

Digital divide: a literature review

Research Report

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Contents

Executive Summary	5
Background	5
Digital divide	5
Introduction	7
Research questions	7
Research question 1: What is the digital divide?	7
Terminology	9
Models and theories of the digital divide	9
Intersectionality	13
What does it mean for our context?	14
Fairness/justice	14
Young people.....	15
The digital divide in formal education	16
Research question 2: How does the digital divide impact education and learning?	17
Connectivity, hardware and software.....	19
Regional connectivity	20
School connectivity	21
Home connectivity	21
Devices	21
Software.....	22
Digital skills.....	23
What are digital skills?	23
Digital skills and educational outcomes	25
Gender	25
Gender and access to digital technology	25
Gender and digital skills.....	26
Age	27
Race/ethnicity	27
Cultural/language background	27
Disability status	28
Digital disability divide.....	28
Disability digital divide in education	29
Learners with disabilities and their digital skills	30
Attitude/motivation	30
School and teacher attitudes	31
Student attitudes	31

Parental attitudes	32
Emotional and social intelligence	33
Socio-economic status	33
Students' SES	34
School SES	34
Immigration status	35
Educational level	35
Geography	36
Policy	37
Who sets policies?	37
What do policies address?	38
Evaluation	38
Curriculum	39
Edtech industry	39
Safety/privacy	40
Policy relating to devices	40
Policy relating to schools	41
Policy relating to teachers	41
Research question 3: How can the digital divide be addressed to make education more equitable?	42
Suggestions for bridging the digital divide	42
Reflection	44
References	45

Executive Summary

Background

Use of digital technology has been steadily increasing in many areas of people's everyday lives, including teaching and learning. This rise in technology use is not experienced equally around the world, however. The digital divide is a term used to describe inequalities in access to, and use of, Information and Communications Technology (ICT). The aim of this literature review is to understand what the digital divide is, how it impacts education and learning, and how it can be addressed to make education more equitable.

Digital divide

The term 'digital divide' can lead to misunderstandings about the nature of digital inequalities. The digital divide goes far deeper than a simple binary between people who have access to technology devices and those who do not, and has been described as a sociological issue rather than a technological one. Van Dijk (2020a) has proposed a framework of three sequential levels to the digital divide and described how social inequalities at every stage contribute to the digital divide. These are:

- 1st level: Access (motivation, physical, skills and usage access)
- 2nd level: Digital skills & usage (developing and applying digital skills)
- 3rd level: Outcomes (using access and skills to achieve objectives)

Figure 1 uses van Dijk's (2020a) causal model of resources and appropriation theory of the digital divide as a starting point, showing the personal and positional characteristics of people which can be sources of digital inequality. The figure adds factors from our own analysis of the literature to those already proposed by van Dijk (2020a). These factors influence the resources (e.g. time, wealth) people have at their disposal to move through the levels. Greater resources allow better access to ICT and more opportunities to develop the skills required to maximise the beneficial outcomes ICT can offer.

Examples of personal characteristics are age, gender, and race/ethnicity. Positional characteristics are related to an individual's place in society: socio-economic status, educational level, etc. Importantly, these personal and positional factors can intersect in multiple ways, meaning that digital inequality must be approached and understood as a complex combination of factors rather than as single, separate issues.

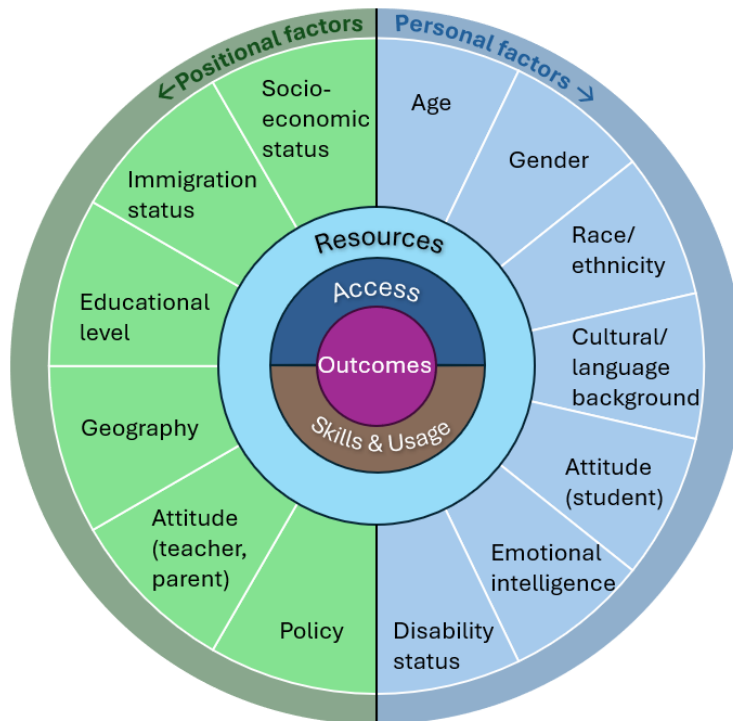


Figure 1: Interpretation of van Dijk's (2020a) framework of the digital divide, incorporating further factors identified by an analysis of the literature

The impact on education and learning of these personal and positional factors is explored, along with other aspects such as connectivity, hardware and software, and digital skills. Taking a system-level view, inequality can affect any aspect from wider government and regional education policy, to school policy and leadership, teachers, parents and individual learners. Examples are given of ways in which categories of inequality have an impact in all these areas, focused particularly on how educational outcomes are affected.

Strategies to address digital inequality are gleaned from sources and include actions that can be taken at mega-, micro- and macro-levels. These include developing a deeper understanding of the issues surrounding the digital divide; ensuring that technology supports marginalised groups; supporting teachers; and evaluating the impact of technology interventions. Technology has the potential to augment teaching and learning but given the potential for disadvantaged groups to be further marginalised through digital inequality, ensuring equitable access, use and outcomes should be a priority.

Introduction

Increasing use of digital technology in all parts of our lives – work, education, leisure and everyday activities – has led to questions about the implications of digital inequality for people’s ability to function and prosper. Global organisations recognise the significance of digital inequality and access to digital technology is directly or indirectly connected to several of the UN Sustainable Development Goals (SDGs) (ITU, 2021). For instance, SDG4 Quality education, Target 4.a, concerns provision of education facilities including access to the internet, while SDG5 Gender equality, Target 5.b, targets the use of ICT to promote the empowerment of women (United Nations, 2025). In addition, the right to education is a protected human right and when access to education relies on digital technology, that becomes an essential component for human rights to be upheld (Rens, 2016).

Understanding the digital inequality faced by learners, teachers and schools is essential for Cambridge University Press & Assessment¹ to fulfil its strategic ambitions to enable access to high quality education and develop its teaching, learning and assessment solutions in order to improve student outcomes. In addition, we know from previous work by Cambridge researchers on the digital divide in the UK during the COVID-19 pandemic that the divide includes more factors than just access to devices and the internet (Coleman, 2021).

Research questions

To establish the wider context of digital inclusion which Cambridge learners, teachers and centres operate within, this literature review aims to answer the following questions:

Research question 1: What is the digital divide?

Research question 2: How does the digital divide impact education and learning?

Research question 3: How can the digital divide be addressed to make education more equitable?

Research question 1: What is the digital divide?

The term “digital divide” dates back to the 1990s (Gunkel, 2003; Light, 2001; Ragnedda, 2017; van Dijk, 2020b), and although many definitions of the term exist, it is generally understood to mean “a division between people who have access and use of digital media and those who do not” (van Dijk, 2020b, p. 1). This description adequately reflects the ongoing difficulties experienced by some in obtaining physical access to Information and Communication Technologies (ICT) hardware, software and the connectivity required to use them. It is now clear that while physical access remains a barrier for sections of the global population, there are multifaceted interactions at play which mean that the term “digital divide” may not be sufficient to describe the scale and complexity of the issues, even where physical access is no longer an acute problem (Carlson & Isaacs, 2018; Paré, 2005; Zheng & Walsham, 2021).

¹ Cambridge University Press & Assessment, referred to as “Cambridge” in this report, is the parent organisation of OCR, Cambridge English and Cambridge International Education.

Some have differentiated the “global digital divide” from the more general digital divide. The global digital divide is described by Ragnedda (2017) as a consequence of inequalities in the global economy where large geographic areas have not been able to keep pace with digital access in developed economies. While this is no doubt a significant issue, it runs concurrently with the wider digital inequalities which will not disappear as regional access improves. The idea that one day these regions will close the gap is also unrealistic, given that wealthier economies will gain faster access to newer and more sophisticated technologies.

Commentators generally agree that the digital divide exists beyond technological issues of devices and internet connection. Van Dijk stated that “the digital divide should not be isolated from social and information inequality in general” (2005, p. 181), and Ragnedda (2017) made the similar point that the digital divide is a sociological issue rather than a technological one.

Ragnedda (2017) provided explanations for why it is important to investigate the deeper contributors to digital inequality. Foremost is the danger that technology can not only perpetuate inequality, but in fact make it worse. There is a circular interaction of digital inequalities with wider social inequalities. Social inequality affects whether and how people have access to digital resources. The resulting digital inequality can then further entrench social inequalities (Ragnedda, 2017). It has also been pointed out that access to digital resources in itself does not necessarily help to reduce social inequality or benefit individuals (Clayton & Macdonald, 2013; Gunkel, 2003; van Deursen & Helsper, 2018). Heeks (2022) sought to develop a theory of adverse digital incorporation, where power structures in the digital landscape promise to improve people’s lives, yet in fact do not benefit them and can exploit and further marginalise them.

There is general agreement that connectivity and development of digital skills are considered essential for people to prosper economically and socially (UNESCO, 2023b), and participate in society in terms of education, employment, citizenship and entertainment (Ritzhaupt & Hohlfeld, 2018). This is demonstrated by references in international development goals and human rights resolutions (Rens, 2016; United Nations, 2025). These aspirations are related to equality of opportunity and development of future-ready skills but also made imperative by an increasing use of “digital technologies for everyday activities” (Ragnedda, 2017, p. 19), such as being unable to pay a bill without a smartphone. Despite the increasing ubiquity of digital technologies, some have cautioned against assuming that all people embrace ICT usage. Relatedly, there are concerns about the paradigms for digital technologies set by economically and politically dominant industrialised countries, and the assumption that less developed countries should pursue the same approaches to develop their digital capabilities (Musa, 2019).

Much of the literature in this area takes a broad view of digital inequality and refers in general terms to the impact of technology on people, but those people are frequently assumed to be adults and the inequalities related to age, ethnicity or income with discussion focusing on issues such as employment. While the broader context is relevant to societies in which education is situated, this literature review seeks to address the specific demographic that we are interested in (learners), those that mediate their experience (e.g., teachers,

parents) and the specific context that we are concerned with (teaching, learning and assessment).

Terminology

The “digital divide” is likely to be a familiar term for most, but some have argued for alternative descriptions. Some of the reasons that the term digital divide is thought to be inadequate are that there is no consensus on its meaning (Gunkel, 2003); it encourages a focus on technology as a source of inequality and downplays other factors (Paré, 2005); and that it entrenches the concept as a binary of “haves and have-nots” when we know the situation is more nuanced (Gunkel, 2003; Ragnedda, 2017; van Dijk, 2020b). Some have pointed out that alternative terms such as “digital exclusion”, “digital inequality” and “digital poverty” suffer from the same problems and emphasise exclusion rather than highlighting the inequalities among those who are included in digital systems (Heeks, 2022). An alternative proposed by Warschauer (2002), who recognised the problem with a binary view of the digital divide, was “technology for social inclusion”. However, no preferred term has emerged from the literature, and we recommend awareness that a variety of terms are in use, with differing interpretations of the meaning of those terms. We have therefore continued to use the term digital divide in this report, while recognising that it is not entirely adequate.

Throughout the literature a variety of terms have been used that are associated with the technology aspect of the digital divide. ICT, digital technology, digital systems, digital resources and others are often used interchangeably. Scheerder et al. (2017) investigated the terms used in literature about the digital divide and found that when referring to skills, “online skills”, “digital skills” and “internet skills” were frequently used terms. “Digital literacy”, “digital competence” and “information literacy” were also used. In our experience with the literature, often it was not explicitly stated what the terms used referred to, what the author(s) understood them to mean, or why they chose certain terms over others. Most authors seemed to be referring to internet access and/or the tools available via the internet, even though some digital tools can be used without internet access. In this literature review, we have usually followed the terminology used by the authors we referred to and have accepted that there may be some lack of clarity.

