

Chapter 2. Children and digital technologies: Trends and outcomes

Digital technologies are ubiquitous in the 21st century. Children are avid Internet users, and make use of a range of information and communication technologies. Across OECD countries, children spend more time online than ever before and at younger ages, despite the persistence of various digital inequalities. With this expansion of Internet use, children are exposed to different online risks, but can also make use of the vast array of online opportunities. However, parents, teachers and policy makers struggle to balance the potential opportunities with the fear of risks. This chapter serves as an overview of the various trends, patterns and outcomes of children's digital technology use, and highlights some policy challenges faced by countries.

Introduction

Across most OECD countries, digital technologies are a staple in everyday life. There has been a shift in the ways people work, learn and communicate, as new technologies have infiltrated and transformed life in the 21st century. On average, OECD countries are close to meeting the Sustainable Development Goal targets of ensuring schools have access to the Internet for pedagogical purposes, and in mobile network coverage (OECD, 2019^[1]). By the end of 2017, there were more broadband subscriptions than people in OECD countries (OECD, 2019^[2]).

These shifts mean that children in this era have been exposed to digital technologies for their entire lives and are the most frequent users of emerging online and digital services (OECD, 2016^[3]). They are “connected” in different contexts, not just in the home environment as children also use mobile technologies “on the go” and at school.

Spending time online is associated with both potential risks and rewards. Children are afforded opportunities for self-expression, learning and consolidating friendships (see Chapter 5) on the one hand, while being online also exposes children to risks such as harmful content and cyberbullying on the other (see Chapter 10) (Livingstone et al., 2011^[4]).

However, all the various risks and opportunities of digital technologies are not evident, and are not the same for all children. Indeed, children do not benefit equally from the Internet and digital technologies and in general, children who are vulnerable offline tend to be more vulnerable in online spaces as well. Large gaps persist in digital access, skills and use, which can affect both online and offline outcomes for children (Helsper, Van Deursen and Eynon, 2015^[5]). Despite these risks, the rights children have to play and to information are recognised internationally through the United Nations *Convention on the Rights of the Child* (United Nations Assembly, 1989^[6]). Policies and practice aimed at protection, inclusion and fostering digital skills and resilience are therefore essential, and more desirable in realising these rights and opportunities than taking a limitation-focused approach to children’s use of digital technologies that can hinder children’s digital engagement.

This chapter will explore some of the trends in children’s use of digital technologies in the 21st century and some of the associated challenges, risks and opportunities.

Children and digital technologies: Trends, patterns and outcomes

Children are more connected than ever

The number of children with access to the Internet at home and to a range of digital devices has been steadily increasing in OECD countries. From 2006 to 2015, the proportion of 15-year-olds in OECD countries with access to Internet at home increased from 75-95% (OECD, 2017^[7]). Similar results were seen in European Union (EU)-28 households, with a rise in Internet access from 55% in 2007 to 87% in 2017 (Eurostat, 2018^[8]). This ranged from 98% of households with Internet access in the Netherlands to 67% in Bulgaria, the EU Member State with the lowest rate of Internet access. Households with dependent children were more likely to have Internet access than those that did not (96% versus 82%) (Eurostat, 2017^[9]).

Other remarkable increases in access to technologies are evident. Computers used to be the device of choice for young people to access the Internet. However, over time, popularity of

devices such as tablets and smartphones to go online has exceeded that of computers. For example, according to PISA 2015, 91% of 15-year-olds reported that they had access to a smartphone, 74% had access to a portable laptop, 60% had access to a desktop computer and 53% had access to a tablet with Internet connection (OECD, 2017^[7]). In a sample of pre-schoolers in the United Kingdom, parents reported that their children had access to an array of technological devices. 50% of the sample had access to between 4 and 10 devices, 32% had access to 11-20 devices while 9% reported access to over 20 devices (Marsh et al., 2015^[10]). Devices ranged from smartphones to tablets to televisions, and children were most likely to have access to an iPad. Despite the advances in many OECD countries, it is important to note that in many countries outside of the OECD, Internet use is less universal (OECD, 2019^[11]).

i-kids: The rise of digital technology use in younger children

Across OECD countries, 18% of students in 2015 accessed the Internet for the first time before the age of six, an increase of three percentage points since 2012 (OECD, 2017^[7]). Some research suggests pre-schoolers become familiar with digital devices before they are exposed to books (Hopkins, Brookes and Green, 2013^[12]), and international trends suggest younger children are increasingly using digital technologies and the age of first use is dropping (Hooft Graafland, 2018^[13]). In the United Kingdom, recent results show that 52% of 3-4 year-olds and 82% of 5-7 year-olds are online (Ofcom, 2019^[14]). Children generally have their first experience with digital technologies before the age of two (Chaudron, Di Gioia and Gemo, 2018^[15]). Often, research on digital technologies focuses on older children or adolescents, so there is a gap in the research on children aged 0-8. However, in recent years, this gap is starting to garner attention and different groups and researchers are addressing it.

