities for reducing the digital gap, especially in the short term. Thus, if the primary producers of inequality are country-specific rather than individual-specific resources and social categories, then countries can more easily develop targeted digital policies aimed at addressing inequalities.

The paper is organized as follows. We first consider the theoretical background and describe our conceptual model and research hypotheses. We next describe the research design in terms of aims, data, and analyses. We then report our results, our theoretical construct measurements, and our estimates of the causal links that explain heterogeneity in the model. Finally, we discuss our findings and present our conclusions.

2. Theoretical background

Social and economic life nowadays is mostly and increasingly digital. The digital technologies play an essential role in almost every aspect of our lives, including social interactions, economic exchanges, and political campaigns. Instant messaging and social media have eroded physical distances and help coordinate in-person interactions. Facebook, Twitter, and even WhatsApp play a critical role in political campaigning (Friesen, Burge, & Britzman 2019). E-commerce, e-government, e-health, e-learning, e-banking, and e-finance are all means for conducting the corresponding activities online, with digital technologies keeping track of all transactions (World Bank 2019). Privileged positions in society are reproduced by firms – and also by individuals – in the deployment of the digital technologies to the advantage of each (Besnahan, Brynjolfsson & Hitt 2002, Autor 2015).

Researchers and policymakers, however, have concerns regarding inequalities in access to and use of the digital technologies. Researchers initially examined the reproduction of social inequalities in terms of access to digital technologies, identifying, as the so-called digital divide, the gap between individuals with and without access within and between countries (Abdollahyan, Semati & Ahmadi 2013). While many policies were introduced that aimed to close that first digital divide, subsequent research showed that a more persistent gap was emerging in terms of different uses made of the internet, referred to as the second digital divide (Hargittai 2002; Hargittai & Hinnant 2008; Tseng & You 2013). The endeavor to understand the processes that generated the second divide led to awareness of what could be named a third divide, related to individual digital skills that explain the gap between access and uses (Hargittai 2002; Scheerder, van Deursen, & van Dijk 2017; van Deursen & Helsper 2015; van Deursen & van Dijk 2015). However, to understand the digital divide better, the gap in digital skills suggests that we need to examine the sequential process that produces the gap, starting from attitudes, motivations, and possibilities for physically accessing the internet and developing digital skills, and ultimately examining particular uses and possible outcomes of internet use. If we look at the sequential process that ends in a digital divide, the first divide would be the access gap, the second the skills gap, and the third the uses and outcomes gap. Understanding the process underpinning internet appropriation is crucial because some individuals or groups are argued to be at a disadvantage in comparison with other sectors of society.

2.1. The social process of internet appropriation leading to a digital divide

van Dijk and associates (van Dijk 2005, 2012, 2020; van Deursen & van Dijk 2015) have proposed a sequential model of internet use to describe the process of internet appropriation that is formalized in their RA theory. The internet appropriation process that results in a digital divide reflecting social inequalities is based on four constructs that influence each other sequentially: attitudes, physical access, digital skills, and internet uses and outcomes. In this study, due to a lack of appropriate data on attitudes, we measure the precedent of attitudes, i.e., *perceived* barriers to internet use.

Perceived barriers to internet use. Motivations segment individuals according to those who want/do not want, can/cannot, or care/do not care about access to digital technologies (van Dijk 2005; Ragnedda & Muschert 2013). While being motivated means having a positive attitude towards doing something (Ryan & Deci 2000), to be motivated to use digital technologies, individuals may need to overcome structural barriers, as argued by Porter and Donthu (2006:1001). According to a World Economic Forum white paper (World Economic Forum 2016), barriers to internet use fall into four categories: (1) infrastructure, (2) awareness and cultural acceptance, (3) affordability, and (4) skills. The first category can be interpreted as the availability of the corresponding public material resource, the second as a social resource – called social barriers by van Deursen and Helsper (2015) when absent or barely present – and the last two as related to economic and digital competence barriers, respectively. In this research, as mentioned above, we refer to perceived barriers to internet use, as our measure of barriers reflects only part of motivated access as described in the RA theory.

Research conducted by Venkatesh et al. (2003) has found that a positive attitude towards digital technologies is a precondition to using digital devices and accessing the internet. Researchers have found support for the proposition that attitudes reflect differences in both internet access (Brandtzæg 2010) and internet use (Dutton and Reisdorf 2017; Helsper 2012; van Deursen & van Dijk 2015; Porter & Donthu, 2006). Poor digital infrastructure and low cultural acceptance may affect physical access, while internet-related anxiety is a psychological barrier that may have a negative bearing on internet use (Durndell & Haag 2002; Meuter et al. 2003). We can therefore expect that such barriers to internet use will have a negative impact on physical access, digital skills, and internet use.

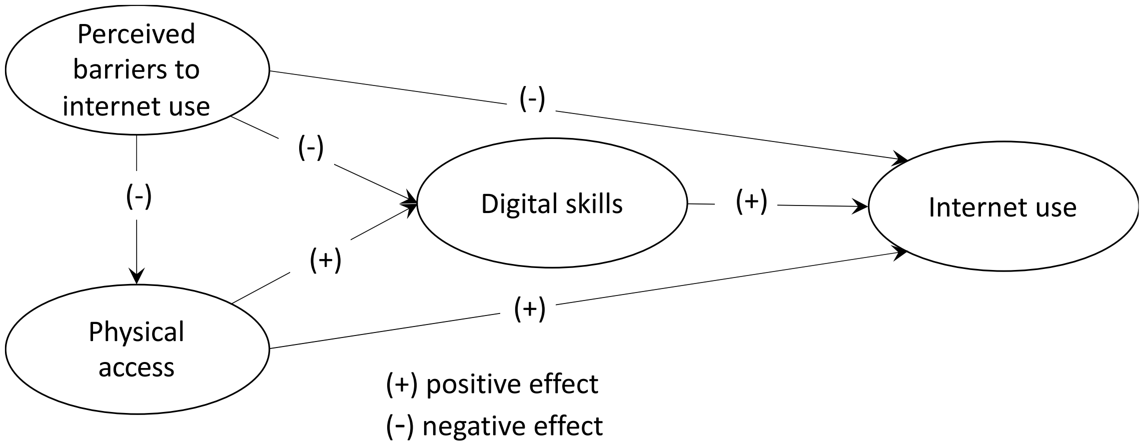
Physical access. Since the earliest studies of the first digital divide, researchers have referred to physical access as the opportunity to access the internet (Dimaggio et al. 2004; Hargittai 2003). According to van Deursen and van Dijk (2015), physical access can be defined in terms of the different devices that people use to access the internet and the entire web, including desktops, laptops, tablets, smartphones, game consoles, and interactive television (van Deursen & van Dijk 2015, 2019). Zillien and Hargittai (2009) have further proposed that the quality of equipment may affect what is done while connected, while van Deursen and van Dijk (2010, 2019) have suggested that differences in physical access might evolve into different online skill levels; according to Napoli and Obar (2014), the outcome could be the emergence of a mobile internet underclass that reflects a deepening of the digital divide. Considering all those findings that physical access is associated with skill levels and diversity of internet uses (Kuhlemeier & Hemker 2007; Mossberger, Tolbert, & Hamilton 2012), we propose that physical access positively influences the development of digital skills and internet use.

Digital skills. From the construction of theoretical concepts regarding attitudes and physical access and their links with internet use, researchers have turned their attention to the issue of the skills and abilities needed to use the internet efficiently and effectively (Hargittai 2002; Hargittai & Shafer 2006). Digital skills have been conceptualized in different ways (Broos & Roe 2006; Hargittai & Hinnant 2008; Litt 2013; van Deursen, Helsper, & Eynon 2014, 2016; van Deursen & van Dijk 2008), but can especially be categorized according to the following six dimensions: medium-related skills, content-related skills, information skills, communication skills, safety skills, and problem-solving skills (Ferrari 2012; Hargittai, Piper, & Morris 2018; van Deursen &

Mossberger 2018; van Deursen & van Dijk 2009, 2010, 2015; van Dijk & Hacker 2003). Following previous research, we define digital skills as the ability to use the internet to (1) obtain information, (2) communicate information, (3) solve software and hardware problems, and (4) solve substantive problems. Researchers have found evidence that the possession of internet skills has a positive effect on internet use (van Deursen, Courtois, & van Dijk 2013; van Deursen, Helsper, & Eynon 2014; van Deursen & van Dijk 2015; van Deursen, van Dijk, & Peters 2011), and particularly on expressive use of the internet (Shaw & Hargittai 2018).