Models and theories of the digital divide

Citing the inadequacy of the term “digital divide” that we have discussed, Carlson and Isaacs (2018) wanted to completely replace it with the construct “technological capital”, an extension of Pierre Bourdieu’s theories of capital. In the 1970s, Bourdieu originally suggested economic, cultural and social capitals, which can be described as “assets that may include cultural and material goods and wealth that are derived through developing and maintaining social relationships, networks, skills and knowledge” (Beckman et al., 2018, p. 200). The value of an individual’s capital depends on the social context (Bourdieu used the term “field”) in which they are operating (e.g., a very fashionable item of clothing might be valued by one’s peers but not recognised as such by someone outside that group). Expanding on Bourdieu’s theory of capitals, Carlson and Isaacs (2018) described how an individual’s “accumulated technological history”, i.e., all their previous experiences with ICT,

make up their technological capital. They went on to identify four factors that benefit individual users of ICT. These were awareness, knowledge, access and the technological capacity of the user's social collective. These factors overlap somewhat with van Dijk's model (discussed below), which also covers access, awareness/motivation and skills/knowledge. Carlson and Isaacs (2018) however, in line with Bourdieu's theories, placed an emphasis on the accumulated history an individual has gained with technology and the social networks they operate in, giving as an example the communication benefits that can be afforded by using the same technology (device, operating system or application) as one's peers. Calderón Gómez (2019) further divided technological capital into two interrelated dimensions: incorporated and objectified. Incorporated refers to internalised technological capital – knowledge, skills and attitudes that a person develops over time. Objectified refers to the material objects, such as devices, that someone might possess.

Lybeck et al. (2023) further expanded on this concept to characterise digital capital as a bridge capital, whereby other types of capital can be transferred or accumulated via it. An example of this could be transferring social capital (a degree level qualification) into political or economic capital (a powerful job) via digital capital (having access to and knowing how to use an online social network to maximise job opportunities). Calderón Gómez (2019) also pointed out that other types of capital can be transferred into technological capital.

Digital or technological capital is therefore a useful concept relevant to this discussion, as learners' life chances can be affected by the technological capital they are able to develop or accumulate, which in turn can affect their ability to access other forms of capital. The term is also one which allows us to picture individuals' differing levels of capital (rather than a dichotomy) and the opportunities to augment it.

One well known model of the situation is van Dijk's (2020a) causal model of resources and appropriation theory of the digital divide, which has been extended since its origins around twenty years ago. It is important to note at the outset that van Dijk's (2020a) model was developed in reference to wider sociological themes and does not specifically target the education context. In addition, it may not capture the nuances of the digital divide globally, especially in the Global South. It is, however, a useful and influential framework. The model originally consisted of sequential levels of access, which were later grouped under the label of the first level divide as van Dijk expanded his model to incorporate wider concepts. Two more levels were later added, when digital skills and then the outcomes of digital use became of greater interest to researchers (van Dijk, 2020a). The three levels are summarised in Figure 2 and then described in more detail below.

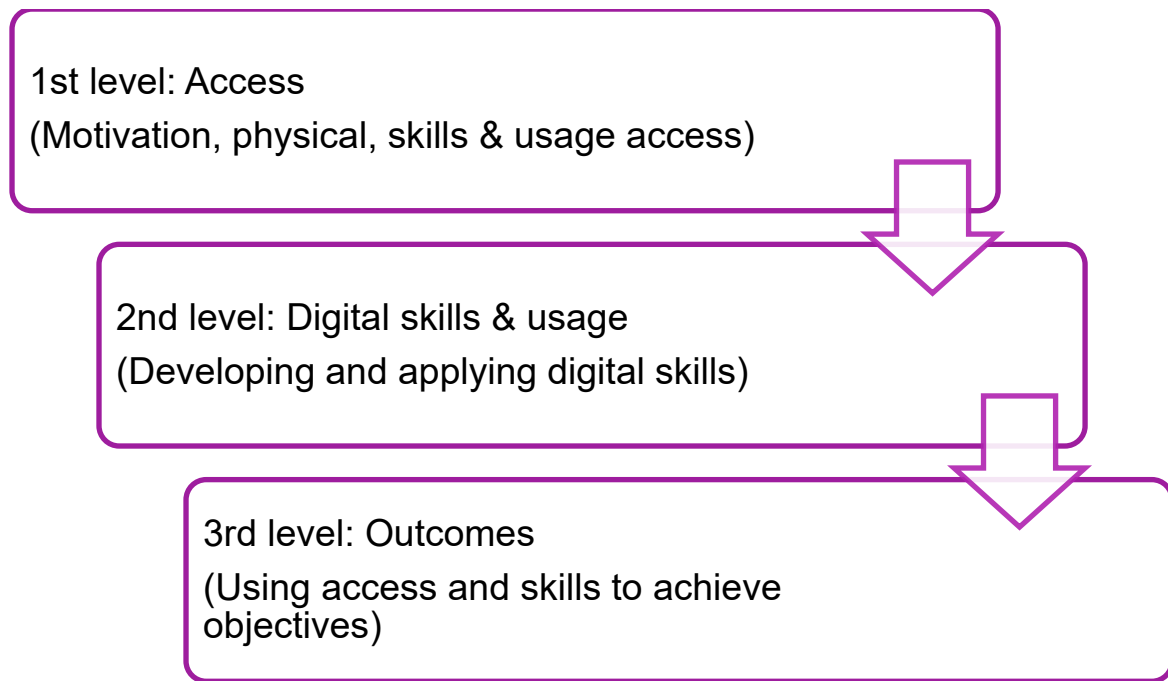


Figure 2: Summary of van Dijk's (2020a) levels of the digital divide

1st level divide: Access

The first part of the model to be developed was the four levels of access. Van Dijk (2020a) stated that at the time he proposed these, issues of physical access were still the primary concern in the debate on the digital divide.

The four levels of barriers to access were categorised by van Dijk (2005) as:

1. Motivational access (e.g., lack of interest, technophobia)
2. Material or physical access (e.g., lack of or outdated devices, poor connectivity)
3. Skills access (e.g., lack of education or support)
4. Usage access (e.g., lack of opportunity to use).

He conceived these as sequential barriers to access – with achievement of one level necessary for progression to the next. Examples of these sequences are that individuals are unlikely to obtain or interact with a device if they don't have the motivation or desire to do so; digital skills can't be developed without access to a device. In van Dijk's causal model of resources and appropriation theory, motivation and physical access is the first level divide. It is possible to envisage further barriers to access, some of which were mentioned by Ragnedda (2017), such as financial (not just having sufficient funds to purchase equipment, but funds to maintain it and any software, applications or subscriptions).

2nd level divide: Digital skills and usage

After 2010, inequality of digital skills became more prominent in debates on the digital divide. Van Dijk (2020a) termed this the second level divide, concerning digital skills and usage.

Van Dijk and van Deursen (2014) proposed six categories of digital skills:

Medium-related skills

- Operational (knowledge of how to use a device or the internet)
- Formal (understanding of digital characteristics, e.g., menus, hyperlinks)

Content-related skills

- Information (searching, selecting and evaluate information via ICT)
- Communication (email, chat, social media, online communities)
- Content creation (writing, images, video – publishing via apps)
- Strategic (planning and using ICT to achieve goals)

Usage is dependent on two of the preceding factors: motivation (being interested in particular ICT tools) and skills (having the skills to use them) (van Dijk & van Deursen, 2014). Van Dijk (2020a) stated that *differences* in usage of digital media and the internet are caused by two further factors: firstly, social and cultural differences in society, and secondly, the number of different types of apps and usage. Consequently, according to van Dijk there is a usage gap, where those with greater resources (education, wealth) are more likely to use digital media for information, education and work purposes than those with fewer resources who will use it for entertainment or chatting. This fits with Lybeck et al.'s (2023) characterisation of technological capital as a bridge capital. Helsper (2012), however, made the point that van Dijk's model contains a value judgement on types of usage and the type of inclusion that they contribute to. For instance, the social inclusion offered by using ICT to chat with friends could be more valuable *to the user* than other types of inclusion that academia is concerned with. Additionally, by emphasising digital uses that overtly contribute to outcomes in the economic domain (e.g., study) and excluding those that contribute to cultural and social domains (e.g., chat), their interconnectedness is overlooked. For example, social networks built through chatting could increase chances of finding employment (digital social capital acting as a bridge to economic capital) (van Deursen & Helsper, 2018).

3rd level divide: Outcomes

The 3rd level divide (outcomes) in van Dijk's (2020a) model features categories described as domains of society: economy, social networks, space/geography, culture, politics and institutions. The premise here is that digital skills and usage of digital systems contribute to outcomes for individuals. Examples given include potentially better health outcomes for someone who has used the internet to find information or advice about a health condition, or improved mental health through using social media to communicate and gather support from family and friends. He stated that outcomes can be positive, but also gave the examples of cybercrime, illegal hacking, hate speech and disinformation, and device or content addiction as negative outcomes (2020a, p. 2). Van Deursen and Helsper (2018) pointed out that scholarly attempts to classify digital skills into "more useful" and "less useful" in terms of enabling individuals to access better outcomes have often failed to take into account wider sociological ideas about the power structures that shape individuals' social spaces. By this they mean that the focus on career and education outcomes from internet use, can lead to social, cultural and personal outcomes being undervalued.

Central to van Dijk's model is a causal relationship between the resources that an individual has available to them, which determines their digital access, skills and usage, which in turn affects the outcomes for them. Resources in the model are labelled: temporal, material, mental, social, and cultural. These relate to the types of capital proposed by Bourdieu that we described earlier. So, to return to a previous example, having better resources (time, money, awareness) and digital access, skills and usage would allow someone to locate high quality health information, determine whether the source is trustworthy and secure better health outcomes. The model can also be seen as a virtuous circle in that the outcomes that are achieved can augment the resources that a person has to begin the cycle again.

The resources that a person has available to them are affected by personal and positional categories. Personal categories are related to individuals and their physical and mental characteristics: "[t]heir significance for social inequality is that they are also social and cultural categories revealing differences of generation, gender, ethnicity, cleverness, and appeal, respectively" (van Dijk, 2005, p. 17). Positional categories relate to a person's place in society – employment status, level of education, area of residence, etc. One example of how these factors are linked is the historic and ongoing burden of unpaid household labour (positional category) on some women and girls (personal category), which means they have limited time and financial ability (resources) to develop skills to access or benefit from digital systems (outcomes).

While thinking about van Dijk's model of the digital divide, it is possible to see how the technological capital theory can be overlaid with it. Technological capital is represented across the levels, that is the access, motivation, digital skills and usage belonging to individuals, along with the resources available to them and the ability to influence outcomes, which could be increased technological capital but also the use of it to access other types of capital: social, cultural and economic. These models are important for understanding the complexity of the digital divide. For young people, the models can indicate how, for example, positional categories (e.g., their parents' socio-economic status) can determine whether ICT access is obtained at home (resources), which impacts their ability to achieve educational success and further their life chances (outcomes/capital).

Intersectionality

Given the growth in understanding of the complexities of the digital divide that we have outlined above, some commentators have used an intersectional lens to analyse digital inequality. Intersectionality is an academic field which began to emerge in the 1960s (Collins & Bilge, 2016), with the first use of the term credited to Kimberlé Crenshaw in 1989, who described how Black women experienced discrimination on grounds of both race and sex, and how single-axis frameworks could not address the combination of different types of discrimination and how they are compounded by one another (Crenshaw, 1989). Over time, intersectionality has grown into a large scholarly field and while it is not possible to fully cover the many related theories here, a basic summary of the discipline expands on Crenshaw's initial theory to include the potential for individuals to belong to multiple categories that combine to affect their experiences of discrimination and inequality. As Crenshaw stated, single-axis frameworks cannot sufficiently address these experiences, so there is a need for us to be mindful of this when we analyse the digital divide.

Collins and Bilge (2016) proposed six core ideas in intersectionality:

- social inequality
- relationality (interconnections rather than binaries)
- social context (people within the same context can have different experiences)
- social justice (issues of fairness and perceived fairness)
- complexity (an inherent quality given the different factors)
- power (expanded on below)

The domains of power which people are subject to:

- structural (social institutions, e.g., schools, government departments, CUP&A),
- disciplinary (rules and policies, e.g., admissions policies),
- cultural (media, popular culture)
- interpersonal (face to face social interactions)

(Collins, 2009)

Zheng and Walsham (2021) described how digital technology can interact with power structures and shape individuals' differing experiences within those power structures. Applied to a learner, we can contextualise their experience of these domains of power as being subject to the rules and policies of their school, facing socio-cultural ideas about educational achievement and absorbing or rejecting opinions from peers, family and teachers. One example could be a learner experiencing digital inequality because their school does not have a reliable internet connection, their inequality further compounded by being excluded from access to a home device due to other family members taking priority.

