The digital divide: a literature review and some directions for future research in light of COVID-19

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Abstract
Purpose – Coronavirus (COVID-19) has exposed the digital divide (DD) like never before and has made it a hot topic of actuality. In this paper, a state of the art of research studies that dealt with the three levels of the digital divide and highlight its shortcomings in light of COVID-19 are presented.

Design/methodology/approach – An integrative literature review was conducted, summarizing the rich literature on the digital divide by presenting its key concepts and findings. This study then provides suggestions for future research in light of the COVID-19 pandemic.

Findings – It can be concluded that the digital divide is insufficiently exposed and examined by researchers. In fact, in recent years, very few research studies have focused on the first-level divide. Moreover, much of the literature has analyzed the second digital divide (in terms of e-skills) in the strict sense and at the national level. This review also shows that the existing studies on the third level-digital divide deal only with the individual results of using the Internet. Finally, future research on the three-level digital divide should study more digital inequality related to emerging technologies is proposed.

Research limitations/implications – This paper draws up a state of art, which has important theoretical and practical implications in the effectiveness of full transformation to digitalization.

Originality/value – The present study contributes to digital inequality research by summarizing key concepts and findings from the literature of the three levels of the digital divide. It highlights the unexplored research topics on some dimensions of DD which were behind the digital transformation failure in many countries and provides insights on future research directions in light of COVID-19.

Keywords Digital divide, ICT access, ICT use, e-skills, Offline outcomes

Paper type Literature review

1. Introduction
The current health crisis caused by a coronavirus (COVID-19) is transforming into a severe global social and economic crisis affecting both developed and developing countries to varying degrees. A war is waged against this invisible enemy, and governments worldwide are mobilizing to save lives. The digital has played a leading role in the fight against coronavirus. E-learning, teleworking, drones, robots, connected electronic bracelets and other technologies were deadly weapons in the battle against the epidemic. However, many countries, individuals and companies have not been able to take advantage of these opportunities offered by digital technologies to mitigate the crisis's negative effect. This is caused due to the digital divide, which refers to the gap in access to, use of or impact of information and communication technology between individuals, households, countries,
COVID-19 has further exposed and exacerbated digital inequalities (Beaunoyer et al., 2020).

To get the most out of information and communication technology (ICT) and keep the development promises of the digital era, countries must reduce the digital divide because it is one of the most challenging problems facing the information society. The reason arises from the digital divide’s very nature because it is a vague and extensive concept that applies to different situations (Rallet and Rochelandet, 2004). By now, a vast array of works have been conducted to study the digital divide phenomenon (Scheerder et al., 2017; Karar, 2019; Hidalgo et al., 2020; Gladkova and Ragnedda, 2020; Unwin, 2020). These studies have made it possible to offer a variety of definitions and different measures and determinants. Still, they have not yet been able to tackle the phenomenon precisely and exhaustively (Scheerder et al., 2017). Some questions remain unresolved, and in our opinion, the studies carried out lack more exhaustiveness. Examples include quantitative and qualitative empirical studies, as well as literature reviews. Therefore, this article aims to answer these following questions:

- What does the DD mean and what are its different dimensions in the relevant literature?
- How to measure the DD and what are its determinants?
- What are the DD dimensions, which behind the effectiveness of the digital transformation revealed by the COVID-19 and then require more attention?

To answer these questions we draw up the state of the art and synthesis of knowledge on the three levels of the digital divide based on a sizeable bibliographic study of (Francophone and Anglophone) research studies already carried out on this topic. Such an analysis gives an idea of the current state of research in this domain, its direction, to identify its limitations and provide some guidance for future research to overcome the deficiencies. While we will present the achievement of digital divide research studies, we will highlight shortcomings and research topics in the field which merit further attention in light of the COVID-19 pandemic.

Our paper is organized as follows. In Section 2, we present our research methodology. In Section 3, we expose the general context of the analysis of the digital divide. Section 4 puts in perspective the existing literature of the first-level digital divide regarding access to ICTs. In Section 5, we expose the thesis of the second-level digital divide and its measures and determinants advanced by the literature. Section 6 discusses the third-degree digital divide regarding the beneficial outcomes of ICT use. Finally, we move forward to discuss and identify the primary deficiencies that exist in the concerned literature in Section 7. Section 8 concludes the paper.

2. Methodology

To achieve the present objective’s study, an integrative literature review has been conducted. This method is the only one that allows for the combination of diverse methodologies (Whittemore and Knafl, 2005). Our research is based on two stages. The first one, illustrated in Figure 1, consists of identifying and collecting the most representative papers in the field of interest and the second in analyzing their theoretical content. To limit the number of irrelevant results, we applied some search restrictions: we have gathered bibliographic data on the bases of publications whose title include the terms “digital divide” or “digital inequality” and “COVID-19” in English and French language and which were published between 1990 and 2020. Additional terms such as “ICT skills” or “digital skills” or “online skills” or “ICT outcomes” or “ICT benefits” or “ICT effects” or “E-learning and
COVID-19” or “education and COVID-19” or “e-Heath” or “telemedicine” and “COVID-19” were added. We conducted searches from seven databases (Cairn, ScienceDirect, Emerald, Sage, Elsevier, Scopus and Springer). In total, 12,576 articles were identified. To ensure the representativeness of the selected articles, we excluded the duplicates, examined the full text of each paper and excluded those not related to digital inequality. Then, we added 78 articles that did not include the term “digital divide” or “digital inequality” but present theoretical or empirical basis for the concept. The search yielded 143 digital divide papers.