Internet use. Internet use has been defined in a variety of ways, including in terms of frequency of use, connection duration, diversity of uses, and variety of activities (Hargittai & Hinnant 2008; van Deursen & van Dijk 2014). Social heterogeneity arising from the social properties of individuals may reproduce traditional distinctions in internet use (Livingstone & Helsper 2007; Robinson 2009; van Deursen & van Dijk 2014; van Deursen, van Dijk, & Ten Klooster 2015). However, van Deursen and van Dijk (2015) have argued that frequency and time spent online should not be necessarily interpreted as the best potential outcomes of internet use; rather, we should also consider precisely how time online is used. The classification of internet activities proposed by Helsper, van Deursen, and Eynon (2016) takes into account potential outcomes of time spent online as follows: economic (related to property, finance, employment, education, etc), cultural (related to identity, belonging, etc), social (reflecting personal, formal, political networks, etc), and personal (health, lifestyle, self-actualization, leisure, etc). Other researchers have classified internet use in terms of activity patterns such as information seeking, personal development, social interaction, leisure, entertainment, commercial transactions, commerce, emailing, blogging, and production (Blank & Groselj 2014; van Deursen & van Dijk 2014). Internet uses can therefore be operationalized in different ways depending on theoretical frameworks and available data. Accordingly, for our purposes and in line with van Deursen and van Dijk (2015), we define internet use in terms of diversity of uses, i.e., as the number and variety of different internet activities participated in online. Our sequential model is depicted in Figure 1.

Figure 1. The sequential model of internet use.



Source: Authors, adapted from van Deursen and van Dijk (2015).

2.2. Between-country differences in internet appropriation: digital development

We expect that there may be differences in causal links due to how country-specific barriers affect physical access, the development of digital skills, and internet use. Several studies have shown that an unequal distribution of resources produces inequalities in attitudes, physical access, digital skills, and internet use within a country (Hargittai 2010; Hargittai, Piper, & Morris 2018; van Deursen & van Dijk 2014; van Dijk 2012). However, inequalities in relation to telecommunication infrastructures, digital policies, wealth, and education also result in between-country differences (Chen & Wellman 2004; Cueto, Felipe, & León 2018; Kos-Łabędowicz 2017; OECD 2001). Cruz-Jesus, Oliveira, and Bacao (2012) have proposed the existence of two kinds of drivers of digital inequality, one operating at the international level, and the other operating at the intra-national level, i.e., between and within countries, respectively. Digital infrastructure development is a major challenge for less digitally advanced countries with large rural populations (van Dijk 2013, 2020; World Economic Forum 2016), as building up an interconnected digital network requires a massive and very costly investment by firms, governments, and individuals. Since most developing countries cannot afford this investment, to their detriment they cannot move on to more advanced digital technologies.

According to van Dijk (2020:38), by 2000-2005, developed countries reached a point in the diffusion of digital technologies from which physical access quickly spread out to all individuals. Developing countries, however, have not as yet reached that point, although mobile internet access may lead to a reduction in the digital gap (Donner 2015; Donner & Bezuidenhoudt 2013; Doner & Walton, 2013). Digital devices are, logically, not of much use to individuals if they cannot connect through stable and affordable connections. An effective digital infrastructure requires a network of access that reaches most individuals, a transparent regulatory framework for firms, a tax system that fosters private sector investment in building the digital network, and the development of new business models that ensure that it is profitable for individuals and firms to engage in the digital transformation of their country. Furthermore, even if individuals can digitally connect, local content has to be available in mother tongues and cultures to reduce the digital gap within a country (Napoli & Obar 2014:330), given that only the most privileged individuals will be able to access content available in other languages (English mainly). Findings reported by Cruz-Jesus, Oliveira, and Bacao (2012) suggest that countries need to advance along two dimensions of the digital divide: the individual level (access to and use of the internet), and the organizational level (firms and governments).

Even with an excellent infrastructure and content reflecting the local language and culture, citizens will still need affordable connections and equipment. Affordability depends on market mechanisms, but demand (depending on how useful the technology is to individuals and their willingness to pay) and supply (depending on competition in offers of affordable technology) are affected by a country's digital infrastructure and other country-specific properties. If the population is sufficiently large and wealthy, the elasticity of demand will drive prices down, whereas the opposite will happen in smaller and less wealthy countries. Even though globalization, by aggregating local markets into a massive global market, can make it profitable to develop and offer low-cost digital devices, firms will still mainly be interested in densely populated markets where an infrastructure can give service to many people.

Lack of awareness of the benefits of digital technologies is typically accompanied by high psychological barriers and by little motivation to access the internet and to develop the skills necessary to benefit from the internet. This fact has both individual and social consequences. Because privileged individuals have the necessary conditions for physical access and perceive the benefits of, and are motivated to use, the internet, they contribute to widening the digital gap between themselves and non-privileged individuals. Furthermore, another kind of inequality emerges when we compare social groups, as people tend to live within social groups in which most members have similar levels of access; the fact that social groups of privileged individuals have physical access to the internet, the necessary digital skills, and varied uses for the internet creates a bubble in which they can exchange help, advice, knowledge, information, etc. In fact, researchers have found that social capital acquired in the usual social network has a bearing on physical access, and also that connection with people in different social networks may also influence internet use intensity (Chen 2013). A famous example is Steve Jobs, cofounder of Apple Computers Inc., who, lacking the technical skills to develop a new game for Atari, turned for help to Steve Wozniak, a close friend and engineer at Hewlett Packard (Wikipedia, 2020).

In generating social inequalities, differences in digital skills operate not only within countries but also between countries. Furthermore, the evolution of digital technologies is such that, today, digital skills are being embedded in devices, making these easier to use but also making them more expensive. This means that individuals in larger and more technologically advanced countries will benefit to the detriment of individuals from other countries.

Consequently, we can expect differences in the effects brought about by causal links in the sequential model of social internet appropriation according to the following hypotheses:

H1: The more digitally developed a country, the less the impact of barriers to internet use on the other constructs in the sequential process.

H2: The more digitally developed a country, the less the impact of physical access on the other constructs in the sequential process.

H3: The more digitally developed a country, the less the impact of digital skills on other theoretical constructs in the sequential process.

2.3. Between-country and within-country differences in the production of inequalities

The RA theory (van Dijk 2005, 2012, 2020; van Deursen & van Dijk 2015) provides an explanation for the unequal distribution of attitudes, physical access, digital skills, and internet use according to relational theories, for which building blocks have been developed by leading scholars like Bourdieu (1984) and Tilly (1998). Those relational theories explain the origins of, and differences in, social practices, and further explain how those practices are produced and maintained. The RA theory has proposed several resources and social categories to explain the inequalities observed in internet appropriation (van Dijk 2005, 2020). These resources and social categories can also explain between-country and within-country inequalities. The main between-country distinction (as described in the previous section) reflects a greater or lesser level of digital development. The main within-country categories are gender (women versus men), age (younger people versus older adults), and education (well-educated versus less well-educated individuals) (van Dijk 2020; van Deursen & Helsper 2015; Wilson, Wallin, & Reiser 2003).

However, an unresolved issue is to determine the relative importance of between-country and within-country resources and social categories in producing and reproducing the digital divide. According to the RA theory, the relative importance of between-country and within-country resources and social categories is a matter of empirical observation and will produce different results for each society (van Dijk 2020). The relational view of inequality adopted by the RA theory (Bourdieu 1984; Tilly 1998; van Dijk 2020) directs our attention to the position of people according to their personal and social categories, both within their country and compared to another country.

3. Research design

3.1. Research questions

van Dijk's model (2005, 2020) has been partially tested across several countries (e.g., Brandtzæg, Heim, & Karahasanović 2011), and has also been tested for skills (Hargittai 2010; Zillien & Hargittai 2009; Helsper & Reisdorf 2017), and for attitudes (Dutton & Blank 2015; Dutton & Reisdorf 2019). However not all aspects of the sequential model were considered in those studies, and, with the exception of the study by van Deursen and van Dijk (2015) for the Netherlands, no study has comparatively analyzed the sequential model to identify the main producers of digital inequalities. We therefore formulate research questions as follows:

RQ1: To what extent does the RA sequential model explain the process of internet appropriation by Europeans?

RQ2: To what extent do the relationships hypothesized by the RA theory differ depending on the digital development of the country?

RQ3: What is the relative importance of between-country and within-country resources and social categories in the production of the digital divide?