What does it mean for our context?

It may be possible to describe the digital divide in education at the macro-level, for example by exploring the issues faced by any particular country at a population level, but a sufficient analysis should take account of the interaction between the different types of inequality described here. This presents a difficulty, as it is impossible to know and account for the unique set of circumstances of each individual who interacts with our services. This leads us to the question of how we can ensure that our products and services sufficiently take account of digital inequalities in order to improve equity.

Fairness/justice

One of the principal concerns in education, learning and assessment is fairness. Yet, as Nisbet and Shaw (2020) pointed out, fairness means different things to different people and fairness can be defined in a number of ways. Crucial to fairness is the concept of equity, with some rightly pointing out that treating everyone equally does not result in fair outcomes when the playing field is not level to start with. Before attempting to address injustice, however, identification of the potential sources of inequality is crucial. This involves tracing, identifying and defining the causes of inequality, as well as deciding whether all sources have been identified or whether there are unidentified or hidden sources. Such work would need to reflect on whether sources of inequality are likely to change over time, and whether some have a greater impact than others. And as the section on intersectionality highlighted, categories of injustice are not discrete.

Another concept discussed by Nisbet and Shaw is the problem of “levels of justice”. Giving a hypothetical example, for instance that it was possible to redistribute resources in such a way as to level the playing field, decisions would need to be made about where the level was set. Nisbet and Shaw (2020) described one theoretical approach as “levelling down”: “reducing the opportunities and benefits to the advantaged for the sake of equal levels for all” (p.128). In the digital divide context, this could be conceptualised as, for example, digital learning resources that require minimal internet connection speeds or run on low-specification devices. Considering the many ways in which digital inequality manifests itself, it is clear that even if some elements could be successfully levelled (e.g., equality of connectivity), there are other factors that would be difficult to isolate and compensate for at a system level (e.g., parental support). This is seen by Nisbet and Shaw to be a tension between equality and freedom, for example, the freedom of wealthy parents to access advantages such as extra tuition for their child.

Fairness as related to the digital divide therefore involves identification of the factors which contribute to digital inequality, ideally with some way to measure the impact of those factors on teaching, learning and assessment in order to identify the priority areas to target. To achieve more equitable products and services, solutions need to go beyond one-size-fits-all approaches, towards those that can attenuate known sources of inequality.

Young people

Much of the work on the digital divide has mentioned the many ways in which people experience inequality through their personal and positional categories. A key objective for this literature review was to scrutinise one group in particular, namely young people, as the primary users of the products and services offered by Cambridge. Teachers, schools and government departments also interact with those services and as such are discussed because they mediate with young people as the end users.

Intersectionality theory tells us that their age category is one source of young people's inequality – power tends to be held in the centre of the age spectrum, with the young and the elderly more marginalised. However, young people may also have other personal sources of inequality compounding that, such as gender, ethnicity, sexuality and disability. In terms of positional sources of inequality, they are especially vulnerable as they have less agency, being dependent on others. Their geographic location, their household socio-economic status, the school they attend, their teachers, government policies, all have an impact on young people's access to and usage of digital media, and they have limited capacity to influence or change those factors compared to many adults. Without financial resources, young people may be excluded from decision making about the personal devices they use, the internet connection they have, or the content they are able to access. Decisions made by their parents, teachers and schools similarly affect their access, skills and usage. This in turn can limit the technological capital they are able to build.

Calderón Gómez (2019) highlighted the tendency to describe young people as a homogenous group and to ascribe certain characteristics to the group denoted by the terms “digital natives”, “net-generation” or similar. The assumption many make is that having grown up with digital tools available, young people as a group possess inherent digital skills

(Hargittai, 2010). This fails to take account of the social inequalities that inform the digital divide, and that young people are especially vulnerable to them. Calderón Gómez found that even in the context of a developed country such as Spain, a typology of young people showed varying groups of internet users, from “digitally excluded” and “basic users” to “cyber-experts”. Hargittai (2010) reported that social inequalities meant that young people from more privileged backgrounds were likely to use digital media in a way that benefitted their education or career, sometimes referred to as capital-enhancing use of ICT. On the other hand, young people from less privileged backgrounds were often found to use digital technology for non-capital enhancing use such as for entertainment (e.g., Zhang, 2015).

The digital divide in formal education

The digital divide impacts educational outcomes like other aspects of social inequality (e.g., SES, race/ethnicity, gender). At the same time, formal education is also often perceived to be well placed to rectify social inequalities including digital divide (Ritzhaupt & Hohlfeld, 2018). Hohlfeld, Ritzhaupt and colleagues began theorising the digital divide in formal education settings in 2008, mainly focusing on the US context. They defined the digital divide within formal education settings as:

[A] social inequity due to disparate quantity and/or quality of teachers’ and students’ access, use, and creation of original artifacts with Information and Communication Technology (ICT) resources.

(Ritzhaupt & Hohlfeld, 2018, p. 22)

Social inequity is defined as inequitable opportunities for participation in society (e.g., social, economic, educational, political) based on one’s status or group (e.g., SES, race/ethnicity, age). ICT resources comprise both physical (e.g., computer, tablet, mobile phone) and digital (e.g., software applications, internet) resources which teachers and students can access and use to create original artifacts, by which they mean the objects that students and teachers can create using ICT (e.g., digital music, animations, web pages, presentations, lesson plans).

Building on previous work on the digital divide, Hohlfeld et al. (2008) proposed a framework for conceptualising the levels of digital divide within schools. The three levels in the framework are hierarchical in that an equitable outcome at each level is pre-requisite for equitable participation at the next level (Hohlfeld et al., 2008; Hohlfeld et al., 2017). The framework is underpinned by the assumption that student and teacher creation of original artifacts using ICT as evidence of empowerment with ICT is the desirable outcome.

Level 1: School infrastructure and access

The first level of the framework concerns the school infrastructure in terms of access to appropriate ICT resources (i.e., hardware, software, the Internet and other technology support) for both teachers and students (Hohlfeld et al., 2008; Hohlfeld et al., 2017; Ritzhaupt & Hohlfeld, 2018).

Level 2: Classroom use of ICT by teachers and students

The second level focuses on the use of technology by teachers and students for instructional purposes in the classroom (Hohlfeld et al., 2008; Hohlfeld et al., 2017; Ritzhaupt & Hohlfeld, 2018).

Level 3: Individual creation by students and teachers

The third and highest level of the framework centres around the productive and creative uses of ICT by students and teachers as opposed to consumption of ICT (Ritzhaupt & Hohlfeld, 2018). This relates to Dolan's (2016) characterisation of students' use of technology as either producers (i.e., active use of technology by students to create products or communicate ideas such as creating websites) or consumers (i.e., passive use of technology such as drilling and practice).

While the framework is useful to examine access and use of ICT within schools, it does not take into account access and use divide outside school. Research has established that ICT access outside school plays pivotal role in ICT literacy development and, by extension, other educational outcomes. Warschauer (2007) outlined five ways in which the digital divide manifested in teaching and learning:

- School access – inequality in availability of hardware and connectivity across schools
- Home access – teacher awareness of differing levels of student access to hardware and connectivity
- School use – differences in socio-economic status of students affects the type of ICT activity they undertake in school
- Gender gap – differences in types of ICT activity undertaken by gender
- Generation gap – differences in levels of comfort with ICT between teachers and students

To conclude this section exploring what the digital divide is, we found that van Dijk's body of work on the digital divide is extremely useful for understanding the issues but that it does not fully address two areas relevant to this literature review: the digital divide in the education context and the digital divide in areas outside the Global North. Ritzhaupt and Hohlfeld (2018) looked specifically at digital divide in the education context and provided a useful conceptual framework, however this was developed in the context of the United States and as such may not be readily applied to other contexts, particularly lower- to middle-income countries.

Research question 2: How does the digital divide impact education and learning?

Ritzhaupt and Hohlfeld (2018) considered the digital divide as a new and potentially more dangerous gap in educational systems. As we are becoming increasingly dependent on ICT in virtually all aspects of our lives, including education, the digital divide could exacerbate achievement gaps. This echoes Warschauer's et al. (2004) argument that there is not a single digital divide in education, but instead a range of intersecting factors which shape ICT use that in turn can widen pre-existing educational gaps.

Ritzhaupt and Hohlfeld (2018) referred to these factors as “dividing factors” to describe the different statuses or groups that have been identified to shape the basis of the digital divide. They identified six dividing factors most documented in digital divide research in educational contexts, i.e., socio-economic status (e.g., level of income), education level (e.g., parental education level), gender, age, geography (e.g., rural, urban) and race/ethnicity. They acknowledged that other factors (e.g., disability status, culture, language) also contribute to the divide.

These dividing factors overlap with the personal and positional categories described by van Dijk (2005), and therefore we have structured the following sections by taking the factors referred to by van Dijk (2005) and Ritzhaupt and Hohlfeld (2018), then adding further selected categories that emerged from the review and warranted their own section (disability status; immigration status; cultural/language background; attitude/motivation of school/teacher/parent; and policy) (Table 1).

Table 1: Personal and positional categories relating to the digital divide

Type	Category	Source
Personal	Gender	Van Dijk (2005); Ritzhaupt & Hohlfeld (2018)
	Age	Van Dijk (2005); Ritzhaupt & Hohlfeld (2018)
	Race/Ethnicity	Van Dijk (2005); Ritzhaupt & Hohlfeld (2018)
	Cultural/language background	
	Attitude/motivation (student)	Van Dijk (2005)
	Emotional and social intelligence ²	Van Dijk (2005)
	Disability status	Van Dijk (2005)
Positional	Socio-Economic Status (SES)	Van Dijk (2005); Ritzhaupt & Hohlfeld (2018)
	Immigration status	
	Educational level	Van Dijk (2005); Ritzhaupt & Hohlfeld (2018)
	Geography	Van Dijk (2005); Ritzhaupt & Hohlfeld (2018)
	Attitude/motivation (school/teacher/parent)	
	Policy (government/regional/school)	

Figure 3 is a graphical representation of the personal and positional factors described by van Dijk (2005) and Ritzhaupt and Hohlfeld (2018), along with the categories that we included having reviewed the wider literature. This figure attempts to show how varying experiences of these personal and positional factors influence the resources which people have at their disposal to gain the access, skills and usage required to achieve outcomes.

² Van Dijk (2005) also included cognitive intelligence, which is discussed in the digital skills section.

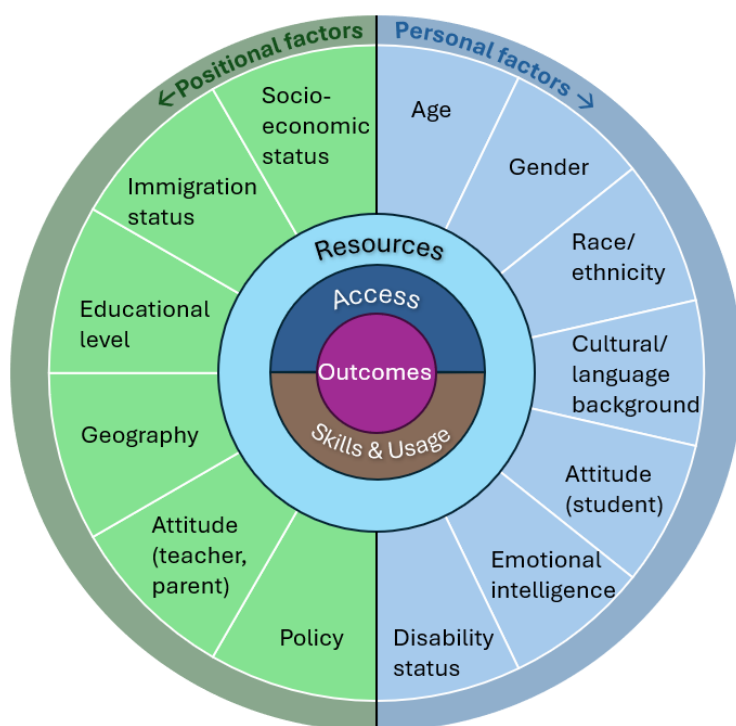


Figure 3: Interpretation of van Dijk's (2020a) framework of the digital divide, incorporating further factors identified by an analysis of the literature

As discussed earlier, the personal and positional factors identified in Table 1 and Figure 3 interact with each other in multiple ways to impact education and learning. It is impossible to exhaustively describe each of these interactions, but in the following sections we have given examples of intersectional factors where appropriate. Connectivity, hardware and software, along with digital skills are discussed first in line with van Dijk's sequential framework of the digital divide. A range of sources has been consulted, including books and journal articles, reports from international organisations (e.g., UNESCO) and results from international surveys (e.g., PISA, ICILS). Some sources have focused solely on single countries, or groups of countries which may have certain demographic characteristics which mean the results are not generalisable to all regions or demographics.