3. General context
The digital divide, which is a theme of political campaigns, refers in a broad sense to inequalities in terms of access and use of the ICTs. In a strict sense, it refers to the divides of access and use of the Internet. In the USA, the technological change in the early 90s in the telecommunication sector aroused a wider debate on the digital divide. Therefore, attention was mainly paid to the regulations to be implemented in front of these changes. The differences in the use and access to the Internet and the role of education in reducing this
gap were the subjects of long debates at the time. The fact that Europe lags behind the USA in investment and the use and access to ICTs led to the emergence of several research studies that focused on the digital inequalities within the OECD countries. Then, the debate was the concern of a higher number of developed countries before spreading to other countries worldwide with particular attention paid to the developing economies. The latter should not further fall behind Europe and the USA due to the digital economy.

To measure and detect the factors responsible for its growth, the digital divide has been the subject of much multidisciplinary academic research in economics, management, information systems, social sciences […]. Although the literature in question is broad, a discrepancy in the opinions and the obtained results is found. This discrepancy is mainly due to the dynamic, changing and multidimensional nature of the digital divide, which makes its analysis a complex task requiring the consideration of several variables, technologies and territories (OECD, 2009). The OECD (2001) defines the digital divide as “the gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard both to their opportunities to access information and communication technologies (ICTs) and to their use of the Internet for a wide variety of activities. The digital divide reflects differences among and within countries. The ability of individuals and businesses to take advantage of the Internet varies significantly across the OECD area and between OECD and non-member countries. Access to basic telecommunications infrastructures is fundamental to any consideration of the issue, as it precedes and is more widely available than access to and use of the Internet.” This definition underlines that the digital divide is a multi-faceted concept covering several aspects (access, use, performance) and has many dimensions (global, regional and social).

At the geographic level, there are several divide dimensions: among the developed countries, between the developed and developing countries, between the regions, as well as between the rural and urban areas (Rallet and Rochelandet, 2004). Regarding the regions, Srinuan and Bohlin (2011) showed that the USA and Canada are the leaders in terms of the number of studies carried out on the digital divide, followed by Europe, Asia Pacific, Africa, Latin America and the Middle East. At the country level, the authors showed that the greatest number of studies was carried out in the USA followed by the UK, India and China. On the other hand, the lowest number of studies was recorded in developing countries. These studies dealt with the individual or domestic divide (as they are about the divide between the regions or the individuals in the same country). In contrast, the research studies on the cross-country split dealt with the overall digital divide (Chipeva et al., 2018).

Recent literature on the digital divide has distinguished between three types of splits: access divide, use divide and result/performance divide associated with ICTs (Helsper et al., 2015; Alexander et al., 2015; Lutz, 2019; Gladkova and Ragnedda, 2020). At the dawn of the digital age, the subject of digital disparities has taken on a material dimension. Besides, the scientific research carried out in this field has focused mainly on access and equipment problems. This digital divide, which is called the “first-level digital divide,” is only one dimension of all numerical inequalities. As Bowie (2000) pointed out « Even if everyone in the world could have a free personal computer and free Internet access via reliable information infrastructures, that would not be enough. The technology could not empower those individuals who were illiterate and lacked the know-how. Literacy itself is of strategic importance to individuals, regions and nations in the information society ». For his part, Ben Youssef (2004) states that « […] The true value associated with these technologies should be derived from the use and not from the equipment […] the value of a network depends not only on the number of the involved individuals but also on their contribution». Once the material difficulties are overcome, new divisions linked to the modes of use appear and
widen, suggesting that the reduction of access inequalities is only a necessary but not sufficient condition to bridge the digital divide caused by the technological diffusion in the society. The availability of infrastructure does not mean effective use of ICTs or even much less, an autonomous and efficient use (Brotcorne and Valenduc, 2009).

Cognitive skills and specific knowledge are essential for the use of ICTs and the exploitation of their content. Therefore, the mastery of ICTs and digitized information requires digital skills grouped by Van Deursen and Van Dijk (2010) into four categories; operational, formal, informational and strategic. This perspective of the digital divide is called the second level divide. The third type of divide is Wei et al. (2011) named the third-level digital divide, which deals with performance associated with information and communication technologies. Several authors such as Van Dijk (2005), Fuchs (2009) and Selwyn (2004) invited to reconsider the digital divide more globally by addressing not only the problems of digital access, use and competence but also the consequences of the use of ICTs. As a result, the debate on the digital divide has changed its focus and recent research studies have questioned the benefits of using ICTs and more specifically the Internet. In the next section, we will review the state of the art for the first-level digital divide (Figure 2).

4. The first-level divide
The speech on the digital divide dates back to the pioneering studies of the American Department of Commerce in the early 90s, which distinguish between two different social groups: the “info-riches” (information haves) and the “info-poor” (Information have-nots). The first group includes people who have access to ICTs while the second includes those who do not. On the other hand, Castells (2002) defines the digital divide as “the inequality of access to the Internet” and stipulates that access to the Internet “is a condition to overcome inequalities in a society where dominant functions and social groups are increasingly more organized around the Internet.” According to Lutz (2019), the digital divide results from inequalities in access to telecommunications such as the gap between the nations that have and those that do not have the technology. Van Dijk (2005), who is considered by many to be the most important theorist of the network company, defines it as “the gap between those who have access to computers and the Internet” and those who do not.