For a time, the literature termed children “digital natives”, suggesting that since children grew up surrounded by devices and gadgets they would know how to use them. This definition, however, is critiqued (Helsper and Eynon, 2010^[16]; Selwyn, 2009^[17]; OECD, 2012^[18]); just being online, or having access to online tools, does not mean children have the skills or knowledge to be safe and effective Internet users, or to exploit the benefits of being online. Education systems are recognising the need for information and communications technology (ICT) skills to be introduced and instilled in younger children, which can be seen by a sharp increase in ICT integration into pre-primary curricular frameworks in a number of jurisdictions in recent years (OECD, 2017^[19]).

Young children go online using various devices and for various reasons. For example, the Parenting for a Digital Future survey surveyed 2 000 parents in the United Kingdom, finding that the majority (73%) of parents of 0-4-year-olds said their child had gone online using a tablet within the past month. Meanwhile, 41% of respondents said their child had used a mobile or smartphone, and 24% had used either a laptop or desktop computer (Livingstone et al., 2018^[20]). In a sample of Estonian parents with children aged 0-3, children used communication apps such as FaceTime and Skype to keep in touch with family members, and they also spent time looking at photographs. In addition, 25% of the children used smartphones and tablets daily to watch television, videos and cartoons on YouTube (Nevski and Siibak, 2016^[21]). Young children tend to prefer touchscreen devices; tablets are popular in this group due to their portability, size of the screen and ease of use of the interactive screen (Chaudron, Di Gioia and Gemo, 2018^[15]).

A specific risk for young children is that they use apps which are not aimed at their age range (Marsh et al., 2018^[22]); thus, parents and caretakers should monitor children’s digital

activities to ensure age-appropriateness of materials. Furthermore, instilling digital skills at a young age is important so children can use devices effectively and safely. Basic digital skills are evident even in samples of young children. For example, in a sample of children aged 0-5 in the United Kingdom, 65% of those surveyed were able to swipe the screen unassisted, and 60% were able to trace shapes with their fingers and drag items across the screen. Luckily for parents, only 14% were able to purchase new apps in an app-store/marketplace unassisted, with 61% being unable or unaware of how to do so (Marsh et al., 2015^[10]).

Spending time online

The increase in access to digital technologies and the Internet has been accompanied by a rise in the amount of time that children spend online. On a typical weekday, 15-year-olds in OECD countries spend almost two and a half hours online outside of school. This rises to more than three hours on a typical weekend day. The daily amount of time spent online rose from 2012 to 2015 by 40 minutes both on weekdays and weekends (OECD, 2017^[7]).

Access to mobile versus fixed technologies has also expanded where and when children access the Internet. “Ubiquitous internetting” suggests that people can choose to be online permanently, assuming they have the right hardware, irrespective of time or place (Peter and Valkenburg, 2006^[23]); children no longer need to be seated in front of a computer to have Internet access. Despite the potential for ubiquitous internetting, children tend to report that they most often use the Internet at home, more so than when they are “on the move” or at school (Mascheroni and Ólafsson, 2014^[24]; OECD, 2015^[25]).

With increases in Internet availability and use, there are some children who go online for many hours during the day. PISA defines “extreme Internet users” as those who spend more than 6 hours online per day outside of school. In 2015, 26% of respondents were considered extreme Internet users on weekends, versus 16% during the week (OECD, 2017^[7]). According to a report from the United States, American teenagers spend on average about six and a half hours with screen media, while children aged 8-12 spend about four and a half hours daily (Rideout, 2015^[26]).