Connectivity, hardware and software

As described by van Dijk, physical access to ICT is one of the basic requirements for acquisition of digital skills, beneficial usage of ICT and positive outcomes. It was the first level of the digital divide to be conceptualised and consists of connection to internet service (broadband or cellular), access to devices (personal computers, tablets, mobile phones), peripherals (printers, hard drives, cameras), and software. Within these categories there are also nuances, such as variances in what connectivity means to people, multiple ways in which people can access devices (owning, borrowing, public access, switching SIMs between devices) and regional differences in behaviours (e.g., pay-as-you-go data plans). There can also be difficulties in collecting data on connectivity, hardware and software, especially from rural or digitally excluded groups, which can impact decision making. Access can also be dependent on the other factors that we will discuss, such as geography and

socio-economic status. UNESCO has stated that “the right to education is increasingly synonymous with the right to meaningful connectivity” (UNESCO, 2023b, p. 3).

This aspect of the digital divide impacts education and learning in multiple ways. At a regional level, access to internet services can vary, which means that schools and homes may have difficulty achieving connection to online services and tools. The socio-economic status of regions, schools and households can affect whether they can afford to obtain the hardware, software and connectivity required to access ICT. As we have discussed, these problems have been characterised as a binary of “haves” and “have-nots”, but in fact many of these factors can be shades of grey in between. For instance, one school may have no devices, while another may have one device that is shared between students. Another school may purchase devices for all students, but they become outdated over time. A household internet connection may be unreliable or very slow. A student may be using a mobile phone to access educational resources designed for personal computers. Compounding factors mean that it is difficult to identify where the digital divide is most harmful. While we may know precisely which regions do not have the infrastructure to support fast, reliable internet access, it is more difficult to find out how many students in a wealthier region are being disadvantaged because they cannot afford a device with which to complete homework set by their school. One point made by UNESCO is the importance of ascertaining whether increased access and connectivity translates into better educational outcomes. Some have suggested that so far, it has not (Hennessy et al., 2021).

Regional connectivity

Internet connection is recognised as enabling economic and wellbeing benefits to people and is addressed by the United Nations’ Sustainable Development Goal 9: Improved infrastructure (United Nations, 2025). When it comes to the global picture, the ICT Development Index aims to measure regional connectivity. In 2023, the index estimated that around 67 per cent of the world’s population was online (79 per cent for those aged 15-24) and that in low-income countries, 27 per cent of people used the internet. A wide gap in internet use existed between rural and urban areas in low-income countries (ITU, 2023).

Local internet speed was found to strongly relate to vocational school students’ achievement in mathematics in Poland during the COVID-19 pandemic. Those students in communities with internet speed in the lowest decile performed particularly weakly in mathematics (Liwinski et al., 2024).

Oyedemi (2019) proposed the term “partially digital” to describe the youth population/university students in South Africa who increasingly have access to the internet on their cell phones and through public access provided at campus computer labs. Oyedemi noted that such access is mostly rigid and restrictive (e.g., students can only access the computer in labs and the internet within limited time; public Wi-Fi connection is often unstable, universities often block access to certain websites), and therefore these young people cannot have the same digital experience as others who have freer and more flexible access to computers and the internet (i.e., at home).

School connectivity

The impact of school connectivity on education and learning is mainly centred on teachers' ability to access the tools and content required for teaching, though other aspects are also affected by connectivity and ICT availability such as school information and monitoring systems and teacher professional development. UNESCO reported that 40 per cent of primary schools, 50 per cent of lower secondary and 65 per cent of upper secondary schools globally are connected to the internet. The national infrastructure and policy influences school connectivity: a lack of electricity supply means that some rural areas face a corresponding lack of connectivity (UNESCO, 2023b). UNESCO pointed out that this is a SDG4 indicator, meaning that it is monitored and reported on.

Home connectivity

Factors such as regional connectivity, household socio-economic status and attitudes to technology will influence whether home internet and device access is available to learners. There is evidence that home internet access and speed affect student engagement and educational outcomes.

The 2023 International Computer and Information Literacy Study (ICILS) survey data showed that having home ICT resources were important factors of student computer and information literacy (CIL) and computational thinking (CT) achievement. Those who had fewer internet disruptions also achieved statistically significantly higher CIL and CT scores on average than those who had less reliable internet at home (Fraillon, 2024).

A study conducted in the US state of Michigan showed that home internet access and speed relate to students' engagement with online educational activities, completion of homework assignments, digital skills, educational outcomes (GPA and standardized test scores) as well as further educational and career aspirations. Students who had no internet access at home and who relied on a cell phone for internet access outside school were less likely to engage in online educational activities outside school and to finish homework assignments (Bauer et al., 2020). Caputo (2019) also noted a widening of the homework gap, where some students are unable to complete homework assignments due to inadequate home internet access.

Devices

Device inequality can manifest in numerous ways – by having access to no devices, one device, different devices at home and at school, or multiple devices. The age of a device is one influential factor – older devices tend to be slower and may become out of date or be unable to run certain programs or software. Part of the difficulty of assessing the impact of devices is that many young people have two (or more) potential routes to ICT access. One is the device(s) used at school, and another is the device(s) used at home. For some students, the device used at school and at home could be the same as some schools provide a device which learners can take home with them, while others operate a system where learners bring their own device to use at school. For those who use different devices at school and at home, required familiarity with different types of devices (e.g. PC, tablet) or operating systems could be seen as either a disadvantage or a benefit to learning.

There are conflicting reports on the effect of device access. On one hand, some studies suggested that access to and use of devices improves education outcomes, while other research suggested otherwise. The lack of consensus on this issue could point to the effect of other interacting factors, such as household socio-economic status or teacher digital skills that mean possession of a device in itself does not relate to education outcomes – a finding common to studies evaluating the effectiveness of One Laptop Per Child programmes.

According to Fraillon (2024), students who reported that they always had access to PC devices at home whenever they needed them for schoolwork achieved statistically significantly higher scores in CIL and CT on average than those who reported otherwise. Students who had a minimum of two PC devices at home had statistically significantly higher scores than those with fewer than two PC devices at home. In addition, experience with devices seemed to offer benefits: students who had used devices for at least five years achieved higher scores in CIL and CT than those with less experience (Fraillon, 2024).

Buying new hardware alone is not necessarily a good use of national or school funds, due to the high cost, and the evidence that shows educational outcomes are not improved without complementary measures such as specialised software and teacher training (GEEAP, 2023). Some countries found that buying devices had no impact or negative impacts on learning (GEEAP, 2023), a finding backed by the ICILS results from three separate cycles: “increased [ICT] usage has not translated into higher achievement” (Fraillon, 2024, p. 231). There is evidence to show that initiatives like One Laptop Per Child (OLPC) were largely ineffective in improving education outcomes (Cristia et al., 2017; Mora et al., 2018). Around 30 per cent of countries had policies to provide each student with a laptop or tablet and about one in five countries offers subsidies for students to obtain devices (UNESCO, 2023b).

GEEAP (2023) highlighted the potential benefits of using mobile phones for learning, given that these are possessed by greater numbers of people and are more accessible to some than other devices. Examples of potential uses given included tutoring phone calls and sending text messages to students and parents to increase engagement. Smartphones have been suggested as a possible approach to address the gender digital divide (Hennessey et al., 2021). Phones, along with radio and television, are used to reach geographically remote learners, displaced people, and those who have a disability or cannot attend lessons (UNESCO, 2023b).

Software

In terms of digital inequality, the main barrier to software access is funds. Whether national government agencies or individual schools are negotiating software purchases, those with less revenue will need to choose which software to prioritise. Some providers offer free resources to schools, such as Google Classroom, but this can be a trade-off between cost efficiency and data privacy. A growing initiative is Open Education Resources (OER), where textbooks, learning and teaching resources are made available without licencing restrictions for teachers to use and adapt. While this is undoubtedly a step towards reducing inequality, concerns have been raised about the quality of such resources and how to ensure it, particularly given the large volume of material available (UNESCO, 2023b). Use of educational software is also linked to factors such as teacher training – software does not

improve learning without teachers that can operate it and incorporate it effectively into their teaching. This could be one reason why software sometimes is not used: research from the United States estimated that around two-thirds of licences there were not used (UNESCO, 2023b). Questions about the link between software design and the intended user should also be a key consideration when thinking about the digital divide – whether the software is accessible for those with limited connectivity or devices with varying specifications, as well as personal factors such as disability status or additional languages.

Potential benefits of software for teaching and learning are the use of drill and practice software, software to supplement instructional time, and personalised and adaptive software (UNESCO, 2023b). However, illustrating that one approach does not fit all, GEEAP (2023) reported that in some cases, using adaptive, personalised or self-paced software could be beneficial in after-school settings, but added that this approach was viable and cost-effective only where electricity, connectivity, hardware and teacher training were already in place. Hennessy et al. (2021) suggested that limitations in research design sometimes prevented identification of successful digital learning strategies, giving the example of a longitudinal research finding that personalised learning software could be more effective over shorter periods of time compared to longer. Software is a key component of educational strategies to support learners with disabilities or additional needs and is discussed further in the section on disability.

Digital skills

To understand inequality in digital skills, there are several aspects to consider. One is how we define digital skills; another is the inequality that exists in obtaining the skills, along with inequalities in being able to use those skills to achieve objectives. Helsper (2016) outlined some of the problems with research in this area, including a reliance on people's sentiment or personal interests to explain user types and reporting outcomes through attitudinal measures rather than more tangible ones.

What are digital skills?

Six digital skills areas were identified in the section on the second level divide, which were:

Medium-related skills

- Operational (basic knowledge of how to use a device and peripherals, basic software or the internet)
- Formal (understanding of computers, networks and how they interact, e.g., menus, hyperlinks, navigation)

Content-related skills

- Information (searching, selecting and evaluating information via ICT)
- Communication (email, chat, social media, online communities)
- Content creation (writing, images, video – publishing via apps)
- Strategic (planning and using ICT to achieve goals)

(van Dijk & van Deursen, 2014)

Frameworks of digital skills and competencies have come into use, including the European Commission's digital competence frameworks DigComp (for citizens), DigCompOrg (for schools) and DigCompEdu (for educators). DigComp specifies 21 digital competences across the areas of information and data literacy, communication and collaboration, digital content creation, safety and problem solving (Vuorikari et al., 2022). Another example is the ISTE standards framework used in the United States and other countries, which also specifies digital skills and knowledge for students, educators, education leaders and coaches (International Society for Technology in Education, 2025).

A typology was devised by Gran et al. (2021) relating to people's awareness of algorithms, the way they work and the potential impact on their lives. The typology classified people into six groups: the unaware, the uncertain, the affirmative, the neutral, the sceptical and the critical. Gran et al. (2021) argued that awareness of algorithmic functions and their effects, along with being able to critically interact with them is an important skill. They found that demographic variables such as age, gender and geographic location were related to algorithm awareness, with young people, men and those living in urban areas showing higher awareness. Gruber and Hargittai (2023) found that knowledge of systems that collected personal data contributed to algorithm awareness and an understanding of the potential harms and benefits. Referring back to the digital divide, they noted that skilled users would likely access more of the benefits than less-skilled users.

The importance of digital skills for learners was emphasised in many of the sources consulted. Increasing use of digital technologies means that learners need to be "informed users" (Fraillon, 2024). This goes beyond operational ICT capabilities and focuses on the ability to evaluate and critically appraise information in the light of online misinformation and cybercrime. Artificial intelligence (AI), particularly generative AI, is a field that is rapidly developing and will have a profound impact on teaching and learning, even if we don't yet know in exactly which ways that will be. Academic study is working to keep up with the opportunities and threats of AI for education in general, and there is, as yet, little research on the impact of AI on the digital divide. The opportunities that AI presents for teachers that could reduce digital inequality include: help for teachers in developing resources and lesson plans; automating tasks such as marking and feedback; and for learners, personalised learning, language support and opportunities to develop ideas and skills such as critical thinking and collaboration (Room, 2024; Smith & Gajjar, 2024). However, there are threats related to AI that could exacerbate the digital divide, such as continued problems with access to the connectivity required to enable AI usage, bias in algorithms (Gran et al., 2021; Room, 2024) and lack of digital skills on the part of teachers and learners to successfully generate, harness or critically appraise results from AI (Gruber & Hargittai, 2023; Kim & Kwon, 2023; Smith & Gajjar, 2024).