On the other hand, Montagnier et al. (2002) argue that [...] the differences in access to ICTs such as computers and the Internet, create a “digital divide” between those who can take advantage of the opportunities offered by ICTs and those who cannot. Long-Scott (1995) was the first to raise the digital divide’s expression to underline, from the point of view of participation in democratic life, the risks associated with the exclusion of the poorest and the community minorities. This division was later known as a first-level digital divide.

![Figure 2. The three levels of the digital divide](source: Authors)
Several empirical studies of the first-level digital divide such as Lentz and Oden, (2001), Chowdary (2002), Lim (2002), Hartviksen and Akselsen (2002) used an element of technological determinism. According to the deterministic perspective, technology is the only cause that determines the societies’ evolution and other factors (social and human) are secondary (Srinuan and Bohlin, 2011). In this case, the liberalization of telecommunications markets is considered paramount and conditions the digital divide. Moreover, from this perspective, overcoming the problem of access to ICTs enables everyone to use and similarly benefit from ICT. This has been reexamined again. The studies that used technological determinism have also incorporated socio-economic factors, given the deterministic perspective’s inadequacy in the explanation of the digital divide.

Further studies focused on the resources and appropriation theory to examine the access divide (Van Deursen and Van Dijk, 2018). This theory states that categorical inequalities in society cause unequal distribution of resources, creating Internet access disparities. The authors define Internet access as a process that begins with a general attitude toward the Internet and subsequently allows physical and material access. For their part, VA Deursen and Andrade (2018) identified two key factors that make up the first-level digital divide: motivation (determined by the attitude toward technology) and access to technology (the opportunity and means that help the access to the Internet).

In recent years, very few studies have examined the first-level digital divide. The generalization of access to the ICTs in the world has gradually turned the attention toward the inequalities of use and digital skills (Van Deursen and Van Dijk, 2018; Hilbert, 2016). However, our current experience with the COVID-19 pandemic shows how precarious ICT access in many countries and regions in the world. The access-digital divide has been exposed like never before and has become a hot topic of actuality. During the lockdown period, digital technology especially the Internet is the main lifeline way to stay connected. People without computers and broadband connection can’t take an online class, work from home, mediate effective communication among friends and family members, [...] Future digital divide research needs to continue to explore the first-level digital divide and give it more attention.

4.1 Measures
In connection with the retained problem, many indicators were used to assess the first instance gap (Table 1). At first, the digital divide debate focused on the inequalities in the rate of computer equipment. It was just a simplistic examination of the cleavages in access to ICT and specifically to the Internet (Eastin et al., 2015). The first chosen indicator is the number of the main lines per 100 inhabitants, which was published by the ITU in 1960. Then, the mobile telephony per 100 inhabitants appeared with analogous technology in 1982 before adopting digital technology. After that, the debate spread and became polymorphous with the introduction of the Internet. Consequently, communication services considerably developed and the used indicators became the number of computers and Internet users per 100 inhabitants. Finally, with the emergence of broadband with high speed, which replaced the rate of Internet connection, as a result, the indicators became more qualitative (e.g. bandwidth).

These measures are often methodological problems and pose difficulties in interpreting the results at the level of national and international comparisons (incomplete data, heterogeneous series, [...]). The development of relevant, exhaustive and precise measures requires a lot of data on infrastructure, equipment, potential access, etc[...].

4.2 Determinants
A great amount of empirical research has focused on the first-level digital divide (van Deursen and van Dijk, 2018; Srinuan and Bohlin, 2011; Forenbacher et al., 2019). Two main
factors are often mentioned in the literature: the structure of telecommunication infrastructure (Quibria, 2002; Helbig et al., 2009; Chinn and Fairlie, 2004) and the income differences between countries and social groups (Dasgupta et al., 2001; Wallsten, 2002; Fink et al., 2003). The first factor is part of the ICT access approach proposed by Helbig et al. (2009) and strongly linked to the idea of technological determinism. According to this approach, the availability and the investment in telecommunication infrastructure are essential in reducing the digital divide. Other secondary determinants such as the enrolment rate and population density have also been identified (Table 1).

5. The second-level divide
In recent years, a wave of theoretical research has called for a reconsideration of the digital divide’s notion beyond the restrictive vision that focuses only on the problems of access to ICTs (Hargittai, 2002; van Dijk, 2005; Selwyn, 2004; Fuchs, 2009). Starting from the observation that social cleavages are not essentially a question of access to ICTs...
(De Haan, 2003), it focuses on digital skills and how ICTs are used. It is the ability to use these technologies and the digital skills that distinguish one from the other and cause a problem as it contributes to the widening of inequalities. Kling (1998) was the first to make a clear distinction between these two types of digital divides: inequalities in access to ICTs (technical access) and inequalities in the technical skills needed to benefit from ICTs (social access). The latter was first referred to by Hargittai (2002) as “second-level divides.” Subsequently, this topic has been much debated by numerous theoretical and empirical studies, which can be divided into two different approaches. The first focuses on the inequalities among internet users from the different social groups in the way they use ICTs (DiMaggio et al., 2004; Guichard, 2004; Hargittai, 2002), while the second focuses on more complicated conceptualizations of the divide, by considering that the differential possession of digital skills is one of the most important factors in conceptualizing the second-order digital divide (van Deursen and van Dijk, 2010, 2015).