3.2.Data

3.2.1. European internet user characteristics

Representative data on digital technology use in 2016 were taken from an EU27+UK survey obtained on request from Eurostat (https://ec.europa.eu/eurostat/). Selected were the main resources and social categories that produce inequality according to the RA theory. At the individual level we used a single positional category (education level) and three individual social categories (gender, age, and occupational status), following the classification provided by van Deursen and van Dijk (2015) and van Dijk (2005, 2020). At the country-level we used a single digital development indicator, in accordance with the classification proposed by Cruz-Jesus, Oliveira, and Bacao (2012), who reduced a set of 16 indicators reflecting the percentage of people and enterprises using the internet in the EU to two digital development factors: information and communication technology infrastructure and adoption by the population, and e-business and internet access costs; they next clustered EU countries according to their factor scores, producing a taxonomy of three classes: digital leaders (Denmark, Finland, Luxembourg, Netherlands, and Sweden); digital followers (Austria, Belgium, Germany, Ireland, Malta, UK, Poland, Portugal, Spain, and Slovakia); and digital laggards (Estonia, Italy, Latvia, Romania, Bulgaria, France, Lithuania, Croatia, Slovenia, Cyprus, Greece, Czechia, and Hungary). Digital leaders not only had the highest score in both digital development factors but also more balanced digital development (Cruz-Jesus, Oliveira, & Bacao 2012:282).

Table 1 summarizes social indicator details. Of the 151 660 survey respondents, 51.6% were female, just over three quarters were aged 25-64 years, 32.7% had a high education level, and 62.7% were employed. As for the digital development level, almost half of the countries were classified as digital leaders or followers.

Table 1. Sample characteristics.

Individuals			Countries		
Variable	**Frequency**	**%**	**Variable**	**Frequency**	**%**
Gender			**Digital development**		
Male	73472	48.4	Leaders	13038	8.6
Female	78188	51.6	Followers	59226	39.1
			Laggards	78658	52.3
Age (years)					
16-24	1991	13.1			
25-44	58822	38.8			
45-64	58749	38.7			
> 64	14179	9.3			
Education					
Low	28288	18.7			
Intermediate	73855	48.7			
High	49517	32.7			
Occupational status					
Employed	95131	62.7			
Unemployed	11292	7.4			
Student	14311	9.4			
Other	30926	20.4			

3.2.2. Measurement scales

In accordance with the model proposed in Figure 1, we used operational measures from the Eurostat survey on perceived barriers to internet use, physical access, digital skills, and internet use. Full details of the measures are provided in Table 2.

Perceived barriers to internet[2] use were measured using a scale of eight items reflecting reasons for not accessing the internet from home (e.g., 'I have access to the internet elsewhere', 'equipment costs are too high', etc). Appendix A reports the

[2] In the Eurostat survey, the perceived barriers to internet use items are designed to reflect perceptions of barriers by internet users without access at home in the previous three months, while barriers are assumed to be none for people with home internet access.

frequencies for each item. On a scale that summed the items – ranging from 0 (no barriers) to 8 (most barriers) – the mean score was 7.960 and standard deviation (SD) was 0.300.

Physical access was measured using a scale of six dichotomous items referring to devices used to access the internet: desktop computer, laptop/notebook, tablet, mobile phone/smartphone, other mobile device (e-book reader, smartwatch, gaming device, etc), or smart TV. On a summary scale reflecting the number of devices used (ranging from 0 to 6), the mean (SD) was 2.430 (1.250).

Digital skills, in accordance with Eurostat, were measured on a Likert scale, ranging from 1 (no skills) to 4 (highest skills), for four different kinds of skills, namely, information skills, communication skills, problem-solving skills, and software skills.

Finally, following van Deursen and van Dijk (2015), internet use was measured in terms of diversity using a dichotomous scale for 18 items reflecting engagement in online activities, including e-mailing, reading news, playing games, listening to music, managing a website, running a business, etc. For the summary scale, ranging from 0 (no internet use) to 18 (most diverse use), the mean (SD) was 7.990 (3.730).

The five social indicators (see Table 1) were used to identify the resources and social categories that most contributed to the generation of digital inequalities.

Table 2. Measures.

Scales	
Perceived barriers to internet use	**Physical access**
What are your reasons for not accessing internet at home?	*Which devices do you use to access the internet?*
1 - Have access elsewhere	1 - Desktop computer
2 - Do not need it (not useful, not interesting, etc)	2 - Laptop/notebook
3 - Equipment costs too high	3 - Tablet computer
4 - Connection costs too high (telephone, DSL subscription, etc)	4 - Mobile phone/smartphone
5 – Perceived lack of skills	5 - Other mobile devices (e.g., e-book reader, smartwatch)
6 - Privacy or security concerns	6 - Smart TV (directly connected to internet)
7 - Broadband internet not available in our area	
8 - Other	
Digital skills	
Rate your skills on a scale of 1 (minimum) to 4 (maximum)	
Information skills	
Problem-solving skills	
Communication skills	
Software skills	
Internet use (diversity)	
Which activities have you used internet for?	
1 - E-mailing	
2 - Telephoning over the internet/video calls (via webcam) over the internet (e.g., Skype or Facetime)	
3 - Participating in social networks (creating user profile, posting messages or other contributions to Facebook, etc)	
4 - Reading online news newspapers/news magazines	
5 - Finding information on goods or services	
6 - Playing or downloading games	
7 - Listening to music (e.g., web radio, music streaming)	
8 - Watching internet-streamed TV (live or catch-up) from broadcasters	
9 - Watching video on demand from commercial services (Netflix, HBO, etc)	
10 - Watching video content from sharing services (e.g., YouTube)	
11 - Uploading self-created content (text, photos, music, videos, software, etc) to any website to be shared	
12 - Creating websites or blogs	
13 - Seeking health-related information (e.g., injury, disease, nutrition, health, etc)	
14 - Making an appointment with a practitioner via the website (e.g., hospital or health care centre)	
15 - Using services related to travel or travel-related accommodation	
16 - Selling goods or services (e.g., via auctions, on eBay, etc)	
17 - Internet banking	
18 - Using payment accounts (e.g. PayPal) to pay for goods or services purchased over the internet	

3.3.Methodologies: PLS-SEM, multi-group parametric test and pathmox analysis

To fit the model we used partial least squares structural equation modelling (PLS-SEM), which has previously been used to evaluate internet use (Alt & Boniel-Nissim

2018; Lu et al. 2007; O'Cass & Fenech 2003). PLS-SEM is a statistical technique used to estimate the parameters of a causal model and determine the strength and direction of relationships between model variables (Lohmoller 1989). We used this method because of its flexibility in terms of distribution assumptions and capacity to handle complex predictive models (Hair et al. 2017).

The digital skills scale was validated following a procedure described elsewhere (Hair et al. 2017). Since the construct was reflective, we calculated different measures of reliability – an approach indicated when the PLS-SEM methodology is used to estimate model parameters. Thus, we verified that loadings were greater than 0.7, that they were all significant, and that composite reliability and Cronbach's alpha were both greater than 0.7. We also confirmed that the average variance extraction (AVE) value was greater than 0.5.

The effect of heterogeneity between countries was assessed using the multi-group parametric test (Hair et al. 2017; Sarstedt, Henseler, & Ringle 2011) and pathmox analysis (Lamberti, Aluja, & Sanchez 2016, 2017). The multi-group parametric test is a procedure for statistically testing for between-segment differences in coefficients. Data are split into groups according to a categorical variable, path coefficients are estimated for each group, and the obtained coefficients are then compared to check for significant differences. In our study, path coefficient differences were compared using the Keil approach (Keil et al. 2000).

Pathmox analysis (Lamberti, Aluja, & Sanchez 2016, 2017) was used to identify the most significant factors generating digital inequalities within and between countries. This method, recently proposed to analyze heterogeneity in a PLS-SEM environment following an exploratory approach, identifies different segments holding different relationships among constructs. The principles of binary segmentation are used to produce a tree with different models in each of the obtained nodes. Starting with the results of a global model, the models with the greatest differences in child nodes are identified by an algorithm applying an iterative procedure (i.e., the data is recursively partitioned to identify iterations whose categories yield the most significant differences after comparing pairs of PLS-SEM models of child nodes).

To avoid the generation of a large number of nodes, pathmox runs a pre-pruning process based on three criteria: limiting the maximum depth of the tree; fixing a minimum node size; and considering the non-significance of the split criterion.