Helsper described how the From Digital Skills to Tangible Outcomes (DiSTO) project aimed to relate digital skills to outcomes in four areas (economic, social, cultural and individual well-being), by finding out whether people had achieved and were satisfied with different outcomes. The DiSTO study was not focused on young people, but of interest was a set of measures for digital skills such as operational (e.g., downloading a file), informational (e.g., verifying online information) and social (e.g., adjusting privacy controls on social media) that could be compared with measures of inequality (van Deursen et al., 2014).

Other factors have an impact on digital skills. Bauer et al. (2020) found large variations in students' digital skills and that students who had no internet access at home had significantly lower digital skills. Furthermore, they found that the magnitude of the relationship between home internet access and digital skills was stronger than that between gender and digital skills. On a Dutch population level, Helsper (2016) noted that education level and traditional literacy were strong predictors of digital skills, along with age, gender and socio-economic status. Helsper found that young people had better technical skills but were less skilled in the area of critical information-searching than older people. Differences in levels of digital skills were attributed to family context and psychological characteristics.

Digital skills and educational outcomes

Results from the 2022 round of PISA (OECD, 2024a) showed that most students were able to find relevant information online, but that around half found it difficult to judge the quality of that information. Frequency of use of digital resources corresponded to confidence in using digital tools. Additionally, results showed that those who were able to critically evaluate online information were motivated to learn and were able to integrate new knowledge to previous learning.

Pagani et al. (2016) found that in Italy, informational digital skills had a positive effect on academic performance. Additionally, they observed that digital skills most benefitted those with lower academic performance in reading and those from households with lower socio-economic status.

Gender

Gender and access to digital technology

There remains a clear gender digital divide in terms of access to digital technology; girls and women are often on the wrong side of the divide. Globally, men are more likely than women to own a mobile phone or a smartphone (UNESCO, 2024). A higher percentage of males had access to the internet than females (ITU, 2023). In general, the poorer the country, the wider these gender gaps tended to be (ITU, 2023; UNESCO, 2024). Such differential access has impact on the accessibility of (distance) education opportunities (UNESCO, 2024).

Gender gaps in access to digital technology have also been found to interact with various other dividing factors, including socio-economic status, socio-cultural norms and geographical location (each to be discussed later). A small-scale study of students' ICT use in urban settings in India found that boys tended to have more access to computers outside of school than girls (either at home or in internet cafes). Furthermore, 86.11 per cent of the girls participating in the survey reported lack of parental support as one reason for not using the internet, while only 10.20 per cent of the boys reported so (Basavaraja & Kumar, 2017). A significant gender digital divide, especially in urban areas, was also observed during the implementation of the One Laptop Per Child policy in Ghana largely due to the sociocultural norms and practices that girls were expected to help with house chores and other responsibilities (selling at the market) (Leslie Steeves & Kwami, 2017). In Ghana, according to the authors, sociocultural norms also discouraged girls from going to internet cafes, as these cafes were considered "an unsavory environment and girls face stigma in these

spaces” (Leslie Steeves & Kwami, 2017, p. 185). Some cafes even did not allow girls to enter, so boys tended to have more opportunity to access computers and use the internet.

Gender and digital skills

The relationship between gender and digital skills appears to be more nuanced. Citing studies from the mid and late 1980’s, Ritzhaupt and Hohlfeld (2018) stated that males scored higher than females on ICT literacy and attitudes especially when self-report measures were used. A later study on the differences between actual and perceived online skills and gender conducted in a US county found that men and women’s actual online skills did not actually differ significantly, but women’s self-perceived/self-assessed skills were significantly lower than those of men, which could significantly affect types of internet use and activities (Hargittai & Shafer, 2006). Results from the 2022 round of PISA (OECD, 2024a) also found a gender gap in digital skills, with male students in general more likely to be interested in learning about digital resources and programming, and to consider digital resources useful for future jobs.

Results from the National Assessment Programme ICT Literacy assessment in Australia and the National Assessment of Educational Progress Technology and Engineering Literacy (TEL) assessment in the US consistently showed that female secondary school students scored significantly higher than male students in ICT literacy assessments (ACARA, 2018, 2023; NAEP, 2014, 2018). The 2023 ICILS results show that in Computer and Information Literacy (CIL) test, female students scored higher than male students, while in Computational Thinking (CT) test, both gender groups performed about the same overall (Fraillon, 2024). It should be noted, however, that these results, including ICILS’, are typically from high-income countries and might not be generalisable to other contexts, especially lower-income countries.

The Global Education Monitoring 2024 Gender Report on Technology in Education provides a more international picture while also acknowledging that the data on which the findings are based overrepresented upper-middle and high-income countries. The report used data from 90 countries collected from 2014 to 2021 and used two digital skills to examine gender gaps: the ability to use a basic arithmetic formula in a spreadsheet and the ability to write computer programme. In terms of the spreadsheet skills, the report concluded that countries with large gender gaps at the expense of young women (15- to 24-year olds) tended to be low-income sub-Saharan African and South Asian countries, while those with large gender gaps at the expense of young men (15- to 24-year olds) tended to Caribbean and Pacific Small Island Developing States, Arab countries and Southeast Asian countries. For instance, there were more much fewer young women than young men with spreadsheet skills in Chad, Gambia, Nepal and Pakistan. On the contrary, there were more young women than young men with such skills in Cuba, Tuvalu, Egypt, Oman, Viet Nam and Thailand. In terms of the programming skills, countries with large gender gaps at the expense of young women tended to be high-income European countries. For example, much fewer young women than young men who were able to code in Ireland, Hungary, Austria, Sweden, Germany and the UK. Conversely, more young women than young men were able to code in Thailand, Saudi Arabia, Albania, the State of Palestine and Gambia (UNESCO, 2024).

A systematic literature review on gender digital divide (Acilar & Sæbø, 2023) concluded that the main factors contributing to the gender digital divide were sociocultural, economic and

education. In developing countries, the gender digital divide in terms of access (Level 1 divide) still persists, while in developed countries, the divide relates more to the use of technology (Level 2 divide) (Acilar & Sæbø, 2023).

Age

We have briefly discussed how age relates to the digital divide in an earlier section on young people. While it is true more generally that young people may have more access to technology (e.g., the percentage of young people (aged 15-24) who used the internet was higher than the rest of the population (ITU, 2023)), their experience is far from being homogenous. Age commonly intersects with other dividing factors e.g., gender in shaping the digital divide. For example, the Multiple Indicator Cluster Surveys report showed that in terms of using a spreadsheet, women aged 20 to 24 years old were twice as likely to be able to use a basic arithmetic formula than those aged 40 to 44 years old based on a sample from 36 low- and middle-income countries (UNESCO, 2024).

The intersections of age and other dividing factors have also been discussed in the digital divide in educational context more specifically. Reynolds and Chiu (2016), for example, showed that age moderated the scores of middle and high school students in computer activities. Ritzhaupt and Hohlfeld (2018) synthesised findings from multiple studies, suggesting that the number of years of teaching experience (a proxy for age) appeared to negatively correlate with technology-related measures such as teacher computer skills, confidence and comfort in using technology and integration of technology for instructional purposes.

Race/ethnicity

Research has shown that race/ethnicity has been related to ICT access, use and skills. A national study on internet use among students in South Africa showed that White students were more likely to use the internet daily than students from other racial/ethnic groups (Oyedemi, 2015). In terms of ICT skills, the results from the last three National Assessment Programme ICT Literacy assessment cycles in Australia (2011, 2017, 2022) consistently showed that non-indigenous students scored statistically significantly higher than indigenous students (ACARA, 2018, 2023). The ICILS 2023 results for the US showed that Asian and White students and students of two or more races scored higher than the national average, while Black and Hispanic students had lower scores than the national average in both Computer and Information Literacy (CIL) and Computational Thinking (CT) (National Center for Education Statistics, 2025).

Cultural/language background

Cultural and language background has been linked to differences in ICT access, use and literacy. Students who spoke the language of the test at home achieved statistically significantly higher scores in both Computer and Information Literacy (CIL) and Computational Thinking (CT) tests of the ICILS than those who did not across most of the participating countries (Fraillon, 2024). This finding contrasted the finding from the 2017 and 2022 cycles of the National Assessment Programme ICT Literacy assessment in Australia

which showed that Year 6 students who spoke a language other than English at home scored significantly higher than those who spoke English at home; no significant difference was found for Year 10 students (ACARA, 2018, 2023).

Another area in which language background could contribute to the digital divide is through the language use in teaching and learning tools, including open educational resources (OER) and assistive technologies. OER and assistive technologies have been regarded as equalising resources to those marginalised (members of the) communities, i.e., the economically disadvantaged and people with disabilities. However, as almost all open educational resources are in English, people who are not proficient in English have reduced access to open educational resources. In Australia, assistive technologies are available for English speakers but not in Aboriginal languages (Hersh & Mouroutsou, 2019), thereby making people with disabilities whose dominant language is Aboriginal languages unable to make the most of assistive technologies.

Disability status

People with disabilities are generally disproportionately excluded and marginalised in multiple ways. They are more likely to be from lower socio-economic backgrounds, racial/ethnic minorities and older age groups (Dobransky & Hargittai, 2021; Scanlan, 2022), which often makes them unable to fully reap the benefits of digital technology (Scanlan, 2022). At the same time, ICT has been argued to have the potential to bridge disability divide, as opportunities presented by ICT and the internet (e.g., assistive and adaptive technologies such as screen reading software and magnification devices) could provide level playing fields for people with disabilities in various life domains including education, employment, civic participation, finance and disaster management (Samant Raja, 2016).

Digital disability divide

Recent research into the disability digital divide has shown some encouraging progress although the divide persists for many people with disabilities. A study comparing digital skills of people with disabilities and those without, using data collected in 2009 and 2020 in the US, found improvements over this time period (Dobransky & Hargittai, 2021). Digital skills in this study were measured through self-report questionnaires where respondents were asked to rate their level of understanding of six Internet-related terms (i.e., internet browser cookie, spyware and malware, operating system, refresh or reload, widget and JPEG file in the 2009 questionnaire; advanced search, pdf, spyware, wiki, cache and phishing in the 2020 questionnaire). Analysis of the 2009 data showed that people with disabilities reported significantly lower online/web-use skills than people without disabilities, after controlling for socio-demographics, but analysis of the 2020 data showed that those differences were no longer significant (Dobransky & Hargittai, 2021).

There have been calls to disaggregate categories of disabilities when studying the digital disability divide (e.g., Dobransky & Hargittai, 2006) to acknowledge the heterogeneity within the group of people with disabilities and therefore the heterogeneity of their experiences. It should also be noted that considerable proportions of people with disabilities reported having more than one diagnosis/impairment (e.g., 44% in Dobransky and

Hargittai (2006) and 68% in Johansson et al. (2021)). The following two studies disaggregated categories of disabilities.

Scanlan (2022), in his study analysing a dataset from the Computer and Internet Use Supplement survey of the 2017 Current Population Survey in the US, divided people with disabilities into five disability categories: deaf/hard of hearing, blind/visually impaired, physical disability, physical-mental-emotional (PME) disability and multiple disabilities. He concluded that while some progress had been made, people with disabilities continued to experience digital divides. In terms of access, people with hearing and visual impairments specifically were equally likely as people without disabilities to own a computer and use the internet, but people with physical and PME disabilities were less likely to own a computer than those without disabilities. People with PME and multiple disabilities were also less likely to have access to the internet at home. In terms of online activities, people with disabilities generally engaged in similar activities to those without disabilities, but they took part in fewer activities related to online communication and finances. They were, however, more likely than people without disabilities to use the internet to engage in online health-related activities (e.g., contacting health professional online). Scanlan (2022) speculated that privacy or safety concerns experienced by people with disabilities when engaging in online activities (e.g., identity theft, tracking by websites, online harassment, cyberbullying) might contribute to the persisting digital disability divide.