According to the first approach, actual use of the Internet, as the last stage of appropriation (van Dijk, 2005), is defined in terms of frequency, duration of Internet use or the type of activity performed online (van Deursen and Andrade, 2018). This last point, which has become increasingly important in recent years, can fall into one of four key areas: economy, culture, society and personnel. On the other hand, Hargittai (2002) defined the second-order divide as a cognitive gap between Internet users who can effectively search online and those who do not. Efficiency here depends on two criteria: whether the requested task is performed or not beside its duration.

Regarding the second approach, the classification of the types of digital skills by some authors such as Mossberger et al. (2003), van Deursen et al. (2016) and van Deursen and van Dijk (2005, 2010), has rapidly advanced research on this topic. The necessary skills to manage ICT were initially sent back to the basic skills such as copying a file on a diskette, attaching files to an e-mail, starting word processing [...]. On the other hand, with the introduction of computers at work, more developed skills have become increasingly necessary. First, it was soon realized that there are several dimensions and not only basic skills and second, that the value of these skills varies depending on social circumstances (Van Dijk, 2005; Steyaert, 2002). Moreover, to clarify the concept of digital skills, Steyaert (2002) suggested three categories of skills such as instrumental, structural and strategic skills. The first category covers the basic skills such as the operational handling of hardware and software, technical and reasoning skills to deal with viruses and other daily technical dangers.

In contrast, the second category refers to the new structure in which the information is presented or the new way of entering online content. This category has become particularly important with the development of online services and information content. Van Dijk (2005) distinguished two sub-categories of structural skills (which he called informational skills): formal informational skills and substantial informational skills. While the first types of skills refer to the capacity to understand and manage the computer’s formal characteristics and the network (menu and file structures, hyperlinks, etc.), the second ones reflect the ability to search, select, process and evaluate information according to specific needs. On the other hand, the third category of skills includes the basic preparation for proactive information seeking, the attitude of making decisions based on the available information and continuous analysis of the environment to use this information in a relevant way to act in one’s personal or professional life.

At a later stage, VA Deursen and van Dijk (2010) introduced formal skills, for formal informational ones) and informational skills (for substantial informational ones) as two separate categories rather than two-subcategories of informational skills. The former is
strongly linked to generic technologies’ characteristics while the latter is linked to the content provided by ICTs. Thus, these authors identified four types of skills: The first is operational skills, which refer to the ability to manage digital media. The second is formal skills, which refer to the skills needed to manipulate digital media structures. Then, informational skills, which include the ability to locate information in digital technology and finally, strategic skills, which refer to the ability to use information that exists in digital technologies to achieve specific objectives and improve their personal and professional lives.

More recently, VA Deursen et al. (2016) have also distinguished between four types of skills such as operational skills (basic skills for Internet use), informational skills (the ability to find, select and evaluate information sources on the Internet), social skills (necessary for online communication and interaction for understanding, exchanging and acquiring social capital), then, creative skills (the ability to create different types of quality contents and publish or share them with other Internet users).

The current crisis has accelerated the need to reduce existing inequalities and to acquire new digital skills. Indeed, apart from the problem of digital access, the transition to online learning and telework in the period of lockdown has revealed significant importance in terms of e-skills between professors, students, workers, businesses, nations [...]. This led to the failure of the e-learning approach in many countries and the impossibility of ensuring business continuity for many companies. Therefore, bridging this digital divide has become a high priority for all countries in the world. Furthermore, the use of emerging technologies requires new competencies in AI, big data, data mining [...]. Few research studies focus on knowledge inequalities in this area (Cotter and Reisdorf, 2020; van Deursen et al., 2019). Hence, future digital divide research should consider this and further investigate how bridging knowledge digital gap between professors, students and workers.

5.1 Measures

The empirical research studies to measure the individuals’ abilities to use ICT and digital skills suffer from several limitations (Van Deursen and Van Dijk, 2010). The lack of comprehensive and general operational definitions of digital skills is the main reason behind a limited number of severe scientific tests that measure them (Hargittai, 2003). These tests, which are usually carried out in small educational environments or during computer courses, etc., only assess whether the objectives of the course in question have been achieved or not. Moreover, the general measurements carried out on a large population use a questionnaire survey. However, this method raises a problem of validity, as it requires respondents to estimate the level of their ICT skills (Dunning et al., 2003; Merritt et al., 2005; Hargittai, 2003).

Hargittai (2002) used an experimental technique that consists of observing 100 Internet users’ browsing behavior to measure the inequalities in the actual Internet use. Using video recordings, it is, therefore, necessary to record the visited websites, the surfing time and check whether the requested task has been completed or not. This analysis could only identify the difficulties encountered by some Internet users in carrying out the requested tasks and prove that measuring online use poses a problem. To overcome these problems, many studies, developed by some authors such as DiMaggio et al. (2004), Guichard (2004) [...], deal with the measurement of online use. Studies that focus on the measurement of digital skills (Van Deursen and Van Dijk, 2010; Van Deursen et al., 2016; etc) often adopted questionnaire surveys or performance tests (van Laar et al., 2017) (Table 2).