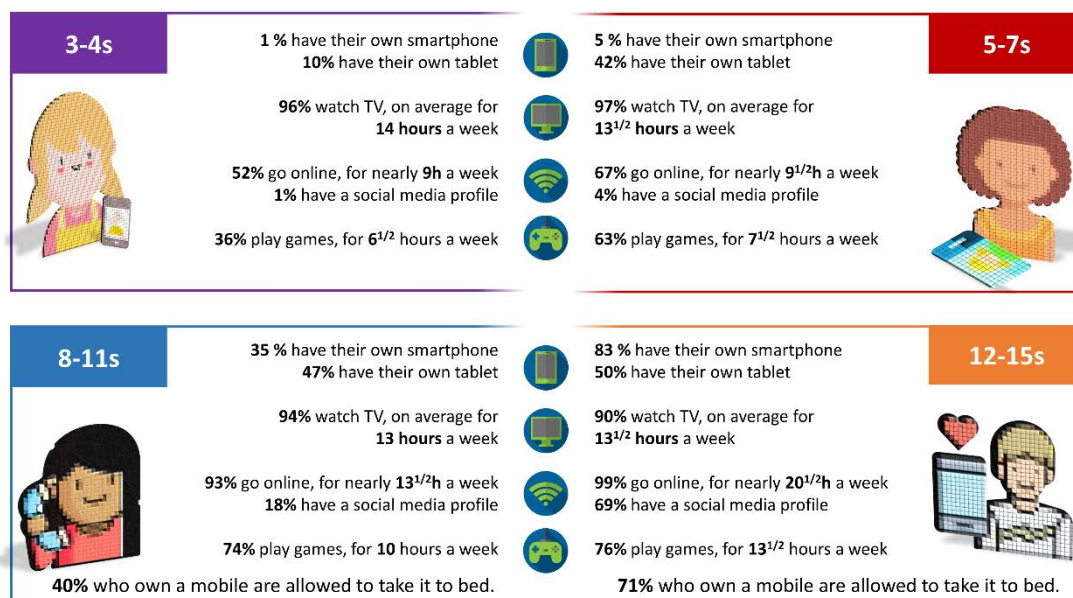
The evolution of children’s online activities

Children are using digital technologies for a multitude of activities both in and out of school. Young people engage with digital devices for many purposes, from watching television to gaming to chatting to doing research for school projects. Television sets and tablets are used by a majority of children, according to data from the United Kingdom. Streaming services such as Netflix and Amazon Prime are quickly gaining popularity as the time spent in front of traditional television sets is decreasing, with YouTube becoming the viewing platform of choice especially for children aged 8-11 (Ofcom, 2019^[14]). YouTube is also a popular platform in samples of young children; the app has proven more popular with pre-schoolers than popular gaming apps such as Angry Birds and Temple Run (Marsh et al., 2015^[10]).

PISA also investigated online leisure activities of 15-year-olds across OECD countries and found that between 2012 and 2015, the share of students engaging daily in online activities increased by four percentage points on average. Overall, 73% of students reported participating in social networks daily, 61% reported chatting online every day and 34% reported playing online games every day or almost every day (OECD, 2017^[7]). Furthermore, across OECD countries, 88% of students reported that the Internet was a great

resource to obtain information and 49% of students agreed that they used the Internet to exchange solutions to problems with others (OECD, 2017^[7]).

Figure 2.1. Snapshot of children’s media use (United Kingdom)



Source: Adapted from Ofcom (2019^[14])