In our study, causal parameters were estimated and causal model heterogeneity was identified using the plspm package version 0.4.9 (Gaston Sanchez, Trinchera, & Russolillo 2015) and the genpathmox package version 0.3 (Lamberti 2017), respectively, both developed in the R Software Language and Environment for Data Analysis.

4. Results

4.1. To what extent does the RA sequential model explain internet appropriation by Europeans? (RQ1)

The structural relationship results for our sequential model are reported in Table 3. According to this model, perceived barriers to internet use mainly negatively affect opportunities for physical access (β=-0.102) and, to a lesser degree, digital skills development (β=-0.076). but have little impact on internet use (β=-0.018). Furthermore, as would be expected, physical access strongly influences digital skills development (β=0.511), but influences internet use far less (β=0.252), while the greatest influence on internet use is digital skills (β=0.608).

We also found evidence to support sequential causality, in that the more significant influences are direct causal links, namely, between perceived barriers to internet use and physical access, between physical access and digital skills, and between digital skills and internet use. Concerning the predictability of the model, we obtained R^2=0.595 and a positive Stone-Geisser test value for predictive relevance of Q^2=0.600 for internet use (Figure 2).

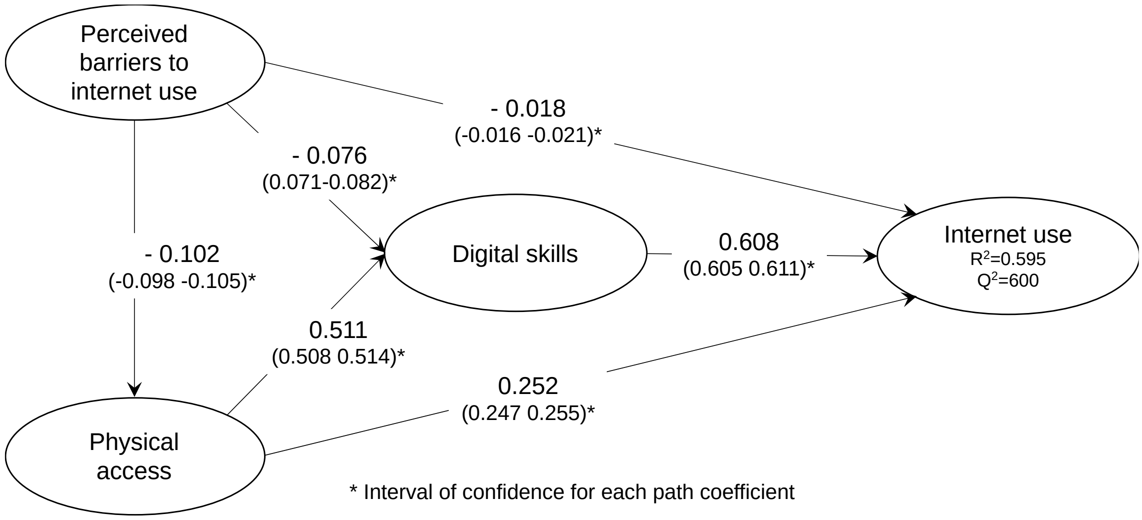
In summary, the RA sequential model depicts the process that produces the digital divide in the EU. Our empirical test of the model adds support to the theory and shows that the first digital gap divides Europeans among those with access to computers and the internet according to perceived barriers (motivations/attitude). However, the digital gap increases with the access divide: the impact of physical access on digital skills, in absolute terms, is almost fivefold the impact of perceived barriers on physical access. This is theoretically the second digital divide. Finally, according to our empirical test, the third theoretical digital divide increases with differences in digital skills, whose impact is even greater than in the second digital divide.

Table 3. Results for the sequential model of inequality production.

Path	**Value**	**T-test value**	**SE**	**Bootstrap**	
				Low	**High**
Perceived barriers to internet use → Physical access	-0.102*	-39.800	0.002	-0.098	-0.105
Perceived barriers to internet use → Digital skills	-0.076*	-34.700	0.003	-0.071	-0.082
Physical access → Digital skills	0.511*	232.000	0.002	0.508	0.514
Perceived barriers to internet use → Internet use	-0.018*	-11.000	0.002	-0.016	-0.021
Physical access → Internet use	0.252*	132.000	0.002	0.247	0.255
Digital skills → Internet use	0.608*	317.000	0.002	0.605	0.611

SE, standard error. Significance: *p=<0.001.

Figure 2. Results for the sequential model.



4.2. To what extent do the relationships hypothesized by the RA theory differ depending on the digital development of the country? (RQ2)

To this point we have assumed that the drivers of internet use are homogenous. However, the level of digital development of countries may affect the magnitude of the digital divide, i.e., the magnitude of the effects in the causality chain, from perceived barriers to internet use, to physical access, to digital skills, to diversity of internet uses. To check whether the model that explains the production of the digital divide differs among countries according to their level of digital development, we estimated the model for the leader, follower and laggard countries (as defined in the methods section). Using multigroup analysis we compared how the digital divide is produced. Results are reported in Table 4; the threshold significance was set to p=0.001 due to the large sample size, with asterisks indicating significant differences.

Table 4. Multigroup comparison by digital development level.

Path	**Le**	**Fo**	**Lg**	**P value**		
				Le vs Fo	**Le vs Lg**	**Fo vs Lg**
Perceived barriers to internet use →Physical access	-0.073	*-0.109*	*-0.098*	*0.000**	*0.000**	0.003
Perceived barriers to internet use →Digital skills	-0.095	-0.076	-0.074	0.054	0.022	0.427
Physical access →Digital skills	0.474	*0.526*	*0.483*	*0.000**	0.078	0.000*
Perceived barriers to internet use →Internet use	-0.013	-0.014	-0.022	0.438	0.038	0.007
Physical access →Internet use	0.207	*0.254*	*0.220*	*0.000**	0.051	*0.000**
Digital skills →Internet use	0.601	*0.613*	*0.620*	0.021	*0.001**	0.013

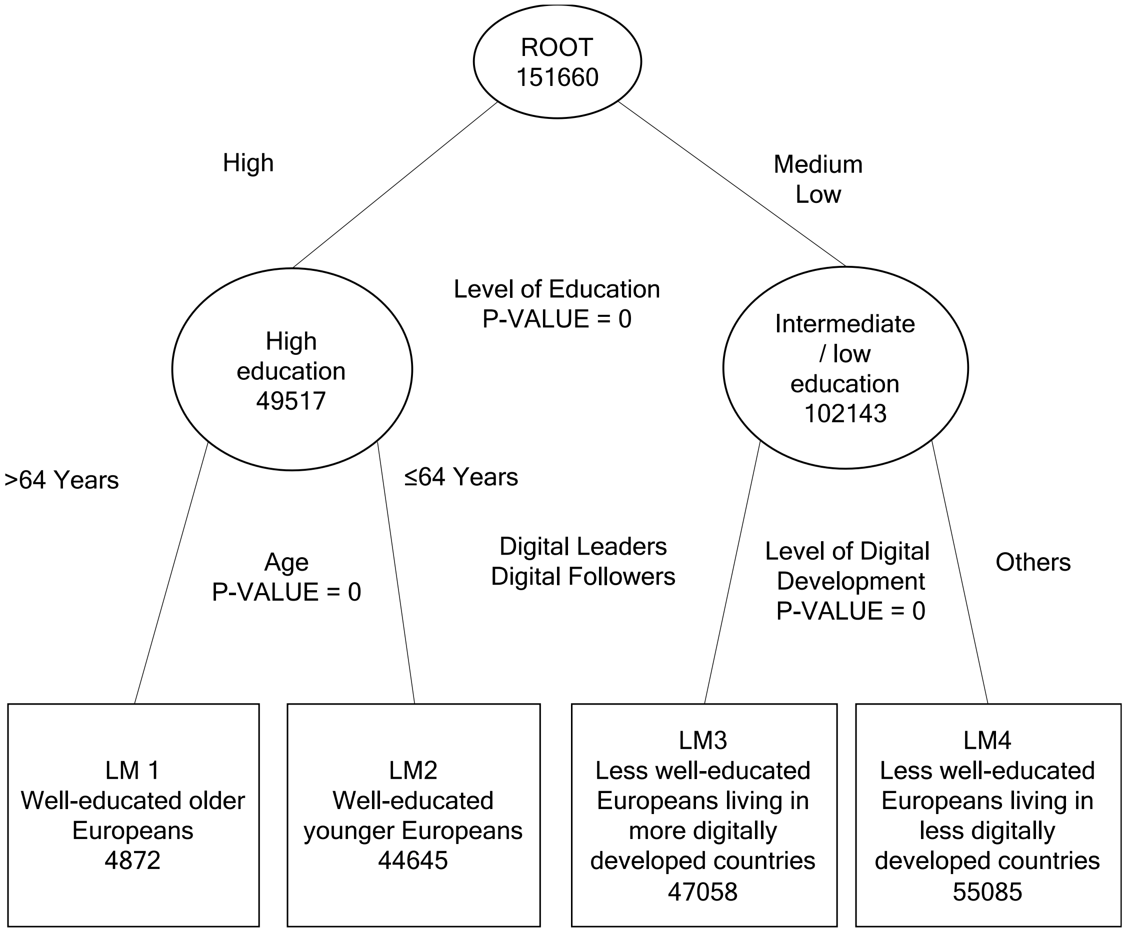
Le, leaders, Fo, followers, Lg, laggards. An asterisk indicates significant differences between path coefficients equal to or lower than 0.001.