On the other hand, some research studies are attempted to summarize the digital divide’s complexity by proposing synthetic indicators combining both ICT access and use indices (UIT, 2017; Orbicom, 2003; Cruz-Jesus et al., 2012; Vicente and Lopez, 2006).
### 5.2 Determinants

A lot of research studies dealt with the factors that explain the second-level digital divide (Ojo et al., 2019). Hargittai (2002, 2003), DiMaggio et al. (2004) and DiMaggio and Hargittai (2001) identified five key factors responsible for the inequalities in the effective use such as disparities in the technical means, differences in the objectives for which people use the Internet, inequality in the autonomy in the use of the Internet, differences in the skills and finally inequalities in the social support. Other research studies emphasized the inequalities in people’s digital skills (Table 2).

There are three levels of factors that explain the digital divide access and usage proposed by Helbig et al. (2009). The first level is determined by the technology access approach, which is strongly linked to technological determinism and shows that investment and infrastructure availability are of great importance in reducing the digital divide. On the other hand, the second level is about the multidimensional approach, including the income, ICT experience, skills, urbanization rate, family structure, density, access cost, age, marital status and socio-professional position.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Measures</th>
<th>Method</th>
<th>Sample, years</th>
<th>Determinants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheerder et al. (2017)</td>
<td>Medium-related skills, content-related, safety and security, general skills</td>
<td>A systematic literature review (PRISMA)</td>
<td>127 studies, 2011–2016</td>
<td>Socio-demographic, economic, social, cultural, personal, material and motivational</td>
</tr>
<tr>
<td>Ben Youssef et al. (2010)</td>
<td>Operational, formal, informational and strategic skills</td>
<td>Questionnaire survey, multinomial logit model</td>
<td>1464 French students, 2010</td>
<td>Student’s characteristics (gender, age, job), organizational forms (cooperation, collaboration), access to ICT, student’s involvement (ICT training, duration of use), learning mechanisms (learning by doing, learning by using)</td>
</tr>
<tr>
<td>Van Deursen and Van Dijk (2010)</td>
<td>Operational, formal, informational and strategic skills</td>
<td>Questionnaire survey + performance test</td>
<td>109 Dutch. 2007–2008</td>
<td>Education and age (operational and formal)</td>
</tr>
<tr>
<td>Hargittai (2002)</td>
<td>Websites visited, duration and completion of the requested task</td>
<td>Experimental technique</td>
<td>54 American Internet users, 2001</td>
<td>Age, gender, educational level, experience with ICT</td>
</tr>
<tr>
<td>Hargittai and Hinnant (2008)</td>
<td>Online activities of web users</td>
<td>Telephone survey + OLS regression</td>
<td>270 adults from the USA, 2004</td>
<td>Educational level, gender, autonomy in the use of ICT, experience with ICT, duration of use</td>
</tr>
<tr>
<td>Van Deursen et al. (2014)</td>
<td>Operational, navigation information, social, creative and mobile skills</td>
<td>Questionnaire survey + interview.</td>
<td>324 people from UK + 306 people from the Netherlands, 2013–2014</td>
<td>--</td>
</tr>
</tbody>
</table>

Source: Author

Table 2. Some existing research studies about the second-level digital divide
The third level is that of the multi-perspective approach, which includes several factors such as race, ethnicity, type of government (policies, laws, regulations, [. . .]), gender, culture, languages, psychological factors, direct network effects, speed and quality of the services and the content.

6. The third level divide

Unlike the first and second levels of the digital divide, which concern the access and the use of ICTs, the third level refers to the differences in the ability to mobilize digital resources to achieve specific objectives. In other words, even if the users have the same level of equipment and adequate skills, they may not get the same returns from their Internet use (Stern et al., 2009; Van Deursen et al., 2014; Van Deursen and Helsper, 2015). Some internet users improve their performance more quickly than others (Ben Youssef, 2004). On the other hand, van Deursen and Helsper (2015) pointed out that individuals who regularly convert their Internet use into high (offline) return benefit from retroactive effects when increased economic resources help them further develop their digital skills (Figure 3). This third-level of the digital divide lacks theoretical studies on digital engagement’s tangible results (Helsper et al., 2015).

At the risk of oversimplification, two levels of analysis of the third-level digital divide can be identified: the aggregate and the individual levels.

At the aggregate level, the problem of divergence in the performance of territories associated with information and communication technologies is tackled by a research line on the contribution of ICTs to productivity and economic growth (Hwang and Shin, 2017; Gordon, 2002; Boyer, 1998; Petit, 2003; Pradhan et al., 2018; Mairesse, 2003; Gilles and L’horty, 2003).

Productivity gains from the massive adoption of ICTs since the 1990s in the developed countries such as the USA have excited some developing countries to start seeing ICTs as an opportunity to accelerate their growth rate and, therefore, the economic catch up (Ben Youssef and M’Henni, 2004). However, the existence of differences in these countries’ economic structures and the industrialized ones has created ambiguity about these expectations. Empirical studies on this issue have often shown a relatively small, if not insignificant, effect of ICTs on their productivity and economic growth. In this context, M’Henni and Methamem (2008) stipulate that ICTs can create an opportunity of catching up only if some prerequisites such as human skills, institutions, public policies, [. . .] are checked up. The authors add that “there is no investment as counterproductive as the one dedicated to ICT when it is not accompanied by adequate organizational transformations [. . .].” This is like saying that ICTs

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**Figure 3.**

A model for the replication of inequalities in the digital society

**Source:** Van Deursen and Helsper (2015)
create differences in productivity and economic performance and heighten the existing inequalities. Table 3 summarizes some empirical studies that examined the macroeconomic performance of nations associated with ICTs. In the same context, some studies focused on the indirect effects of ICT on economic growth such as their impact on job creation (Katz, 2018; Liebenau et al., 2009; Thompson and Garbacz, 2008).