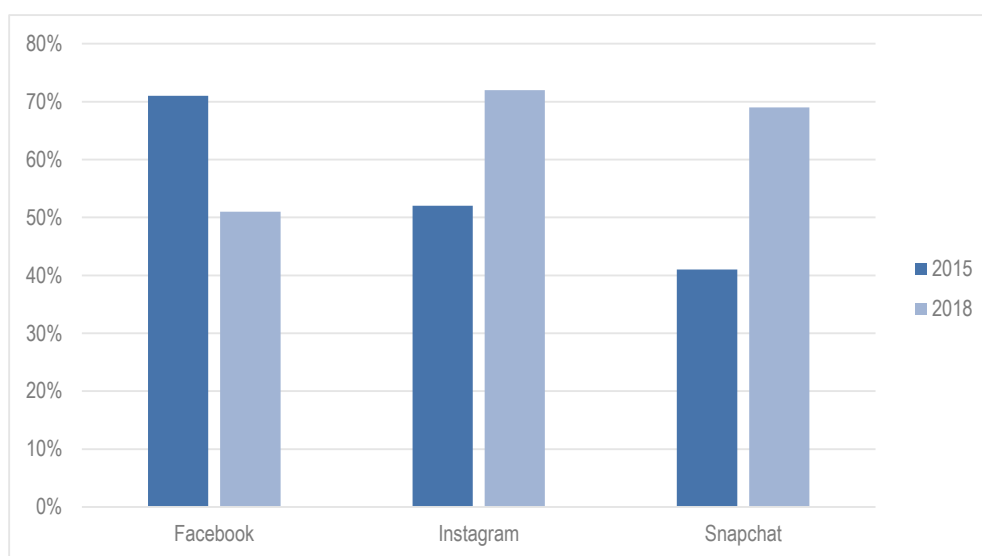
Social media use in children is prevalent, especially among teens. For example, in the United States about 97% of teens aged 13-17 are active on at least one social media platform (Pew Research Center, 2018^[27]). Data suggest that in the United Kingdom, 69% of children aged 12-15 (Ofcom, 2019^[14]), as depicted in Figure 2.1, had a social media profile. A small proportion of young children also have social media profiles, which violates many platforms’ age policies (e.g. Facebook, Instagram, Snapchat, Tumblr and Twitter all have a 13+ age policy).

With the rise and fall in popularity of different social media platforms, and the development and disappearance of apps happening almost daily, children’s platforms of choice can change rapidly. For example, as seen in Figure 2.2, over the course of three years the popularity of different platforms changed quite significantly in teens from the United States. In the United Kingdom, Facebook remains the most popular social media site for 12-15 year-olds, although the popularity of Instagram and messaging app WhatsApp increased between 2017 and 2018 (Ofcom, 2019^[14]).

In addition to these overall averages, different groups of children, such as boys and girls, use the Internet in different ways. Boys of all ages are more likely to use desktops and gaming consoles while teenage girls are more likely to use smartphones, laptops and tablets to go online (Mascheroni and Ólafsson, 2014^[24]). This is the case across OECD countries, where 75% of 15-year-old boys reported playing one-player games regularly, with more than 13% playing every day. A slightly lower proportion played multiplayer or collaborative online games regularly (70%) with 20% doing so every day. In comparison, the majority of girls reported never or hardly ever playing one-player games, with an even larger proportion not engaging in collaborative online games either (OECD, 2017^[7]). In the United States, girls were more likely than boys to use the multimedia messaging app

Snapchat; on the other hand, boys rated YouTube as their preferred online platform (Pew Research Center, 2018^[27]). Internet habits can also differ among children from different socio-economic or cultural backgrounds, which can in some instances compound and deepen digital inequalities.

Figure 2.2. Change in popular social media platform use in U.S. teens from 2015-2018



Source: Lenhart (2015^[28]) and Pew Research Center (2018^[27])

Diversification of digital technologies: Beyond the screen

Digital technologies are moving beyond the screen, which affords different opportunities for children. Developments such as artificial intelligence, machine learning, the Internet of Things (IoT) and autonomous technologies are emerging rapidly. The IoT refers to objects that, when tagged, can communicate with other tagged objects (Pascual-Espada et al., 2011^[29]), and is becoming more prevalent in children's lives (Hooft Graafland, 2018^[13]). Wearable fitness trackers, devices that keep parents alert of their children's location, and 21st century baby monitors that provide feedback about child sleeping patterns and other physiological functions pose certain problems (see Chapter 6). These include the influence that these devices have on the behaviour of children and issues around data security and privacy (Manches et al., 2015^[30]).

Among the growing world of the IoT is the Internet of Toys, in which toys are wirelessly connected to other toys or databases. The prevalence of Internet-connected toys is projected to increase in the coming years (Mascheroni and Holloway, 2017^[31]), and with this come various data security and safety risks (Holloway and Green, 2016^[32]). The potential benefits for children include enjoyment, educational benefits and the accessibility of functions such as programming and 3-Dimensional design (Holloway and Green, 2016^[32]). Autonomous technologies (technologies with the ability to function without being told what to do) are also becoming more common. These enable children to interact with artificial 'peers' who appear to have feelings, narrowing the gap between machines and living things (Druga et al., 2017^[33]).