The issue of perceived barriers to internet use as a driver for physical access was significantly more important for follower countries than for leader and laggard countries ($p<0.001$ in each case). The same occurred with physical access as a driver for digital skills, more important for followers than for leaders and laggards ($p<0.001$ in each case). As for internet use, we found differences in physical access and digital skills: physical access as a driver for internet use was more important for followers than for leaders and laggards ($p<0.001$), while digital skills digital skills as a driver for internet use were more important for laggards than for leaders ($p=0.001$). We conclude, therefore, that H1, H2 and H3 receive empirical support: differences in the production of the digital divide reflect the level of digital development of countries.

4.3. What is the relative importance of between-country and within-country resources and social categories in the production of the digital divide? (RQ3)

When analyzing the digital divide across countries, it is important to assess to what extent between-country differences play a more important role than within-country similarities in the production of the digital divide. To find an answer to that question we used the pathmox algorithm that identifies which positional and social categories explain the most variation in the estimated sequential model. We limited the process to identifying the three resources and social categories that most explain the social production of digital divide. That means that the pathmox segmentation tree must be restricted to a maximum depth of two levels, bounding the final number of segments to a maximum of four. The minimum admissible size for a node was set to 10% of the total sample, while threshold significance for the partitioning algorithm was set to p=0.001 due to the large sample size. The pathmox segmentation tree is depicted in Figure 3, where the root node corresponds to the global model described in Table 3 and Figure 2. The terminal nodes depict the main social indicators explaining heterogeneity, resulting in four segmented local models labelled LM1 to LM4.

Figure 3. Pathmox segmentation tree



The indicator that most explained inequality was the positional category of education, as it reflected the most significant variation in the model ($F=2317$; $p<0.001$), separating Europeans with a high education level (to the left in Figure 3) from those with an intermediate or low education level (to the right in Figure 3). In a subsequent segmentation step, well-educated Europeans were further segmented according to age as older and younger than 65 years ($F=789$; $p<0.001$), while less well-educated Europeans were further segmented according to the digital development of their country of residence ($F=1406$; $p<0.001$).

Table 5 reports the F-coefficient test results (statistics and p values) for each partition of the tree. This test identifies the path coefficients responsible for the splits obtained by the pathmox (in our analysis, education, age, and country digital development), providing a measure of how great differences are across the theoretical constructs once the sample is partitioned according to the categorical variable.

Concerning education, primarily responsible for the split was physical access as a driver for digital skills (F=2781.583; p<0.001) and digital skills as a driver for internet use (F=259.595; p<0.001), followed by perceived barriers to internet use as driver for physical access (F=35.197; p<0.001) and physical access as a driver for internet use (F=15.876; p<0.001). As for age, we found that the split primarily derived from physical access as a driver for digital skills (F=402.796; p<0.001) and digital skills as a driver for internet use (F=105.189; p<0.001). Finally, for country digital development, the split was primarily caused by digital skills as a driver for internet use (F=102.108; p<0.001), physical access as a driver for digital skills (F=60.923; p<0.001) and perceived barriers to internet use as a driver for physical access (F=53.325; p<0.001).

Table 5. F-coefficient results.

Path	**Split 1 Education**		**Split 2 Age**		**Split 3 Digital development**	
	Statistic	**P value**	**Statistic**	**P value**	**Statistic**	**P value**
Perceived barriers to internet use →Physical access	35.197	<0.001*	9.253	0.002	53.325	<0.001*
Perceived barriers to internet use →Digital skills	3.462	0.063	4.19	0.041	1.497	0.221
Physical access →Digital skills	2781.583	<0.001*	402.796	<0.001*	60.923	<0.001*
Perceived barriers to internet use →Internet use	3.52	0.061	0.05	0.823	2.378	0.123
Physical access →Internet use	15.876	<0.001*	8.027	0.005	0.592	0.442
Digital skills →Internet use	259.595	<0.001*	105.189	<0.001*	102.108	<0.001*

Significance: *p=<0.001

Returning to the terminal nodes, the four resulting models were LM1 and LM2, reflecting well-educated older Europeans and well-educated younger Europeans, respectively, and LM3 and LM4, reflecting less well-educated Europeans living in more and in less digitally advanced countries, respectively. The structural coefficients for LM1 to LM4 are reported in Table 6, where it can be observed that the sequential causality chain is maintained for all the models, as indicated by van Deursen and van Dijk (2015). This means that perceived barriers to internet use impact on physical access, that physical access remains crucial for the development of digital skills, and that digital skills are an essential driver for internet use. However, differences across models are evident.

For well-educated Europeans, when older (LM1), perceived barriers to internet use has the strongest negative influence as a driver for digital skills (-0.097) among all groups; and when younger (LM2), physical access has the strongest positive influence (0.279) as a driver for internet use, whereas the positive influence of digital skills was less important (0.528). For less well-educated Europeans, if they lived in a more digitally advanced country (LM3), physical access was critical as a driver for digital skills (0.533), and digital skills as a driver for internet use (0.640); however, if less well-educated Europeans live in a less digitally advanced country (LM4), digital skills have the strongest influence in driving internet use (0.641), whereas – relative to the individuals living in a more digitally advanced country – perceived barriers to internet use have a smaller impact on physical access (-0.092), and, likewise, physical access on digital skills (0.469).

Table 6. Path coefficients for the structural model.

Path	β LM1	LM2	LM3	LM4
Perceived barriers to internet use → Physical access	-0.077*	-0.095*	-0.110*	-0.092*
Perceived barriers to internet use → Digital skills	-0.097*	-0.091*	-0.077*	-0.070*
Physical access → Digital skills	0.466*	0.398*	0.533*	0.469*
Perceived barriers to internet use → Internet use	-0.028*	-0.019*	-0.013*	-0.023*
Physical access → Internet use	0.228*	0.279*	0.232*	0.200*
Digital skills → Internet use	0.614*	0.528*	0.640*	0.641*

Notes. LM1 = well-educated older Europeans; LM2 = well-educated younger Europeans; LM3 = less well-educated Europeans living in more digitally developed countries; LM4 = less well-educated Europeans living in less digitally developed countries. Significance: *p=<0.001.

To sum up the findings, even though differences occur in the production of the digital divide according to country digital development, it is the educational level of Europeans that mainly explains social heterogeneity in the production of the digital divide. Education, an indicator of cultural capital according to Bourdieu (1984), is the resource across countries that best explains unequally distributed internet use and the digital divide. Furthermore, this digital divide results, first, from the development of digital skills driven by physical access, and second, from internet use as fostered by the development of digital skills. Among the best educated Europeans, a generational gap exists that explains the differences in this group, and surprisingly, country digital development seems to act as a public material resource that particularly benefits less well-educated Europeans.

5. Discussion

While a direct comparison with previous research was not possible due to measurement differences, our results generalized for the EU27+UK tend to support previous findings (Hargittai 2002; Scheerder, van Deursen, & van Dijk 2017; van Deursen & Helsper 2015; van Deursen & van Dijk 2015) concerning the sequential link between physical access, digital skills, and internet use. Overall, the general model for the EU explains to a great extent the production of the digital divide. As was expected, overall, perceived barriers to internet use have a negative effect on the other theoretical constructs, indicating that perceived barriers (motivations/attitudes) may have a negative impact on the process of appropriating digital technologies (van Dijk 2005, 2012, 2020; World Economic Forum 2016).