At the individual level, we identify two main lines of investigations; the first deals with the effects of ICT on the wage inequality between skilled and unskilled workers (Marouani and Nilsson, 2016; He and Liu, 2008; Lee and Wie, 2015; Chu et al., 2015; Acemoglu, 2000, 2001, 2002, 2005). According to this line, ICTs could have an opposite effect when benefiting some people much more than others. On examining the link between growth, inequality and globalization, Aghion and Williamson (2000) pointed out that technological change is the most important element in explaining internal inequality dynamics within nations. The introduction of new technologies into the production process and the companies’ functioning, in general, leads the latter to recruit a better-educated workforce at the expense of the less educated. The plausible explanation that can be given is that the skilled workforce can better adopt and implement new technologies within firms. As a result, their productivity increases and that of unskilled workers decreases and subsequently leads to wage divergence. Therefore, wage inequalities are widening and ICTs are biased in favor of skilled workers. Several empirical studies support the thesis of a skill-biased technological change (particularly in the American case) and show that technology can replace the unskilled workers and aggravate the existing wage inequalities between the two categories of workers (Lee and Wie, 2015; Chu et al., 2015; Acemoglu, 2000, 2001, 2002, 2005).

<table>
<thead>
<tr>
<th>Auteurs</th>
<th>Country/year</th>
<th>Method</th>
<th>Main results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pradhan et al. (2018)</td>
<td>The G20 2001–2012</td>
<td>Analysis of co-integration on panel data</td>
<td>ICT (the use of the internet and broadband) have a significant positive effect on economic growth</td>
</tr>
<tr>
<td>Edquist et al. (2018)</td>
<td>135 countries 2002–2014</td>
<td>Fixed effect model. The approach of instrumental variables</td>
<td>A 10% increase in broadband Internet adoption increases gross domestic product (GDP) by 0.8%</td>
</tr>
<tr>
<td>Lee et al. (2005)</td>
<td>20 developed and developing countries 1980–2000</td>
<td>Time series analysis. Solow residual</td>
<td>The ICTs contribute to economic growth in many developed and newly industrialized economies but not in developing countries</td>
</tr>
<tr>
<td>Ishida (2015)</td>
<td>Japon 1980–2010</td>
<td>Autoregressive distributed lag model (ARDL)</td>
<td>ICT investment has no significant impact on GDP</td>
</tr>
</tbody>
</table>

Table 3. Studies analyzing the effect of ICT on economic growth

Source: Author
Still, at the individual level, the second line consists of new literature that attempts to understand the beneficial effects of Internet use (Wei et al., 2011; Stern et al., 2009; van Deursen and Helsper, 2015; Scheerder et al., 2017). Following this research line, VA Deursen and Helsper (2015) divide offline results into five categories of activity areas: economic, social, institutional, political and educational, a categorization previously carried out by Van Dijk (2005). Empirical studies that investigated the impact of Internet use on economic outcomes showed that the individuals who use the Internet more intensively could increase labor incomes and benefit from advantages such as employment opportunities (DiMaggio and Bonikowski, 2008; Kuhn and Mansour, 2014). For their part, Bhatnagar and Ghose (2004) focus on consumption and stipulate that people favored by ICTs can benefit from a digital consumer dividend by obtaining goods and services at more advantageous prices than less or unfavored people. On the social level, the studies concerned identify a series of gains for those favored by ICT. Indeed, the use of ICTs and more particularly the Internet makes it possible to diversify and broaden social ties (finding partners, making new friends, [...]) (Muscaneel and Guadagno, 2012). It also increases the volume and intensity of interactions within local communities (Kavanaugh et al., 2005; Katz and Rice, 2002). At the political and institutional level, ICT-enhanced people benefit more from their direct interaction with state institutions that adopt new technologies. In addition, individuals with broader and more diverse social networks tend to participate more actively in political and civic affairs than others. There is a wealth of empirical work on the impact of ICT use on student education and performance on the educational level. According to Moore and Kearsley (2011), the Internet offers various formal and informal learning opportunities.

Nevertheless, VA Deursen and Helsper (2015) stipulate that it is difficult to verify whether acquired educational resources (diplomas or learning outcomes) are due to more productive use of the Internet. Scheerder et al. (2017), like Helsper (2012), classify the offline results obtained from Internet use into four categories: economic, cultural, social and personal. Cultural outcomes, as defined by Helsper et al. (2015), are the shared norms (understanding, education and knowledge of the value of entertainment) that determine behavior that reinforces group membership. For personal outcomes, they relate to physical and mental well-being and skills. More recently, some research studies have focused on the negative outcomes of Internet use. Nevertheless, few digital divide studies have focused on the negative side (Scheerder et al., 2019; Lutz, 2019).

In the age of emerging technologies, the problem of inequalities in returns from ICT usage has become more difficult and complex. We do not talk only about offline results of the use of the Internet and computers but also about artificial intelligence, big data, blockchain [...]. For example, in a recent paper, McKinsey (2018) argued that the adoption of AI widens economic and social gaps between workers, companies and countries. Recent events of COVID-19 have shown that countries leaders in emerging technologies have used it to identify, track and forecast the pandemic’s effect and reduce its social and economic impacts. In contrast, many other countries were unable to benefit from it. Indeed, some authors show that the effectiveness and success of the e-learning approach adopted in a period of confinement depend on the availability of ICT and the digital skills of learners and teachers (Mishra et al., 2020; Haider and Salman, 2020). Others have focused on health aspects and underline ICT’s role in the control and monitoring of the pandemic (Mbunge, 2020; Wu et al., 2020; Ortega et al., 2020). These impacts differ from one country to another, so a comparison between countries (especially between developed and developing countries) is a focal point that requires more attention from researchers in their future works on the digital divide.