Researching digital inclusion for people with disabilities in Sweden, one of the most digitised countries in the world, Johansson et al. (2021) collected data from people with disabilities with 35 different diagnoses/impairments in 2017. It was found that overall people with disabilities reported having less access to devices, used the internet for paying bills and online shopping less and felt less included in the digital society than the general Swedish population. However, there were variations within disability groups and across gender categories. For example, among the ADD, ADHD, autism and bipolar groups, large proportions reported having access to devices and facing the least difficulties in using the internet. In terms of gender, women with disabilities reported using the internet more and for more complex tasks than men with disabilities. One important finding reported in the study is that people with disabilities used digital technology, particularly social media engagement. It should be noted that all these studies were conducted using data from high-income countries and therefore the findings may not directly be generalisable to low- and middle-income countries. People with disabilities in low- and middle-income countries, for example, still face challenges in accessing assistive devices due to cost and availability (Samant Raja, 2016), so access barriers to using ICT are likely to remain high for these people.

Disability digital divide in education

In educational settings more specifically, ICT has the potential to bridge the disability divide by lowering the barriers for students with disabilities in accessing (quality) education through the use of inclusive/assistive technologies and the implementation of the Universal Design for Learning principles (UNESCO, 2023b). Numerous studies have shown the extent to which assistive technologies have been used by learners with disabilities and how these technologies have helped learners with disabilities in their education. Among secondary school students with disabilities in the US, deaf-blind students and students with visual impairments were the two groups who reported using assistive technologies the most, while students with speech and language impairments, learning difficulties and

emotional/behavioural disorders reported using such technologies the least (Bouck & Long, 2020). A study of students with visual impairments in Delhi has shown that assistive technologies helped them improve their academic performance and learning capacity (Senjam et al., 2020). A systematic review of technology-enhanced support for children with Down syndrome concluded that assistive technologies were beneficial for the development of numeracy, speech, language, memory and social skills for children with Down syndrome (Shahid et al., 2022). A World Bank report (Samant Raja, 2016) summarised three ways in which ICT can overcome barriers to participation in education for people with disabilities: a) accessing and understanding content, b) content creation and classroom participation and c) organisation and memory.

Technology also supports learning continuity in the face of emergencies (UNESCO, 2023b), such as during the COVID-19 pandemic where learning was moved online in many parts of the world. The abrupt transition to remote learning during such emergencies, however, presented immense interruptions to students with disabilities due to the challenges and lack of appropriate resources for translating their supports to online learning environment (Golden et al., 2023).

Learners with disabilities and their digital skills

Despite all this progress, the divide remains. Wu et al. (2014) compared the ICT access and competencies of elementary school students with and without learning disabilities in Taiwan. A self-report questionnaire was used in the study, whereby ICT access was operationalised as access to computer class at school, computer access at home, internet access at home, frequency of using computer at home and frequency of internet browsing at home, while ICT competencies comprised basic computer operation skills, word processing, spreadsheet usage, presentation usage, graphic software usage and internet usage. Wu et al. (2014) found that while there was no significant difference in terms of access to a computer and the internet at home and school between students with and without learning disabilities, a significant difference was found in terms of ICT competencies, whereby students with learning disabilities scored lower than their peers. In a later study, Wu et al. (2018) also found that learning disability had a direct negative effect on ICT competency for students in elementary and junior high school. Students with learning disabilities reported lower ICT competency than their peers without learning disabilities, even though they took ICT courses together.

Attitude/motivation

Van Dijk (2005) placed motivational access as the first barrier to digital equality in his framework to understand the digital divide. His argument was that people must possess a desire to interact with technology before they can gain other forms of access (and move through the subsequent levels of the conceptual framework discussed earlier). Examples of the reasons given by people for not buying or engaging with technology included a lack of need, interest, time, money and skills. Other reasons for rejection of technology can be based on social, moral, and safety concerns (van Dijk, 2005).

The areas discussed here can be viewed as a cascade of factors relating to the digital divide. The attitude of school leaders towards technology use in education affects how

teachers are able to use technology for learning. For instance, financial decisions in a school can be affected by senior management's beliefs about the use of technology and consequently may affect whether a teacher receives appropriate training to successfully integrate technology into teaching. A teacher with negative beliefs about the value of technology in teaching is unlikely to incorporate it effectively into their lessons. Students experience the outcomes of these accumulated beliefs and will have their own attitudes shaped by that experience of technology in learning. A poorer quality learning experience with technology is likely to lead to less positive student attitudes.

School and teacher attitudes

Those involved in education management sometimes lack the confidence to integrate technology and may have attitudes and beliefs about technology that prevent adoption (UNESCO, 2023b). These could relate to any of the reasons outlined by van Dijk (2005) such as lack of school funds or safety objections. Equally, there is a danger that the possibilities offered by technology can be overstated or misunderstood (Blackwell et al., 2014).

Teachers, regardless of their personal attitudes, operate under school and regional policies implemented by people with attitudes to technology that may be at variance with those of teachers. UNESCO (2023b) noted that teacher confidence relating to ICT use was sometimes lacking. Additionally, teachers with "high digital self-efficacy" were unevenly distributed in schools and less likely to teach in disadvantaged schools (OECD, 2022).

It can be useful to think about the different kinds of ICT used by teachers to support learning, such as digital tools (hardware, software), digital learning materials and digital content (websites, social media) (Gleisner Villasmil, 2024). Teachers can be critical of any or all of these kinds of ICT and teachers' attitudes determine whether and how such technology is used to support learning (Blackwell et al., 2014; Gottschalk & Weise, 2023). Examples of teacher beliefs includes doubts about whether ICT improves performance, whether it could hinder communication and concern that ICT could be a distraction from learning. Other reported fears included whether ICT in learning is appropriate for certain age groups, and safety risks, such as data security (UNESCO, 2023b, p. 168).

It is unclear whether teacher age affects attitudes towards education technology. OECD (2019) found that in relation to technology, older teachers were less skilled and had lower self-efficacy while novice teachers were slightly more confident in supporting student learning using digital technology. Differences here could be related to how nations structure their CPD for teachers, where teachers who have completed teacher training more recently have experienced programmes which specifically address ICT integration. However, other research suggested that resistance from teachers to using technology was not related to age, but to preparation. In contrast, older teachers had the content and pedagogical skills required to maximise the opportunities afforded by technology (Burns, 2023).

Student attitudes

For learners, van Dijk's barriers to access may not function in quite the same way as the general population. To give an example, as ICT-related learning is a compulsory subject in some jurisdictions, motivation is *not necessarily* a requirement for students to interact with

technology in school and they may develop ICT skills without possessing a strong desire to do so. However, compulsory study could further entrench negative attitudes towards ICT. Results from the 2023 International Computer and Information Literacy Study (ICILS) (Fraillon, 2024) discussed emotional engagement of students and particularly focused on self-efficacy as shaping emotions and attitudes towards ICT.

Chuang et al. (2009) found that among Taiwanese students from low socio-economic status backgrounds, school-related internet use and computer and internet resources outside the home were significant predictors of perceived motivation to use technology to learn English. They also found that the length of time spent online each week had a negative relationship with motivation, which the authors hypothesised could be a negative effect of computer game use. Other research has found that students with home internet access had higher technology self-efficacy, attitudes towards technology and developmental outcomes (Lei & Zhou, 2012). In addition, home internet access and parental support were positively associated with technology self-efficacy, interest in technology, perceived importance of the internet and perceived impact of the internet on learning. UNESCO (2023b) reported that student engagement with learning can be improved by affordances of technology such as digital games, interactive whiteboards, simulations and collaboration tools.

Parental attitudes

Parental attitudes affect whether access to technology is available to learners at home and, as with teachers, may relate to beliefs about the benefits or risks of such technology. This strongly interacts with other factors, such as socio-economic status, where the cost of providing technology competes with other household expenses, although physical provision of devices and internet connectivity is not the only aspect of this category. During the COVID-19 pandemic, when the majority of students were attending remote lessons, issues of parental engagement and support with education technology had an impact on outcomes for learners. Parental attitudes to technology can vary by socio-economic status and education level, with students from disadvantaged households experiencing less parental support (Muñoz-Najar et al., 2021). The engagement and support that parents are able to offer can be affected by their own digital skills, their available time, and the age of the student (e.g., younger children may need more parental supervision, while older children may have more complex technology support needs) (Muñoz-Najar et al., 2021). This again brings in the concept of self-efficacy, where parents who have confidence in their digital skills are likely to have a positive attitude towards the usefulness of education technology and engage more with their children's learning, leading to positive outcomes (Gruchel et al., 2022).

Digital technology can also play a role in shaping parental attitudes through increasing parental engagement with their child's learning, through actions such as parent-teacher communication and feedback, homework setting, language support, reminders, etc. In many cases parental engagement took the form of text messages, which led to improvements in learning outcomes and school attendance (UNESCO, 2023b).

Emotional and social intelligence

Many definitions of emotional intelligence exist. In general, it refers to skills and attitudes relating to understanding and managing one's own emotions and understanding and responding to others' emotions. Emotional responses to learning impact wellbeing as well as academic achievement, mainly through learner engagement and motivation. Research has shown that trait (self-reported) emotional intelligence can predict educational attainment (Vidal Rodeiro et al., 2012). Consequently, emotional intelligence factors and student wellbeing are recognised as core elements of education and are often addressed in personal and social education programmes. In addition, new terms have emerged relating to emotional intelligence in the digital sphere, such as digital empathy (Elrayah & Alshiha, 2024).

Dolev et al. (2022) reported that emotions have positive and negative effects on learning and can relate to achievements, cognitive challenges, academic topics and social interactions with teachers and peers. Despite the difficulties of observing emotions experienced during online learning, studies suggested that learners felt similar emotions whether learning online or face-to-face (Dolev et al., 2022). Negative emotions can affect learning through reducing the cognitive resources available for learning due to the increased cognitive load of negative emotions. Studies undertaken during the COVID-19 pandemic showed that a shift to increased online interaction had differing effects on emotional intelligence, both negative (e.g., decreased understanding through the lack of non-verbal cues when interacting online) and positive (e.g., seeking out ways to bond through shared experiences) (Imjai et al., 2024). Students with fewer digital skills are likely to feel more anxious about using technology and the increased cognitive load of digital inequality (e.g., worries about keeping up with digitally advantaged peers) may result in reduced cognitive resources for learning (Dolev et al., 2022). There are benefits of social support in terms of material benefit (access to devices or connectivity), companionship and emotional support, for protecting against the damaging effects of negative emotions and/or digital inequality (Dolev et al., 2022).

Imjai et al. (2024) cited a study which showed higher emotional intelligence resulted in better online communication skills. The interaction between emotional intelligence and digital skills is bidirectional: emotional intelligence can influence digital skills through increasing confidence in technological learning, and digital skills and tools can help to develop emotional intelligence (Papoutsis et al., 2022). However, there is the potential for negative associations, as pointed out by Imjai et al. (2024): social skills could be diminished by online activities.

Socio-economic status

Socio-economic status might be the most researched dividing factor in the digital divide literature. Socio-economic status is commonly measured through income level, which can refer to the income levels of the student, teacher, parents, school and community (Ritzhaupt & Hohlfeld, 2018). Other proxies of student socio-economic status may include the number of books at home one has (e.g., Fraillon, 2024) and parental education (e.g., Fraillon, 2024; Hargittai & Walejko, 2008). The percentage of students on free or reduced-price school meals is a common measure of the socio-economic levels of a school (e.g., Ritzhaupt & Hohlfeld, 2018). Socio-economic status is very much related to Bourdieu's concept of

capital, discussed earlier in the report. Students from higher socio-economic backgrounds tend to have more resources (or capital) in the forms of tech savvy parents, access to ICT devices and software and time to experiment with the devices and software that can facilitate the development of capital-enhancing digital skills (Tichavakunda & Tierney, 2018). Therefore, it is not unexpected that socio-economic status, at the level of both student or household and school, has been found to be a strong dividing factor contributing to the digital divide.

Students' SES

Students from higher income backgrounds showed higher levels of ICT literacy and more positive attitudes towards ICT than their peers from lower income backgrounds (Ritzhaupt et al., 2013). ICILS results from 2013, 2018 and 2023 have shown that achievement in the Computer and Information Literacy (CIL) and Computational Thinking (CT) tests was consistently higher for students from higher socio-economic backgrounds (Fraillon, 2024). Higher levels of parental education are also associated with higher levels of internet uses and skills (Hargittai, 2010). Digital content creation and sharing are also not randomly distributed among youth population; rather it is influenced by their socio-economic backgrounds (measured by parental education) (Hargittai & Walejko, 2008).

Students from different socio-economic backgrounds have also been found to use the internet differently. Zhang (2015), for example, examined young people's interest in and usage of two highly popular websites KhanAcademy.org and CartoonNetwork.com in the US. The former website was chosen to represent a capital-enhancing use of the Internet (in Bourdieu's sense), while the latter represents a non-capital enhancing Internet use. Zhang (2015) found that interest in KhanAcademy.org was positively correlated with high sociodemographic status and high academic performance, while interest in CartoonNetwork.com was positively correlated with low sociodemographic status and low academic performance.