Our findings support our hypotheses and, therefore, the RA theory (van Dijk 2005, 2020). Thus, considering the effect of country digital development on the sequential model, we found that perceived barriers to internet use and physical access are especially crucial for individuals living in digital follower and digital laggard countries. Those findings give support to our hypothesis (H1) that the more digitally advanced a country, the less the impact of perceived barriers, particularly as a driver for physical access to digital devices. Reducing perceived barriers (improved infrastructure, more localized content, and more affordable connections) would therefore have a more significant impact on individuals living in less digitally advanced countries. Other effects of the perceived barriers were not found to be statistically significant. We also find empirical support for our hypothesis (H2) that the more digitally advanced a country, the less the impact of physical access on the other constructs in the sequential model; in other words, for individuals living in less digitally advanced countries, the effect of physical access as a driver for digital skills and internet use is higher. This would suggest that increased physical access would have a relatively greater impact in less digitally advanced countries. Finally, as hypothesized (H3), the effect of digital skills as a driver for internet use is higher for individuals living in digital laggard countries.

Regarding the relative importance of between-country and within-country resources and social categories in the production of the digital divide – irrespective of the country of origin – education (an individual-specific resource or positional category) was found to be the most critical source of inequality in the process of internet appropriation (measured in this study in terms of diversity of uses), as Europeans in the sequential causality chain were split according to their education level into high and intermediate/low subgroups. As in other studies, whether of parents (Gui & Argentin 2011) or respondents (Dutton & Reisdorf 2017; Reisdorf & Groselj 2017; van Deursen & van Dijk 2010, 2015), education most strongly predicts differences in the social process of generating digital inequalities. In our model, well-educated Europeans are segmented by age into an older group (>64 years old) and a younger group (≤64 years old), while less well-educated Europeans are divided according to the digital development of their country of origin. Country digital development of countries is therefore revealed as a public material resource that particularly benefits socially less privileged Europeans. These findings suggest that, in less digitally developed countries, education could yield the cognitive (and probably material) resources to overcome perceived barriers to internet use, and also that well-educated individuals may form a social group that crosses EU frontiers. As for less well-educated individuals, perceived barriers to internet use and physical access may be less if they happen to live in a more digitally developed country.

In terms of comparison between our four groups of Europeans, the causality model indicates that the impact of perceived barriers to internet use as a driver for both digital skills and internet use is especially crucial for well-educated older

Europeans, suggesting that fewer perceived barriers might increase internet use in this group of individuals. For well-educated younger Europeans, physical access may have the greatest impact in increasing internet use in this group. As for less well-educated Europeans, when these live in more digitally developed countries, they avail of better digital support and infrastructure, which, in turn, improves physical access, digital skills, and internet use, as has been argued by van Dijk (2020). This group is, consequently, more significantly impacted, in terms of physical access and digital skills, by perceived barriers to internet use, whereas for their counterparts living in less digitally developed countries, enhancing physical access has less impact on internet use.

In summary, we identify education as the primary generator of inequalities in the process of internet appropriation, but suggest that the fact of living in a digitally advanced country may overcome some of the limitations faced by less well-educated Europeans regarding physical access and digital skills. In consequence, a key result concerning the overall analysis of the impact of between-country and within-country resources and social categories is that the sequential causality chain is maintained but operates differently depending on both country- and individual-level positional resources and social categories. In other words, the models we estimated according to the inequalities generated in the sequential links are particular cases of the general causality model: perceived barriers to internet use influence physical access, physical access is crucial to developing digital skills, and finally, digital skills affect how the internet is used. While these findings are hardly surprising (since they are aligned with the RA theory), for the first time we demonstrate that the strength of links between constructs may vary depending on positional and social categories and also show that education plays a key role in generating the digital divide.

5.1. Policy implications

Our findings have several implications for reducing digital inequalities. As a precursor to improving digital skills and enhancing internet use, less well-educated population segments should be the target of policies aimed at reducing perceived barriers and enhancing physical access, as improving physical access to digital devices and connections, and therefore, to the internet is crucial to developing the necessary digital skills, according to both our own findings and those of other researchers (Helsper 2012; van Deursen & van Dijk 2015, 2020; Shaw & Hargittai 2018). Digital skills can be developed in less privileged individuals in two main ways: by improving a country's digital infrastructures to reduce material and other barriers, and by increasing general and widespread access to a variety of digital devices, encouraging access through as many different devices as possible. Device variety is important in enhancing digital skills overall, because different devices are optimized for specific uses (van Dijk 2020; Napoli & Obar 2014). The issue of perceived barriers is ultimately crucial to reducing inequalities because, as they are dismantled, physical access and digital skills will improve, and variations between groups will be reduced.

However, while this inference is valid for both more and less digitally advanced countries, ultimately, any reduction in digital inequalities will be hampered by underlying inequalities in education (see Shaw & Hargittai 2018). We suggest that more user-friendly technologies and devices would reduce the need for advanced digital skills, particularly among older well-educated individuals; while older people are reported to make more rational use of the internet, they have poorer operational skills, which means they make less use of the internet compared to younger people (van Deursen & van Dijk 2014;

van Deursen, van Dijk, & Peters 2011). Ultimately, however, education is key, as only better educated individuals, on the basis of their digital skills and their social capital, will be equipped to take full advantage of the digital technologies (Hargittai, Piper, & Morris 2018) and ensure better outcomes from internet use.

5.2. Limitations and future research

To investigate the digital divide in the EU27+UK, we tested the four theoretical constructs of the sequential model developed by van Deursen and van Dijk (2015): barriers to internet use, physical access, digital skills, and internet use (defined in terms of diversity of uses). The main limitation of our approach was that the indicators available were not as rich as the indicators obtained for the (more specific) research by van Deursen and van Dijk (2015), because of the need to harmonize fieldwork for the EU27+UK. As a consequence, instead of measuring internet motivations/attitudes as, we had to measure the antecedent, i.e., *perceived* barriers to internet use, according to the logic that the existence of perceived barriers makes a positive attitude to the internet less likely. Further related to the perceived barriers, the survey only partially accounted for the perceptions of European users, as this concept was only measured for users without home internet access. Therefore, although we found support for the sequential model, the measurement model could undoubtedly be improved with better data.

From a methodological point of view, at least two limitations arise from the use of causal models. First, without panel data, the cyclical nature of the sequential model cannot be reflected. Second, according to Bollen and Pearl (2013), causal models do not allow causal effects in the strictest sense to be estimated. Nonetheless, these models are useful for evaluating the plausibility of causal chains. One interesting future line of work would be, for Europe in recent decades, to monitor evolution in digital inequalities and to include indicators of implemented digital policies to identify what key policies might have narrowed the digital divide.

6. Conclusions

In our generalization of the van Dijk model (2005, 2020) to a representative EU27+UK dataset, we contribute to the development of the RA theory (van Dijk 2005, 2020) in suggesting that the social process of internet appropriation differs depending broadly on country-level digital development and individual-level education, with the relative importance of specific resources and social categories (country digital development and individual education and age) contributing in different ways to social production of the digital divide.

To sum up, individuals with relatively fewer personal resources will enjoy a comparative advantage if they happen to live in a more digitally advanced country, meaning that an advanced digital context is a public good that benefits all of society. As for more privileged individuals, and particularly young educated individuals, these are well positioned to take advantage of the digital technologies. Our findings suggest that the social process of internet appropriation unfolds differently within and between countries, not only because attitudes and motivations (representing possible barriers to internet use), physical access, digital skills, and internet use are socially patterned, but also because the impact of causal links between them also varies.

Acknowledgements

We would like to thank the European Union for giving us access to its 2016 survey data and the anonymous reviewers who helped improve this manuscript. Ailish Maher, an English-language professional academic editor, corrected the English in an advanced version of this article.

Author contributions

All authors have read and agreed to the published version of the manuscript.

Funding

Grant #2017 SGR 1056 funded by AGAUR-Generalitat de Catalunya, and Grant #870691-INVENT funded by the EU H2020 program.

Conflicts of interest

The authors declare no conflict of interest.

References

Alt, D., and M. Boniel-Nissim,. 2018. Using multidimensional scaling and PLS-SEM to assess the relationships between personality traits, problematic Internet use, and fear of missing out. *Behaviour and Information Technology* 37 (12): 1264–1276. doi:10.1080/0144929X.2018.1502353.

Blank, G., and D. Groselj. 2014. Dimensions of Internet use: Amount, variety, and types. *Information Communication & Society* 17 (4): 417–435. doi:10.1080/1369118X.2014.889189.

Bollen, K. A., and J. Pearl. 2013. Eight myths about causality and structural equation models. In *Handbook of Causal Analysis for Social Research*, ed. S.L. Morga, 301–328. Springer, Dordrecht.