6.1 Measures
At the aggregate level, two distinct approaches have focused on examining and quantifying the effect of ICT on productivity and economic growth: growth accounting (Hwang and Shin, 2017;
Oliner and Sichel, 2000; Colechilla and Schreyer, 2002; Jalava and Pohjola, 2002) and dynamic general equilibrium models (Martinez et al., 2010; Pakko, 2005).

Early empirical studies of the effect of ICTs on economic growth often showed limited or even insignificant effects of ICTs on growth and productivity (see, for example, Motohashi, 1997; Gordon, 2000). Solow (1987) argued: “you can see the computer age everywhere these days, except in the productivity statistic.” Some authors such as Attewell (1994) and Brynjolfsson (1993) attribute this to four key causes: measurement errors (of gains from ICTs), time lag (between investment and earning), redistribution and IT management (ICTs require organizational change). More recent work has revealed significant positive effects of ICTs on economic growth (Table 3).

Empirical studies using large surveys to measure and capture Internet gains use are rare (van Deursen and Helsper, 2015). In addition, the study of the “opportunity divide” focuses mainly on the different types of Internet use but not on the outcomes (Mossberger et al., 2003; Akca et al., 2007; Stern et al., 2009). The other studies focused on a single type of outcome such as increasing political participation (Sylvester and MacGlynn, 2010) or expanding social networks (Boase et al., 2006). On the other hand, most of the measures proposed by the literature in question focused either on a very narrow range of indicators of a particular type (Sylvester and MacGlynn, 2010; Boase et al., 2006) or on a set of outcomes without explaining the decision of choosing the indicators (Table 4). A further step has recently been taken by Van Deursen and Helsper (2015). They conducted an operational study in The Netherlands on 1,149 individuals to quantify offline outcomes in the economic, social, institutional, political and educational fields and link them to inequalities identified by digital divide literature. The main results showed that Internet use is more beneficial (in terms of results obtained in various fields) for high social status people.

6.2 Determinants
The literature on the third-level digital divide determinants is relatively limited (Scheerder et al., 2017). Empirical studies that attempted to explain the differences in offline resources essentially identify three categories of factors: socio-demographic, economic and social determinants. The most commonly examined variables are gender, income, education and age. As DiMaggio et al. (2004) stated, high levels of income and education are positively related to the internet’s more productive use. For their part, Dobransky and Hargittai (2006) and Pautasso et al. (2011) associated the adoption of the Internet with other factors such as professional status (unemployment, retirement, […] and disability. Other authors such as Graham (2008), Stern et al. (2009) and Hale et al. (2010), focused on social structures (rural/urban population). More recent work addressing the determinants of offline outcomes has identified the factors needed to benefit from Internet use (Van Deursen et al., 2016). This work showed that the difference in the results obtained from Internet use is due to the different determinants of the digital divide. For example, economic performance differences are related to differences in economic resources such as income and education.

At the aggregate level, the divergence in countries’ economic performances is attributed to structural factors such as human capital, institutions, public policies, infrastructure […]

7. Discussion and limits
For years, the digital divide has been a source of heated debate in the overabundant multidisciplinary literature. The research profile on the digital divide revealed both a consensus and a controversy. At the dawn of the digital age, it seemed accepted that the digital divide refers to people's access or not to ICT infrastructure, including continuity and autonomy of access. With the rapid growth of ICTs and increasing access rates, many
<table>
<thead>
<tr>
<th>Author</th>
<th>Surveyed population/period</th>
<th>Type of result</th>
<th>Measures</th>
<th>Determinants</th>
<th>Main results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Castellaccia and Viñas-Bardolet (2019)</td>
<td>35,856 European workers. 2005 et 2010</td>
<td>Job satisfaction</td>
<td>Categorical indicator (1: not satisfied, 2: satisfied, 3: very satisfied)</td>
<td>Income, educational level, professional category and work organization</td>
<td>The Internet improves job satisfaction by both facilitating social interactions and communication and creating new activities</td>
</tr>
<tr>
<td>Boase et al. (2006)</td>
<td>2,200/2,201 adults, 2 telephone surveys. 2004/2005</td>
<td>Make important decisions, help, increase the size of the network and keep important links</td>
<td>Design usage items for each result</td>
<td>Use of ICT, personal characteristics and social perspectives, the scope of social networks, associational activity, professional networks and demographic factors</td>
<td>The Internet helps to build social capital</td>
</tr>
<tr>
<td>Van Deursen and Helsper (2015)</td>
<td>1,149 individuals from the Netherlands. 2013</td>
<td>Economic, social, institutional and political</td>
<td>Design usage items for each domain and then translate them into items to measure the corresponding results</td>
<td>Income, gender, education level, age, marital status and job</td>
<td>The Internet makes a positive contribution to the life of the Dutch people in all four areas The result of divergence is explained by the indicators of the digital divide use and skills</td>
</tr>
<tr>
<td>Helsper et al. (2015)</td>
<td>1,107 individuals from the Netherlands. 2014</td>
<td>Economic, cultural, social and personal</td>
<td>Scale items measuring quantity (result achievement) and quality (result satisfaction)</td>
<td>Gender, age, education, income, employment status, marital status, frequency and number of years of Internet use, operational, informational and social and creative skills</td>
<td>Economic and personal results are the most achieved, followed by cultural and social results Achieving or being satisfied with one type of outcome does not mean that the individual is achieving or is satisfied with the other results</td>
</tr>
</tbody>
</table>