Box 2.1. Artificial intelligence

With new developments and diversification of digital technologies, there has been a boom in the development of artificial intelligence, which is part of daily life in many countries. Artificial intelligence is the “ability of machines and systems to acquire and apply knowledge, including performing a broad variety of cognitive tasks” (OECD, 2019, p. 20^[34]). These tasks can include pattern recognition, decision making and processing language. For example, learning algorithms can detect online behavioural patterns, and then use these patterns to influence things like search results and advertising.

Other ways in which artificial intelligence is prominent in the daily lives of children and adults is through virtual assistants, such as Siri (Apple) and Alexa (Amazon). Voice recognition allows children to relay various commands to these tools, and the anthropomorphic framing (i.e. giving a name and a human voice to both Siri and Alexa) can help stimulate empathy for them (Hooft Graafland, 2018^[13]). There are opportunities for artificial intelligence to help education systems around the world as well. For example, the use of artificial intelligence can help promote personalised learning through taking over routine tasks thereby freeing up teachers’ time to work with their students directly (Pedro et al., 2019^[35]).

Despite these huge opportunities, issues such as ethics, fairness, transparency, safety, accountability and privacy feature heavily in policy agendas focused on artificial intelligence (OECD, 2019^[34]). For example, safety concerns over driverless vehicles and biases in machine learning pertaining to race, gender and stereotypes can be harmful (OECD, 2019^[34]).

The diversification of technologies, including mobile and fixed devices, enable children to engage different behaviours. For example, the notion of “screen-stacking,” also referred to as media multitasking (i.e. using more than one technological device at the same time), is a relatively understudied phenomenon. It is thus unclear what potential outcomes this can contribute to (Uncapher et al., 2017^[36]).

The changing nature of online inequalities

Digital inequalities are intersectional; factors such as socio-economic background and gender affect digital inequalities (Robinson et al., 2015^[37]). Inequalities in digital domains have the potential to both reinforce and exacerbate existing social inequalities (DiMaggio and Garip, 2012^[38]), which make them important elements for policy makers to address. The literature points to three main categories of “digital divides” or levels of digital inequality, the first, second and third level divides, which will be subsequently outlined. The term divide is used here, as this is what is commonly used and understood in policy circles. However, there is some scholarly debate on this use of terminology that suggests a split between “haves” and “have-nots”, rather than portraying a spectrum of access and skills (see Chapter 9).

With the expansion of broadband uptake and accessibility of ICTs, the “first-level digital divide” – the gap between those who have Internet access and those who do not – is shrinking. By now, most adolescents across OECD countries have physical access to the Internet and to digital devices (OECD, 2017^[7]). While this divide is diminishing, there remain important barriers to access for children across OECD countries such as differences

in material access (Gonzales, 2016^[39]) (i.e. access to hardware, software and peripheral devices like printers and hard drives).

Divides also persist between children from different socio-economic backgrounds, and in rural versus urban settings. Lower uptake in rural areas is explained by factors including lack of broadband penetration into these areas, higher prices in harder to serve areas and issues of quality such as speed and reliability. Broadband speed is not consistent within or between countries, often due to geographical limitations and difficulties servicing remote or rural communities. However, a number of OECD countries have set ambitious targets to bring higher-speed coverage (at least 100Mbps) to the majority of their populations (OECD, 2019^[11]). Ensuring adequate broadband speed and quality is essential for children to participate in online spaces and harness the full benefits of the Internet.

As more people are gaining access, “second-level digital divides” – inequalities in skills and usage patterns (Hargittai, 2002^[40]) – are becoming increasingly important. According to the Survey of Adult Skills, 56% of the adult population have no ICT skills or have adequate skills to fulfil only basic technology-related tasks; although young people are more ICT proficient than older people (OECD, 2016^[41]). However many children also lack digital skills, highlighting the need for expanding opportunities to develop digital literacy (UNICEF, 2017^[42]). Not only are there gaps in children’s digital abilities, they also use technologies in different ways. For example, PISA results suggest that advantaged students were more likely to read the news and use the Internet to obtain practical information than their disadvantaged peers, who were more likely to spend their online time playing games or chatting (OECD, 2016^[43]). It is clear that simple access to digital technologies does not ensure equality of opportunities (Livingstone and Helsper, 2007^[44]); children need adequate skills and motivations in order to make full use of the opportunities available online, and in order to protect themselves from risk and build resilience.