Bourdieu, P. 1984. *Distinction: A Social Critique of the Judgment of Taste*. Cambridge, MA: Harvard University Press.

Brandtzæg, P. B. 2010. Towards a unified media-user typology (MUT): A meta-analysis and review of the research literature on media-user typologies. *Computers in Human Behavior* 26 (5): 940–956. doi:10.1016/j.chb.2010.02.008.

Brandtzæg, P. B., J. Heim, and A. Karahasanović. 2011. Understanding the new digital divide - A typology of Internet users in Europe. *International Journal of Human Computer Studies* 69 (3): 123–138. doi:10.1016/j.ijhcs.2010.11.004.

Broos, A., and K. Roe. 2006. The digital divide in the playstation generation: Self-efficacy, locus of control and ICT adoption among adolescents. *Poetics* 34 (4–5): 306–317. doi:10.1016/j.poetic.2006.05.002.

Chen, W., and B. Wellman. 2004. The global digital divide - Within and between countries. *IT & Society* 1: 39–45.

Cruz-Jesus, F., T. Oliveira, and F. Bacao. 2012. Digital divide across the European Union'. *Information and Management* 49 (6): 278–291. doi:10.1016/j.im.2012.09.003.

Cueto, S., C. Felipe, and J. León. 2018. Digital Access , Use and Skills across Four Countries: Construction of Scales and Preliminary Results from the Young Lives Round 5 Survey. Oxford: Young Lives.

DiMaggio, P., E. Hargittai, C. Celeste, and S. Shafer. 2004. Digital inequality: From unequal access to differentiated use. In *Social Inequality*, ed. K. M. Neckerman, pp. 355–400. New York, NY: Russell Sage Foundation.

Donner, J., and Bezuidenhoudt. 2013. In a world with mobile data, survey questions about internet use should no longer implicitly favor the PC. In *Mobile media practices, presence and politics: The challenge of being seamlessly mobile*, eds. K. M. Cumiskey and L. Hjorth (p. Chapter 6). Routledge. Retrieved at: https://www.routledge.com/Mobile-Media-Practices-Presence-and-Politics-The-%20Challenge-of-Being-Seamlessly/Cumiskey-Hjorth/p/book/9780415821278

Donner, J., and Walton, M. 2013. Your Phone Has Internet - Why Are You at a Library PC? Re-imagining Public Access in the Mobile Internet Era. In *Human-Computer Interaction – INTERACT 2013* eds., P. Kotzé, G. Marsden, G. Lindgaard, J. Wesson, and M. Winckler (Vol. 8117, pp. 347–364). Berlin Heidelberg: Springer doi: https://doi.org/10.1007/978-3-642-40483-2_25

Donner, J. 2015. After Access: Inclusion, Development, and a More Mobile Internet. MIT Press.

Durndell, A., and Z. Haag. 2002. Computer self efficacy, computer anxiety, attitudes towards the Internet and reported experience with the Internet, by gender, in an East European sample. *Computers in Human Behavior* 18 (5):521–35. doi:10.1016/S0747-5632(02)00006-7.

Dutton, W. H., and G. Blank. 2015. Cultural Stratification on the Internet: Five Clusters of Values and Beliefs among Users in Britain. *Communication and Information Technologies Annual: Digital Distinctions and Inequalities Studies in Media and Communications* 10: 3–28. doi:10.1108/s2050-206020150000010001.

Dutton, W. H., and B. C. Reisdorf. 2017. Cultural Divides and Digital Inequalities: Attitudes Shaping Internet and Social Media Divides. *Information Communication & Society* 22(1): 18–38. doi:10.1080/1369118X.2017.1353640.

Ferrari, A. 2012. Digital competence in practice: An analysis of frameworks. EUR 25351, The joint research centre, Institute for Prospective Technological Studies, Luxembourg: Publications Office of the European Union

Friesen, A., R. Burge, and K. Britzman. 2019. Digital segregation: Gender, occupation, and access to politics. *Social Science Computer Review*, 1–18. doi:10.1177/0894439319851164.

Gui, M., and G. Argentin. 2011. .Digital skills of Internet natives: Different forms of digital literacy in a random sample of Northern Italian high school students. *New Media & Society* 13 (6): 963–980. doi:10.1177/1461444810389751.

Hair, J.F., C. L Hollingsworth, A. B Randolph, and A. Y. L. Chong. 2017. An updated and expanded assessment of PLS-SEM in information systems research. *Industrial Management and Data Systems* 117 (3): 442–458. doi:10.1108/IMDS-04-2016-0130.

Hargittai, E. 2002. Second-level digital divide: Differences in people's online skills. *First Monday* 7 (4): http://firstmonday.org/issues/issue7_4/hargittai/index.html.

Hargittai, E. 2003. The digital divide and what to do about it. In New economy handbook, ed. Derek C. Jones, 822–841, San Diego, CA: Academic Press.

Hargittai, E. 2010. Digital Na(t)Ives? variation in Internet skills and uses among members of the "Net Generation". *Sociological Inquiry* 80 (1): 92–113. doi:10.1111/j.1475-682X.2009.00317.x.

Hargittai, E. and A. Hinnant. 2008. Digital inequality: Differences in young adults' use of the Internet. *Communication Research* 35 (5): 602–621. doi:10.1177/0093650208321782.

Hargittai, E., A. M. Piper, and M. R. Morris. 2018. From Internet access to Internet skills: Digital inequality among older adults. *Universal Access in the Information Society*: 1–10. doi:10.1007/s10209-018-0617-5.

Hargittai, E., and S. Shafer. 2006. Differences in actual and perceived online skills: The role of gender. *Social Science Quarterly* 87 (2): 432–448. doi:10.1111/j.1540-6237.2006.00389.x.

Helsper, E. J. 2012. A corresponding fields model for the links between social and digital exclusion. *Communication Theory* 22 (4): 403–426. doi:10.1111/j.1468-2885.2012.01416.x.

Helsper, E. J., and B. C. Reisdorf. 2017. The emergence of a “Digital Underclass” in Great Britain and Sweden: Changing reasons for digital exclusion. *New Media & Society* 19 (8): 1253–1270. doi:10.1177/1461444816634676.

Helsper, E. J., A. J. A. M. van Deursen, and R. Eynon. 2016. *Measuring types of Internet use*. From Digital Skills to Tangible Outcomes Project Report: http://www.lse.ac.uk/media@lse/research/From-digital-skills-to-tangible-outcomes.aspx.

Keil, M., B.C.Y. Tan, K. K. Wei, T. Saarinen, V. Tuunainen, and A. Wassenaar. 2000. A cross-cultural study on escalation of commitment behavior in software projects. *MIS Quarterly* 24 (2): 299–323. doi:10.2307/3250940.

Kos-Łabędowicz, J. 2017. The issue of digital divide in rural areas of the European Union’. *Ekonomiczne Problemy Usług* 126: 195–204. doi:10.18276/epu.2017.126/2-20.

Kuhlemeier, H., and B. Hemker. 2007. The Impact of computer use at home on students’ Internet skills. *Computers and Education* 49 (2): 460–480. doi:10.1016/j.compedu.2005.10.004.

Lamberti, G. 2017. Genpathmox (version 0.3): https://CRAN.R-project.org/package=genpathmox

Lamberti, G., T. B. Aluja, and G. Sanchez. 2016. The Pathmox approach for PLS path modeling segmentation. *Applied Stochastic Models in Business and Industry* 32 (4): 453–468. doi:10.1002/asmb.2168.

Lamberti, G., T. B. Aluja, and G. Sanchez. 2017. The Pathmox approach for PLS Path modeling: Discovering which constructs differentiate segments. *Applied Stochastic Models in Business and Industry* 33 (6): 674–689. doi:10.1002/asmb.2270.

Litt, E. 2013. Measuring users' Internet skills: A review of past assessments and a look toward the future. *New Media & Society* 15 (4): 612–630. doi:10.1177/1461444813475424.

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

Lohmoller, J. B. 1989. *Latent variable Path Modeling with Partial Least Squares*. Springer-Verlag Berlin Heidelberg.

Lu, E. Y., H. Ma, S. Turner, and W. Huang. 2007. Wireless Internet and student-centered learning: A partial least-squares model. *Computers and Education* 49 (2): 530–544. doi:10.1016/j.compedu.2005.10.009.