Source: Author

Table 4. Some existing research studies on the digital divide related to offline results

Future research in light of COVID-19
findings of a divide in the way ICTs are used are emerging and shift attention to inequalities in ICT use. Thus, two new debates have emerged: the first concerns the effective use of ICTs while the second concerns digital skills or so-called “e-skills.” Subsequently, a new wave of research has argued that the divide is a divide of access and use and crosses the results obtained from Internet use, which according to Helsper et al. (2015), still lacks theoretical developments. In addition, the search for relevant measures at different levels of the digital divide has sparked a thorny debate. Between simple or composite indicators, it is still difficult to measure them precisely and synthetic way gave their multidimensional and changing nature. Identifying the determinants of the digital divide is also an important part of the literature on the digital divide. The most studied determinants are socio-demographic and socio-economic factors.

By looking deeply into the existing research studies about the digital divide, we have found that some limitations require great attention. In recent years, most of the studies have focused on the second and third-level digital divide. However, it has recently been shown that the first level of the digital divide is still persistent and may aggravate the other divisions. In this respect, specialists and policymakers should not neglect it but rather pay particular attention to it. Second, analyzes of the second-level digital divide are often limited at the national level, which means that the empirical research that has dealt with the global divide (in terms of digital skills) is very limited. Therefore, comparative analyzes in terms of digital skills between countries make it possible to broaden the scope of analyzes of the second-level digital divide and reveal its real challenges. In addition, future second-level digital divide research should focus more on advanced knowledge inequalities (in the area of emerging technologies) and further investigate how to bridge the existing knowledge digital gap between professors, students and workers. Third, the existing research studies (mainly in English) on the third level digital divide focus only on inequalities in individual and non-aggregated results. Inequalities between countries and regions in the benefits of ICTs in terms of productivity, economic growth, employment […] are often ignored and not mentioned in the relevant literature, although it is a form of the third degree digital divide (Ben Youssef, 2004).

Similarly, the literature on the phenomenon of biased technological change is absent in the studies that have examined this divide. In addition, the majority of these studies have focused on the digital divide in the strict sense, i.e. the one related to the Internet and not to the ICTs as a whole. Moreover, little research has focused on identifying the factors that explain the third-level digital divide, negative outcomes of Internet use and inequalities in returns (negative and positive) from emerging technologies. However, determining and analyzing the differences in the results obtained from using ICTs and especially emerging technologies is essential, as these inequalities may aggravate those that already exist.

8. Conclusion
8.1 Methods
Given its harmful effects on individuals and populations, the digital divide has been the subject of several theoretical and empirical studies. Its reduction has absorbed a growing political and media interest from governments and international organizations such as the United Nations, the World Bank, International Telecommunication Union, European Union, […]).

This research aims to provide state of the art about the digital divide phenomenon by presenting an integrative review of the existing research studies on the subject. First, it was necessary to explain the digital divide analysis’s general context to examine the phenomenon and its main aspects synthetically. Through an exhibition of three literature
reviews for the different levels of the digital divide, it was possible to put the research on each of them into perspective and identify some of their limitations.

8.2 Results, theoretical and practical implications
The literature review shows, first, that most of the work has focused mainly on analyzing the second-level divide, which is related to the efficiency of ICT use and digital skills and second, the third-level divide. The first-level has been exceeded, while the current crisis has shown that the access divide still requires attention from researchers and policymakers. Second, much of the literature has analyzed the second digital divide (in terms of e-skills) in the strict sense and at the national level. Moreover, few research studies in this area have focused on advanced digital skills (in AI, big data [ . . . ]). Hence, future second-level digital divide research should focus more on global (second)-digital divide, advanced digital knowledge inequalities and further investigate how bridging existing knowledge digital gap between professors, between students and between workers. Finally, the new wave of research on the third-degree divide focuses on the individual internet’s outcomes. It ignores two important paths in the literature that are an integral part of this divide: the impact of ICTs on nations’ macroeconomic performance and their effect on increasing the skills premium.

This paper contributes to research on DD by elucidating the theoretical evolution of DD research. Broadly, this paper’s results contribute to the epistemological discourse on collective knowledge about the DD and its various levels. Furthermore, the findings show how knowledge of DD is evolving and advancing over time. In addition, this article outlines provides insights on future research directions in light of COVID-19.

The results of our study also have various practical implications. A major practical lesson is that the digital divide is quite complex and was exacerbated by the COVID-19. Therefore, to get the most out of ICT and ensure the effectiveness of full transformation to digitization in all fields of life, countries must first bridge the first level digital divide by improving access and connectivity for households, businesses, public administrations and universities. Furthermore, it is important to develop e-skills by providing more ICT training and paying more attention to the use of emerging technologies.

The present study has some limitations because it only includes articles in French and English languages. Indeed, this literature review has not mentioned studies that examined the impacts of the digital divide on the control and monitoring of the COVID-19 epidemic outbreak in developed countries compared to developing countries.

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Further reading


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