In countries with near-universal Internet access, a “third-level digital divide”, referring to inequalities in offline outcomes (e.g. material or social benefits/outcomes), has become more noticeable. This divide suggests that equal access, skills and use of digital technologies may not afford equal offline outcomes (Hooft Graafland, 2018^[13]). The Internet may thereby be magnifying existing offline inequalities.

Where there are opportunities there are risks, and vice versa

As children go online more often and more frequently, their exposure to online risks and opportunities increases. Staksrud and colleagues (2009^[45]) classify online opportunities and risks in three categories: content, contact and conduct, as outlined in Table 2.1. These risks and opportunities evolve with developments in technology and different patterns of engagement (for more, see Chapter 10).

It is important to note that children who are vulnerable offline are also more likely to be vulnerable online (Livingstone and Bulger, 2014^[48]) and are more likely to report harm resulting from online risks (UNICEF, 2017^[42]; Kardefelt-Winther, 2017^[49]). Factors that make children more vulnerable to online risks include personality factors (such as low self-esteem, psychological difficulties and sensation-seeking), social factors (such as lack of parental support, peer norms) and digital factors (such as specific online practices, online sites and skills) (OECD, 2018^[46]). Furthermore, children online tend to be more vulnerable than adults in terms of succumbing to clever marketing and advertising, and are not as good at distinguishing commercial from non-commercial content (OECD, 2014^[47]). While children may think critically about the websites they visit, they tend to be less likely to understand search engine advertising (Ofcom, 2019^[14]).

Table 2.1. An overview of online risks and opportunities

Type of risk	The child is the:	Opportunities	Risks
Content	Recipient	<ul style="list-style-type: none"> receiving advice on personal or health issues seeking out educational resources and information. 	<ul style="list-style-type: none"> advertising and spam commercial advertising masquerading as news, or embedded marketing receiving content that is pornographic, violent, racist, hateful or generally harmful.
Contact	Participant	<ul style="list-style-type: none"> contacting others who share similar interests sharing experiences or ideas with others creating or participating in joint online activities. 	<ul style="list-style-type: none"> being bullied, harassed or stalked meeting strangers and being groomed or succumbing to online fraud tracking or harvesting of personal information (online privacy); personal data misuse.
Conduct	Actor	<ul style="list-style-type: none"> civic engagement self-initiated or collaborative learning generating content and expressing identities/ideas. 	<ul style="list-style-type: none"> engaging in illegal activity such as downloading or hacking bullying or harassing others creating or uploading harmful material (i.e. pornography) providing harmful advice (i.e. pertaining to suicide, eating disorders).

Source: Adapted from Staksrud et al. (2009^[45]), OECD (2018^[46]) and OECD (2014^[47])

It is thus important that policies and practices target disadvantaged or vulnerable groups in terms of online protection, and fostering digital literacy and resilience. Children tend to be more aware of the risks associated with using digital technologies if schools integrate programmes aimed at developing digital literacy and technologies in the curriculum (Chaudron, Di Gioia and Gemo, 2018^[15]). Young people should also be prepared to handle and understand various advertisements that are present in their lives.

Box 2.2 Facing risks to build resilience

Risks tend to feature more heavily in popular media than do opportunities. An analysis of media coverage of children and the Internet showed that 64% of coverage was on risks versus 18% on opportunities, with the most widely covered risks being pornography and cyberbullying (Livingstone et al., 2011^[50]). This kind of attention can put children's online time in a negative shadow, overstate the potential for harm, and can overlook potential benefits, opportunities and the capacity of children to build resilience.

Children need to explore and encounter different online risks in order to develop digital skills and resilience. In a psychological sense, resilience refers to the interplay of different factors (i.e. social, relationship and dispositional) that help promote positive adjustment when facing adversity. In other words, despite facing risky situations or having negative experiences, some individuals end up having relatively good outcomes (Rutter, 2007^[51]). Digital resilience thus refers to children having the ability to adjust positively when facing online adversity. Therefore, children need to be exposed to risk in order to build digital resilience (UNICEF, 2017^[42]; Livingstone et al., 2011^[50]).

Families can play an important role in mediating children's experiences online. Enabling and restrictive mediation are two broad strategies; parents who are more digitally skilled are more likely to adopt an enabling approach providing their children with more

opportunities as well as risks, whereas lower skilled parents are likely to adopt a restrictive approach thereby limiting opportunities and risks (Livingstone et al., 2017^[52]). Enabling mediating seems to be a more effective and suitable approach, allowing children to embrace technologies and benefit from digital tools (Middaugh, Clark and Ballard, 2017^[53]). This highlights the need for digital lifelong learning approaches in OECD countries to ensure that parents are up to speed with knowledge and skills to effectively use digital tools, as well as guide and moderate their children’s online activities.