Meuter, M. L., A. L. Ostrom, M. J. Bitner, and R. Roundtree. 2003. The influence of technology anxiety on consumer use and experiences with self-service technologies. *Journal of Business Research* 56 (11): 899–906. doi:10.1016/S0148-2963(01)00276-4.

Mossberger, K., C. J Tolbert, and A. Hamilton. 2012. Measuring digital citizenship : Mobile access and broadband. *International Journal of Communication* 6: 2492–2528.

O'Cass, a., and T. Fenech. 2003. Web retailing: A study of Internet users adoption of the web as a retailing medium. *Journal of Retailing and Consumer Services* 10: 81–94.

OECD (Organisation for Economic Co-Operation and Development). 2001. *Understanding the Digital Divide*. Paris: OECD Publications.

Porter, C. E., and Donthu, N. 2006. Using the technology acceptance model to explain how attitudes determine Internet usage: The role of perceived access barriers and demographics. *Journal of Business Research, 59*(9): 999–1007. doi: https://doi.org/10.1016/j.jbusres.2006.06.003

Ragnedda, M., and G. W. Muschert. 2013. *The Digital Divide The Internet and Social Inequality in International Perspective*. *Theorizing Digital Divides*. New York: Routledge. doi:10.4324/9781315455334.

Reisdorf, B. C., and D. Groselj. 2017. Internet (non-)use types and motivational access: Implications for digital inequalities research. *New Media & Society* 19 (8): 1157–1176. doi:10.1177/1461444815621539.

Robinson, L. 2009. A taste for the necessary: A bourdieuian approach to digital inequality. *Information Communication & Society* 12 (4): 488–507. doi:10.1080/13691180902857678.

Ryan, R. M., and E. L. Deci. 2000. Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology* 25 (1): 54–67. doi:10.1006/ceps.1999.1020.

Sanchez, G., L. Trinchera, and G. Russolillo. 2015. Introduction to the R package Plspm: http://arxiv.org/abs/1411.1830.

Sarstedt, M., J. Henseler, and C. M. Ringle. 2011. Multigroup analysis in partial least squares (PLS) path modeling: Alternative methods and empirical Results. *Advances in International Marketing* 22: 195–218. doi:10.1108/S1474-7979(2011)0000022012.

Scheerder, A., A. J. A. M. van Deursen, and J. A. G. M. van Dijk. 2017. Determinants of Internet skills, uses and outcomes. A systematic review of the second- and third-level digital divide. *Telematics and Informatics* 34 (8): 1607–1624. doi:10.1016/j.tele.2017.07.007.

Shaw A., and Hargittai E. 2018. The pipeline of online participation inequalities: the case of Wikipedia editing. *Journal of Communication* 68 (1): 143–168. https://doi.org/10.1093/joc/jqx003

Tilly, C. 1998. *Durable Inequality*. California: University of California Press.

van Deursen, A. J. A. M., C. Courtois, and J. A. G. M. van Dijk. 2013. Internet skills, sources of support, and benefiting from internet use. *International Journal of Human-Computer Interaction* 30 (4): 278–290. doi:10.1080/10447318.2013.858458.

van Deursen, A. J. A. M., and E. J. Helsper. 2015. A nuanced understanding of Internet use and non-use among the elderly. *European Journal of Communication* 30 (2): 171–187. doi:10.1177/0267323115578059.

van Deursen, A. J. A. M., E. J. Helsper, and R. Eynon. 2014. *Measuring digital skills*: From Digital Skills to Tangible Outcomes Project Report: http://www.lse.ac.uk/media-and-communications/assets/documents/research/projects/disto/Measuring-Digital-Skills.pdf

van Deursen, A. J. A. M., E. J. Helsper, and R. Eynon. 2016. Development and validation of the Internet skills scale (ISS)’. *Information Communication & Society* 19 (6): 804–823. doi:10.1080/1369118X.2015.1078834.

van Deursen, A. J. A. M., and K. Mossberger. 2018. Any thing for anyone? A new digital divide in Internet-of-things skills. *Policy and Internet* 10 (2): 122–140. doi:10.1002/poi3.171.

van Deursen, A. J. A. M., and J. A. G. M. van Dijk. 2008. Measuring digital skills: Performance tests of operational, formal, information and strategic Internet skills among the Dutch population. Paper presented at 58th Conference of the international communication association, Montreal, Canada May 22-26,2008. doi:10.1057/9781137437037.

van Deursen, A. J. A. M., and J. A. G. M. van Dijk. 2009. Using the Internet: Skill related problems in users' online behavior. *Interacting with Computers* 21: 393–402. doi:10.1016/j.intcom.2009.06.005.

van Deursen, A. J. A. M., and J. A. G. M. van Dijk. 2010. Internet skills and the digital divide. *New Media & Society* 13 (6): 893–911. doi:10.1177/1461444810386774.

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

van Deursen, A. J. A. M., and J. A. G. M. van Dijk. 2015. Toward a multifaceted model of internet access for understanding digital divides: An empirical investigation. *The Information Society* 31 (5): 379–391. doi:10.1080/01972243.2015.1069770.

van Deursen, A. J. A. M., and J. A. G. M. van Dijk. 2019. The first-level digital divide shifts from inequalities in physical access to inequalities in material access. *New Media & Society* 21 (2): 354–375. doi:10.1177/1461444818797082.

van Deursen, A. J. A. M., J. A. G. M. van Dijk, and O. Peters. 2011. Rethinking Internet skills: The contribution of gender, age, education, Internet experience, and hours online to medium- and content-related Internet skills. *Poetics* 39 (2): 125–144. doi:10.1016/j.poetic.2011.02.001.

van Deursen, A. J. A. M., J. A. G. M. van Dijk, and P. M. Ten Klooster. 2015. Increasing inequalities in what we do online: A longitudinal cross sectional analysis of Internet activities among the Dutch population (2010 to 2013) over gender, age, education, and income. *Telematics and Informatics* 32 (2): 259–272. doi:10.1016/j.tele.2014.09.003.

van Dijk, J.A.G.M. 2005. *The Deepening Divide: Inequality in the Dnformation Society*. London: SAGE Publications.

van Dijk, J. A. G. M. 2012. The evolution of the digital divide-The digital divide turns to inequality of skills and usage. In *Digital Enlightenment Yearbook 2012*, ed. J. Bus, M. Crompton, M. Hildebrandt, and G. Metakides, 57–75. Amsterdam: IOS Press.

van Dijk, J. A. G. M. 2013. A theory of digital divide. In *The Digital Divide: The Internet and Social Inequality in International Perspective*, ed. M. Ragnedda and G. Muschert, 29–51. London: Routledge.

van Dijk, J. A. G. M. 2020. *The Digital Divide*. Cambridge: Polity Press.

van Dijk, J. A. G. M., and K. Hacker. 2003. The digital divide as a complex and dynamic phenomenon. *The Information Society* 19 (4): 315–326. doi:10.1080/01972240309487.

Venkatesh, V., M. G. Morris, G. B. Davis, and F. D. Davis. 2003. User acceptance of information technology: Toward a unified view. *MIS Quarterly* 27 (3): 425–478.

Wikipedia. (2020). Breakout (video game). Retrieved at: https://en.wikipedia.org/w/index.php?title=Breakout_(video_game)&oldid=962481303

Wilson, K. R., J. S. Wallin, and C. Reiser. 2003. Social stratification and the digital divide. *Social Science Computer Review* 21 (2): 133–143. doi:10.1177/0894439303021002001.

World Bank. 2019. *Information and Communications for Development 2018: Data-driven development*. Washington, DC.

World Economic Forum. 2016. *Internet for all: A framework for accelerating internet access and adoption*. Geneva: the World Economic Forum.

Zillien, N., and E. Hargittai. 2009. Digital distinction: Status-specific types of Internet usage. *Social Science Quarterly* 90 (2): 274–291. doi:10.1111/j.1540-6237.2009.00617.x.

Appendix A

Summary statistics of perceived barriers to internet use.

Perceived barriers to internet use	Freq.	%
1. Have access elsewhere	1904	1.26%
2. Do not need it (not useful, not interesting, etc)	643	0.42%
3. Equipment costs too high	1062	0.70%
4. Connection costs too high (telephone, DSL subscription, etc)	995	0.66%
5. Perceived lack of skills	346	0.23%
6. Privacy or security concerns	259	0.17%
7. Broadband internet not available in our area	232	0.15%
8. Other	467	0.31%
Total number of users with no home internet	5908	3.90%
Total number of users with home internet	145752	96.10%
Total number of users	151660	100.00%