The above studies, however, were mainly conducted in high-income countries. A study of high school students' internet access and use in Ecuador (Tirado-Morueta et al., 2017) found that SES had an influence on physical access and operational abilities of students but little to no influence on their abilities/knowledge (including academic achievement) and more complex internet practices (e.g., expressive use).

School SES

Research has found that school SES contributes to the differential access and use of ICT by students in schools. For example, using seven-year longitudinal data between 2008 and 2015 of elementary, middle and high schools in Florida, Hohlfeld et al. (2017) found that at Level 1, access to modern computers had improved throughout those years; students in high-SES and low-SES elementary, middle and high schools appeared to have equitable access to computers (i.e., desktops and laptops). Differential access to software programmes, however, had persisted especially in elementary schools; students from high-SES elementary schools had access to more software programmes than those from low-SES schools. At Level 2, although students were using ICT in schools at about the same levels, the type of activity they engaged in differed between low- and high-SES schools, especially in elementary schools. Students in low-SES schools tended to use more

computer-directed software (e.g., drill and practice software, integrated learning systems with assessment software), while those from high-SES schools tended to use more student-directed software (e.g., research tools, word processors, graphic organisers, simulations). Such differences were not statistically significant in middle and high schools (Hohlfeld et al., 2017).

School SES was also found to relate to students' ICT skills. The ICILS 2023 results for the US, for example, showed that the average Computer and Information Literacy (CIL) and Computational Thinking (CT) scores were higher for students in public (state) schools with less than 25 per cent of students eligible for free or reduced-price lunch than the national average scores (National Center for Education Statistics, 2025).

Research has also shown that school SES relates to teachers' physical access to and use of ICT. Teachers from high-SES schools appeared to have significantly more access to ICT and used ICT more frequently, for instructional purposes, communication with students and professional development activities (Valadez & Duran, 2007). Additionally, there also appeared to be a relationship between school SES and the distribution of teachers with certain characteristics of ICT skills. Citing results from TALIS (the Teaching and Learning International Survey) 2018, OECD (2022) stated that teachers with high digital self-efficacy tended to work in private schools or in high-SES schools. Unsurprisingly, these private and high-SES schools also tend to be more equipped with ICT access (Level 1) than low-SES schools. Teachers' digital self-efficacy is an important factor, as it is associated with use of ICT in the classroom; teachers with higher digital self-efficacy tended to use ICT in the classroom more. There also appeared to be a pattern in some TALIS participating jurisdictions that teachers with pre-service ICT training tended to work in low-SES schools, while those with in-service ICT training tended to work in private or high-SES schools (OECD, 2022).

Immigration status

Immigration status, as a dividing factor, has not been widely researched. Results from the 2017 National Assessment Programme ICT Literacy assessment in Australia showed that while there was no significant difference in the achievement between Year 6 students born in Australia and overseas, Australian-born Year 10 students achieved higher scores on average than their overseas-born peers (ACARA, 2018). The ICILS results from 2013, 2018 and 2023 have consistently shown that Computer and Information Literacy (CIL) and Computational Thinking (CT) achievements were consistently higher for students who were not from an immigrant background (Fraillon, 2024).

Educational level

Educational level and internet access were often found to correlate. Martin (2022), researching the use of mobile phones for learning in a rural East African context, found that individuals with higher levels of education tended to have more access to the internet; only around 6 per cent of the respondents without formal education compared with nearly 87 per cent of those with a university degree used the internet. As pointed out by Ritzhaupt and Hohlfeld (2018), parents' educational attainment is also often used to examine differences in

education outcomes. Parental education level interacts with other factors, such as socio-economic status and geography. Lower levels of parental education can affect the educational outcomes of their children, reduce the likelihood of a household having internet access (Ritzhaupt & Hohlfeld, 2018) and reduces the probability of the parents having digital skills (UNESCO, 2023b).

Scheerder et al. (2019) compared highly educated and less-educated Dutch households in their use of the internet at home. They found that the highly educated group made considered decisions and adopting a “studious leisure” attitude towards internet use, while the less-educated group were more likely to feel obliged to use the internet through social pressure and were more likely to rely on younger family members for technical support. This also links to the usage gap discussed earlier, where those households using digital media for information, education and work purposes build technological capital and potentially improve life chances.

Geography

Schools, teachers, students and households can be disadvantaged by geographical location in terms of ICT access, use and literacy (Ritzhaupt and Hohlfeld, 2018). As discussed in the section on connectivity, there is a range of levels of infrastructure between and within countries to support internet access, with urban areas likely to be prioritised over rural areas for faster and more reliable internet connection. Some populations, such as displaced or nomadic people, are particularly likely to rely on mobile phone coverage, the cost and quality of which can also vary depending on geographic location. Low-income countries have the most acute difficulties in this area, but high-income countries are also affected (UNESCO, 2023b).

There was a large gap between the numbers of internet users in rural and urban areas globally and this gap was wider in some regions, such as Africa (UNESCO, 2023b). Socio-economic status can interact with geographical area to exacerbate or make it difficult to determine the sources of digital inequality, e.g., rural internet access can be expensive due to the high costs of installation, compounded by rural populations in general having less wealth to afford internet access. Even if connectivity issues and socio-economic status are not a significant barrier, other aspects relating to geography can influence learning, such as the location of teachers. For example, some areas of England were found to have shortages of computer science teachers (Common & Pledger, 2023).

When it comes to ICT skills development, a geographic divide emerges partly because digital skills are needed for the kinds of jobs that are more common in high-income, urbanised countries. Employment in low-income, rural areas is less likely to require ICT skills. Furthermore, other aspects of the digital divide compound this, e.g., in low-income countries, women in rural areas were much less likely to develop certain digital skills than those in urban areas (UNESCO, 2023b). Even if schools, teachers and curricula emphasise ICT skills, there may be a perception in some geographic areas that they are unnecessary or even undesirable. Chitanana (2019) described how some rural Zimbabweans would not be interested in using ICT, which as we have seen is a barrier to digital skills and technological capital development. There are indications that younger people are more likely to want to

use ICT, but as discussed earlier, it should not be assumed that young people are a homogenous group with exactly the same wishes when it comes to digital skills.

Policy

This positional category is affected by the digital divide and can itself be a source of digital inequality. In terms of the global economy and unequal distribution of wealth, some countries may not have the resources to effectively address digital education policy questions. Inadequate policies may then fail to address or exacerbate digital inequality, in isolation or through combination with any of the categories we have identified. This section discusses international, national and school level policies relating to the digital divide and the effect on groups and individuals.

Gottschalk and Weise (2023) investigated international and regional policy frameworks that influence the governance adopted by nations. International bodies such as the United Nations are likely to drive action on the way in which countries develop their policies in education and technology, particularly in the light of commitments such as Sustainable Development Goal 4 (Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all). As one example, the UN Transforming Education Summit saw a call to action to establish national strategies and budgets to address digital learning in the areas of content, capacity and connectivity (United Nations, 2022). UNESCO (UNESCO, 2023a) stressed that the starting point for technology in education should be the problems that need to be addressed and whether and how technology can address them. They noted two advantages technology can bring in addressing inequality in education:

1. Technology can help to reach groups of disadvantaged learners (e.g., physically remote groups, groups with fewer time resources, those learning in emergency situations, those with disabilities and additional needs).
2. Content can be distributed cheaply, in a variety of formats that can be adapted for their context (UNESCO, 2023a).

The authors of the GEM report, however, noted that evidence-based decision making was lacking, and poorly directed interventions could have negative impacts:

Resources spent on technology, rather than on classrooms, teachers and textbooks for all children in low- and lower-middle-income countries lacking access to these resources are likely to lead to the world being further away from achieving the global education goal, SDG4.

(UNESCO, 2023b, p. 2).

Who sets policies?

Sources suggested that government decision-making on digital education policy faced problems related to governmental structure. The Profiles Enhancing Education Reviews (PEER) report (UNESCO, 2023c) noted that “[...] in 82% of countries a government department or agency is in charge of ICT or education technology. Yet, in only 58% of those countries, the education ministry takes the lead alone; in 36%, the education ministry and

another ministry share the responsibility, and in 6%, another ministry is the sole leader.” In addition, UNESCO described how education ministries “need to collaborate with economic development, infrastructure, energy and telecommunications departments in the governance of education technology use” (2023b, p. 146). Gottschalk and Weise (2023) noted the potential problems caused by these scenarios, stating that “[a] lack of coordination can cause both unnecessary overlap and gaps in other areas, leading to inappropriate or missing measures”.

What do policies address?

Globally, the picture is mixed in terms of policy focus. The problem of basic access is still an issue for many regions, and consequently 85 per cent of countries have legislation or policies for improving access and connectivity (UNESCO, 2023c). These include a variety of policies to support the use of education technology, such as improving access to electricity in schools and subsidies for students/families to buy devices. Some countries have moved forward enough with access to turn their attention to policies for digital competencies of students or teachers, although there is a continued gap here: only 54 per cent of countries have identified or defined digital skills for learners in a framework, policy, plan, or strategy, while 88 per cent aim to do so (UNESCO, 2023b, p. 130). OECD (2023) found that most of the countries they surveyed had a published digital education strategy. Some had broader education policies which emphasised digitisation in education. They acknowledged that some countries opted to devolve decision-making in this area to sub-levels of government or regional government. Other countries make do without policies or any plans to produce them. Additionally, most of the countries surveyed by the OECD had specific plans to develop online education platforms and digital learning and teaching resources. Improvements to data management systems also featured, such as student information, admissions, and exam administration. More recently, some countries were starting to create policies related to AI in learning (OECD, 2023).

Evaluation

With policy implementation, there is a corresponding need for countries to evaluate the effectiveness of their policies, which can be difficult to achieve for several reasons. Outcomes related to policy typically take years to work through systems, and particularly in the case of digital technology, advances occur so rapidly that decisions must be made before sufficient information is known. To determine the effect of policy on digital inequality, governments must decide on the indicators of digital inequality, they must be able to measure them and be able to establish how government policy has affected them, as well as link those findings to outcomes such as educational achievement. Gottschalk and Weise (2023) pointed out that these difficulties can lead to a reliance on easily quantifiable measures, such as how many children have a device rather than whether use of the device has improved education outcomes, a finding echoed by UNESCO:

[C]ountries often appear to pay little attention to whether their investment has been relevant and had an impact on learning, whether it has been equitable and inclusive, whether it is economically efficient, and whether it has longer-term negative effects on human rights and well-being.

(2023b, p. 14)

Curriculum

OECD reported that various nations were moving towards digital curricula which included integrating digitalisation and content related to ICT. This included adding new subjects to national curricula such as computer science and programming or new content, cross-curricular themes or competencies (OECD, 2020). Responses to the 2023 ICILS survey showed that reduction of the digital divide between groups of students was explicitly stated in plans and policies in national curricula for 68% of schools and implicitly stated in 26% (Fraillon, 2024). Some countries include digital literacy in national curricula. The 2023 ICILS survey found that most countries surveyed explicitly included in their national curriculum a range of learning content related to CIL and CT, such as “responsible and respectful publication of information” and “writing code, programs, or macros” (Fraillon, 2024). There is an underlying question however, about the source of such content, when over half of countries have digital skills standards “but often these have been defined by non-state, mostly commercial, actors” (UNESCO, 2023b).

At the same time as promoting digital skills, digital curricula are also a potential source of inequality and risk further entrenching it. The importance of curriculum design that caters for diverse users was highlighted by Gottschalk and Weise (2023), who cautioned that groups of users such as those with special educational needs could find digital curricula inaccessible. There are possible biases inherent in curriculum design, which can further marginalise disadvantaged groups, Indigenous or minority people and cultures.

Edtech industry

Rapid change in the area of digital education tools means that governments often depend on private businesses to develop and provide a range of solutions such as hardware, software, platforms, etc. However, concerns have been raised about such public-private partnerships:

Governments’ goals for education equity, inclusion, quality and efficiency are not necessarily aligned with those of the education technology industry
(UNESCO, 2023b, p. 146)

A number of potential conflicts have been raised, such as industry pressure to bring products to market resulting in less consideration of accessibility and schools becoming reliant on products and tied into costly services (Gottschalk & Weise, 2023). West (2023) discussed how technology providers have targeted schools through offering schemes such as free, web-based learning platforms and affordable devices such as Chromebooks. The benefits for technology providers include financial gain from user data and advertising, along with “habituating” learners to gain from them long term allegiance to their products and services or tying users into their systems (Veale, 2022; West, 2023). Further concerns with the edtech industry relate to the practice of private companies commissioning research which supports their own commercial interests. UNESCO (2023b) described this kind of activity being undertaken by technology companies in order to counter independent research that showed products were not beneficial and could potentially be harmful to teaching and learning.