Schools have a role to play as well. Effective ways for schools to promote resilience can include training teachers in digital risks and implications, fostering a zero-tolerance approach to behaviours such as cyberbullying, and through incorporating ethics and e-safety learning opportunities in the curriculum (OECD, 2018^[46]).

What about well-being?

The proliferation of digital technologies has been accompanied by increasing worry about children’s well-being. Fears that smartphones are ruining a generation and that children are depressed because of technology are rampant in the media, and even in some research circles. Although the impact digital technologies have on children is not so clear, this moral panic is probably unwarranted as the literature tends to be inconclusive, and there is evidence of some beneficial effects of digital technology use. For example, they can use it to unwind, to find sources of moral and social support in times of need and to maintain social relationships, which are all beneficial for emotional health. Furthermore, the notion that using digital technologies “displaces” other more beneficial activities is controversial and critiqued (Kardefelt-Winther, 2017^[49]; Gottschalk, 2019^[54]).

According to PISA, “Extreme Internet users” reported less life satisfaction and were more likely to be bullied at school (OECD, 2017^[7]). Extreme Internet users were also more likely to report feeling lonely at school than “high Internet users” (i.e. between 2-6 hours per day), “moderate Internet users” (i.e. between 1-2 hours per day) and “low Internet users (i.e. under 1 hour per day) (OECD, 2017^[7]). Respondents also tended to report “feeling bad” when not connected, although this varies by country and gender. Despite the relationship in the PISA study between various emotional well-being outcomes and time spent online, the direction of the relationship is unclear. This is to say that it is unclear whether children with lower life satisfaction or who feel lonely spend more time online, or whether the time spent online results in these outcomes (see Box 2.3).

Links to behavioural outcomes, such as delinquency, risky behaviours, sexual behaviours and substance abuse are also weak for moderate or low Internet users. Even “excessive screen use” (in excess of 6 hours per day) in some research has been suggested to be only weakly correlated with depression and delinquency (Ferguson, 2017^[56]). Some research reports a non-linear relationship between the two, suggesting there may be an “ideal” amount of screen time for children, and some is better than none or too much. This parabolic effect has been termed the “Goldilocks hypothesis” (Przybylski and Weinstein, 2017^[57]). This hypothesis has been tested also in young children aged 2-5 (Przybylski and Weinstein, 2017^[58]), and can be seen in cognitive outcomes as well. For example, PISA 2015 results suggest that in many countries high and moderate Internet users outperform both low and extreme Internet users (OECD, 2017^[7]).

There is a growing body of evidence highlighting the weak relationship between screen time and mental well-being (see Chapter 8). Findings in this field tend to be inconsistent even when re-analysing the same data set, with many conflicting results, and tend to receive

much attention even when the correlations are quite small (Orben and Przybylski, 2019^[59]; Gottschalk, 2019^[54]). When a reported effect size is small, even if it is significant in a statistical sense, it is often unclear whether this has meaningful relevance in “real life”. Despite the potential negative effects of technology on adolescent well-being, some scholars argue that the variation in well-being attributed to the use of digital technologies is too small to warrant policy change (Orben and Przybylski, 2019^[59]).

Box 2.3. Correlation versus causation in the digital technologies and well-being debate

The vast majority of research examining the effects of screen time on well-being in children is correlational. This means that researchers are generally unable to say definitively that the use of digital technologies causes the outcome they measure; rather, they can state that it is related to, or correlated with, the outcome they measure.

There is a growing body of literature linking digital technologies to various child outcomes. These results tend to rely on large-scale social data that is cross-sectional (i.e. collected at one point in time); longitudinal data, which tracks the same sample at different points in time, is hard to come by. Unfortunately, “with correlational data, it is not possible to isolate the empirical system sufficiently so that the nature of the relations among the variables can be unambiguously ascertained” (Cliff, 1983^[55]). Indeed correlational data can point towards a potential causal relationship; however, it is not possible to establish one on these points alone.