Safety/privacy

Any use of the internet comes with risks such as theft of personal information, scams, cyberbullying or misinformation. Providers of digital education tools collect information about users and has led to some being banned for not complying with data protection (UNESCO, 2023b). However, data protection laws do not always recognise the special characteristics of young people and do not specifically address education contexts: “Just 16% of countries enforce data privacy in education through laws, and 29% through policies. Only 16% have laws addressing cyberbullying in education, while approximately 40% have policies or strategies in place” (UNESCO, 2023c). Young people may not yet have the digital skills required to recognise and protect themselves against the risks. They do not necessarily get a choice in how their information is used (e.g., if their school requires that work is completed using a particular platform) (UNESCO, 2023b).

Devices and internet connectivity can also represent a physical or wellbeing risk to learners. The urgency of the move to remote learning caused by the COVID-19 pandemic meant that policy in this area was not ready for such a widescale shift. Research has found that the move to remote learning resulted in some detrimental effects on young people such as weight gain, body dysmorphia and social isolation. Negative effects were explained by West (2023) as being related to a number of aspects, such as advertising hosted on some of the platforms being used to deliver learning and internet algorithms designed to keep users consuming content. The use of video for lessons led some young people to develop a negative self-image. West also reported that young people were using unfamiliar online technology, without guidance, leaving them vulnerable to overtly dangerous content. Some, however, have discussed the issues with characterising young people as either a homogenous group of innocent and vulnerable ICT users or as ‘digital natives’, neither of which recognise the variation in young people’s ICT use and experience (Barbovski & Marinescu, 2013). Excessive internet use has also been flagged as a concern which must be considered if young people are in possession of internet-enabled devices. Helsper and Smahel (2020) conveyed the complexity of excessive internet use, given that this is characterised as negative, while the often high levels of digital literacy of excessive users are viewed positively.

Policy relating to devices

As discussed in the section on connectivity, hardware and software, some countries have policies relating to devices with the aim of providing a device for each learner, although the evidence is unclear for the benefits of such policies. PISA results from 2022 showed that devices distracted 30 per cent of students from maths lessons. There appeared to be a clear relationship between the type of device use and achievement. More time per day spent online for learning was associated with higher PISA maths scores, while students spending more time online for leisure achieved lower maths scores (OECD, 2024b). Distraction due to devices was also mentioned by UNESCO as having a negative effect on learning and academic achievement, and as a concern for teachers (2023b). According to the PEER report (2023c), a quarter of countries have brought in bans on smartphones in schools, due to concerns about data privacy, safety or wellbeing. There is some evidence to show that mobile phone bans could help improve academic performance (UNESCO, 2023b).

Despite the evidence for issues relating to devices, there are regions where mobile technology represents a pathway to engagement to disadvantaged or geographically isolated groups.

Policy relating to schools

Some jurisdictions tightly control school policy in this area, while others allow schools more autonomy on interpreting guidelines and shaping their digital strategy (OECD, 2023 p.191). Either way, a number of factors are likely to shape the practice. Socio-economic status of the school is likely to affect the hardware and software it can afford to provide. Schools in disadvantaged areas are likely to struggle to recruit skilled teachers.

Blackwell et al. (2014) found that perceived support of the school and specific technology policy was likely to result in increased use of various technologies in the classroom and to slightly increase teacher confidence. Similarly, Gleisner Villasmil (2024) found that the school environment (i.e., sufficient access to technology and associated professional development) along with support, were influencing factors on teachers' use of digital learning resources.

Policy relating to teachers

As investment is made in digital education tools, teachers are essential intermediaries between the tools and the learners (OECD, 2015). As such, teachers need appropriate digital competence themselves to produce the best outcomes for learners, a fact that seems to be overlooked in some cases, as "schools often purchase expensive software licences but do not invest in teacher training programmes" (UNESCO, 2023b). Hennessey et al. (2021) stressed the importance of parallel teacher development when programmes aim to increase device access. This was made obvious during the Covid-19 pandemic, when a general lack of digital skills on the part of teachers to use technology for remote teaching affected learning (West, 2023). Zinger et al. (2019) argued that this involves two aspects: supporting teachers to develop the skills needed to use digital tools and helping them to use such tools effectively in teaching. According to UNESCO, around half of countries had ICT standards for teachers, although wealthier regions were more likely to have them (2023b, p. 169). Most countries surveyed by OECD had guidelines on developing teacher digital competencies, such as teacher professional standards and competence frameworks (OECD, 2023). They did note some differences, with countries tending to focus more on such competencies for pre-service teachers and less so for in-service teachers, although data from UNESCO showed a mixed picture on the amount of formal training and professional development activities teachers received (UNESCO, 2023b, p. 173). Sometimes digital competencies were integrated across the whole teacher training, while some created separate frameworks. Gottschalk and Weise (2023) pointed out that this could lead to digital competencies being isolated in certain subject areas and being developed by specialist teachers only. Another approach to teacher digital competencies is to introduce expectations for student digital competencies and outcomes, with the assumption that teachers need a certain level of competence themselves to be able to get students to meet expectations.

Different frameworks have been developed to define and track teacher digital competencies, some by countries, some by organisations (e.g., European Commission) and some by non-governmental organisations or researchers (UNESCO, 2023b). UNESCO produced its own

framework designed to support policy development, the ICT Competency Framework for Teachers (2018), which sets out areas in which teachers should move from basic knowledge and understanding to knowledge creation and innovation, those areas being understanding ICT in education, curriculum and assessment, pedagogy, application of digital skills, organization and administration and teachers' professional learning. This represents a fairly complex set of skills for teachers to master, with the expectation that the better skilled the teacher, the better the outcomes for learners.

Some programmes have been designed to help teachers foster inclusivity in their practice through their own professional development and the use of digital tools in teaching to support disadvantaged groups (Gottschalk & Weise, 2023). Teachers themselves may have digital inequalities to overcome, including their own personal categories (e.g., gender, ethnicity) as well as positional (socio-economic status, geographic location). Their own development may be enhanced or hindered by digital technology, which could give them an insight into the student experience of inequality with learning technologies. There is a danger that teachers could perpetuate the digital inequalities they experienced in their own teaching. Hennessy et al. (2022) systematically reviewed the literature on technology use in teacher professional development in low- and middle-income countries. Their analysis showed that technology could help address inequalities such as teachers in remote or rural areas and could allow marginalised voices to be heard. They did, however, raise the possibility that technology could worsen existing inequalities. Policy in this area should consider the barriers teachers themselves face trying to build their own technological capital.

Having summarised the key contributors to the digital divide in this section, the natural next step is to ask what can be done to address these drivers of inequality, particularly in the education and learning context. The following section describes some of the solutions suggested by the literature.

Research question 3: How can the digital divide be addressed to make education more equitable?

Suggestions for bridging the digital divide

The manifestation of digital inequality differs widely across regions and incorporates multiple factors, as we have discussed. Governments and other policy makers will have achieved varying levels of progress in different areas. Therefore, reported here is a general overview of the kinds of actions that commentators consider to be necessary to tackle digital inequality. Some of the actions have been discussed in earlier sections and some certainly merit critical evaluation (e.g., involvement of edtech companies; policies relating to devices). Appraisal of supporting evidence for the efficacy of these measures would be necessary before implementing any of them.

Room (2024) called on those responsible for education policy development to take the following actions:

- Understand that digital poverty presents different challenges in different countries and tailor solutions accordingly.

- Use their expertise and influence to promote inclusiveness through endorsement of policies and organisations, knowledge-sharing and practical support.

A number of high-level recommendations regarding technology in education were made by UNESCO (2023b). Highlighted here are those most relevant to the digital divide issues we have discussed:

- Make sure digital technology supports those most marginalised.
- Ensure resources and devices comply with accessibility standards.
- Invest to ensure teachers and learners have safe, quality online experiences in line with the right to free education.
- Support adoption of OER, platforms, etc.
- Create and/or use digital competencies frameworks.
- Evaluate the quality and impact of programmes, resources, etc.

Ritzhaupt and Hohlfeld (2018) proposed solutions at three levels, which although focused on the system in the United States provided some generalisable points:

Mega level solutions: International and national leadership role

- Create and adopt standards and frameworks such as the International Society for Technology Education (ISTE) technology standards (aligned with UNESCO's SDGs) and ISTE essential conditions.
- National initiatives to expand electricity and internet access, teacher training, etc.
- Support large-scale work by national and international non-profit organisations and bodies (e.g., OECD, NAEP in the US) to research and evaluate the issues (e.g., PISA).
- Partner with the private sector, e.g., edtech companies.

Macro level solutions: Leadership at the state and district level

- Education policy should address curriculum and teacher preparedness.
- Teacher professional development to equip teachers with motivation and skills for ICT integration into lessons.
- Implement policies such as Bring Your Own Device and 1:1 devices.

Micro level solutions: Leadership and implementation at the school level

- School ICT planning should involve all stakeholders including local community and business leaders.
- School leadership affects schools' and teachers' ability to bridge the digital divide by implementing policy, maintaining ICT infrastructure and allocating resources.
- Teachers take responsibility for ensuring equitable use of ICT.
- Students should be encouraged to be active learners and use ICT responsibly and creatively.

Van Dijk (2020a) proposed a series of policy instruments to bridge the digital divide, some of which specifically mentioned education-related approaches:

- Better design of applications and contents for educational software.
- Adapt curricula for both medium- and content-related skills.
- Improve teacher skills.

He also included others that could be relevant to the education and learning context:

- Special hard- and software designs for particular groups such as the elderly, children, etc.
- Create special content relevant for cultural minorities and socially deprived groups.
- Increase usability and user-friendliness of ICTs.

The essential conditions referred to by ITSE are the pre-requisites considered to be essential for implementing their technology standards framework. The seven elements are:

- Shared vision
- Implementation planning
- Equitable Access (to devices, connectivity, teachers and platforms for all students)
- Prepared Educators
- Skilled and Sufficient Technical Support
- High-Quality Learning Activities and Content
- Ongoing Evaluation

(International Society for Technology Education, 2025)

These suggested actions all relate to the factors discussed in this report and range from the abstract to more practical measures.

Reflection

This literature review has demonstrated the complexity of the circumstances commonly referred to as the digital divide. Digital inequality is not confined to issues of access to technology, but encompasses resources, digital skills and usage, all of which contribute to outcomes for individuals. Multiple factors relating to the personal and positional characteristics of people affect the technological capital that they are able to build through ICT access and use. Importantly, while messages about the equalising potential of ICT abound, the digital divide also has the potential to exacerbate existing inequalities and create new ones.

In education and learning contexts, learners, teachers, parents and schools are all affected by digital inequalities. Teachers have a vital role to play in that for effective teaching and learning to take place, they require sufficient personal ICT skills as well as the ability to successfully harness ICT tools to support learning. Government and departmental policies have a profound effect on ICT provision in schools and on whether support for teachers and ICT-related training for new teachers or CPD is available. The use of technology in classrooms should be appropriate and purposeful – supporting learning objectives rather than driving them, integrating pedagogy and designed with diverse users and contexts in mind, including those experiencing digital inequality. Support may need to be put in place to assist teachers in adapting their pedagogy to incorporate innovative approaches to learning.

Many of the areas we have discussed could merit full literature reviews of their own (e.g. the gender digital divide): a huge amount of academic research is focused on digital inequality. One of the areas which has yet to be fully investigated is that of AI and its impact on the digital divide. In the education context it's possible to view AI as another ICT tool impacted

by digital inequality: issues are likely to centre on learners and teachers getting access to AI, as well as developing the digital literacy skills to use it effectively and critically evaluate the results. However, given that we know the digital divide can exacerbate inequalities, it's important to understand the ways in which a new and powerful tool like AI can contribute to inequality in teaching and learning, particularly the risk from factors like algorithmic bias.

For education and learning organisations, this literature review has highlighted two points. A deep understanding of the digital divide factors at play and recognition of how these affect learners, teachers and collaborators at individual and regional levels can help to provide more equitable products and services. This can be achieved through promoting awareness of the personal and positional factors that can contribute to digital inequality and understanding of their impact on school leaders, teachers and learners. As part of their provision to teachers and learners, organisations can support teachers to develop their own digital literacy as well as helping them with the skills needed to use ICT tools effectively for teaching and learning.

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