As with many areas of research, the ways in which digital technologies affect child development are difficult to test experimentally. Performing longitudinal studies can help the field advance on the causation versus correlation debate. For now, though, policy makers, parents and educators should be cautious and critically assess the correlational evidence presented to them in research and by the media. These results can be misleading and erroneously suggest causation thereby distorting opinions and recommendations about children’s digital device use.

While parents, teachers and policy makers may fear a “rewiring” of children’s brains attributed to their use of digital technology, major brain changes (and “rewiring”) resulting from screen time are fortunately unlikely (Mills, 2014^[60]). Child outcomes are determined by many different factors, such as experience, environment and genetics. Any inputs, including the use of technology, can have an impact on child development. However, the key is to maximise the potential benefits for cognition, and physical and social outcomes, while minimising risks and fostering resilience.

Developing successful policies

Generally, successful policies will focus on improvement of technological infrastructure and supporting digital skill development. Adequate infrastructure is a necessary precursor for digital skill development, and the richness of online content can also be a driver for skill development. Fostering children’s digital skills through educational policies requires a coordinated effort including providing ICT in schools, teacher training and professional development opportunities, as well as support for the integration and implementation of ICTs in the curriculum (Hooft Graafland, 2018^[13]). Furthermore, ensuring the availability of local language content can provide more online opportunities.

It is important to keep in mind that children, despite their early and frequent exposure to technology, need guidance on safe and responsible uses of technology. As mentioned previously, the idea that they are “digital natives” is contentious in research communities (see Chapter 9). It is essential therefore, that adults are adequately skilled and knowledgeable in the use of digital technologies, understanding both the risks and opportunities they afford, to be able to guide children in this realm effectively. The voices of children are also important to include in the policy debate, as this is often overlooked (Hooft Graafland, 2018^[13]). It is also essential to base policies and guidelines on robust, high quality evidence (Gottschalk, 2019^[54]).

Areas for further research

Despite the proliferation of research on this topic, there are still many unknowns when it comes to children and digital technologies. Currently, some of the issues in the research base are:

- There is a paucity of research on young children: the focus has historically been on adolescents and pre-teens, therefore filling the gap on how younger children engage with technology and how this affects different outcomes is necessary.
- There is a heavy emphasis on the negative aspects of digital technology use such as risks and maladaptive behaviours: it is critical to expand the knowledge base on the different online opportunities children can harness, both in personal and educational settings.
- There is a strong focus on certain risks while others remain relatively unstudied. For example, there is little research to date on “cyber bystanders”, or children who witness cyberbullying online, despite not being the perpetrator or victim.
- Research tends to be behind the curve: by the time certain developments are studied, they may be obsolete or overshadowed by newer developments. The ebb and flow in popularity of different platforms makes it difficult to study and understand the impacts on children, and on parents (see Chapter 6).
- Research regarding health and well-being tends to be weak: the research base often focuses on correlational results using cross-sectional study design. There is thus a need for longitudinal data, and to assess how and why children use technology (not just that they are using it, which is inevitable). Furthermore, linking effect sizes to real world outcomes is important.

High priority challenges in OECD countries and systems

The proliferation of digital technologies in the 21st century has put children’s use, learning and access to technologies high on the international policy agenda. It is undeniable that digital skills are necessary for life and effective participation in 21st century labour markets and education systems. Protecting and guiding children online, while still allowing them to be children, and learn and build resilience from making mistakes, is essential. The 21st Century Children Policy Questionnaire asked systems to identify which of the following challenges they face in their national or regional context, as well as which were most pressing in terms of policy priorities. Twenty-four countries responded to this section of the Policy Questionnaire, and Table 2.2 outlines these responses.

Table 2.2. Overview of priorities and pressing challenges in digital technologies across countries and systems

	Total Challenges	Total Most Pressing Challenges	AUS	BEL-FL	BEL-FR	CAN	CHE	CZE	DNK	ESP	FRA	GBR(SC)	GRC	IRL	JPN	KOR	LUX	LVA	MEX	NLD	NOR	PRT	RUS	SWE	TUR	USA
Digital Citizenship	22	13		•		•	•		•		•		•				•	•	•		•	•			•	•
Cyber-bullying	20	15	•		•	•			•	•	•	•	•	•		•		•		•			•			•
Excessive Use	20	2					•																		•	
Second Digital Divide	19	8			•									•			•		•		•	•			•	
IA/GD*	18	3								•			•				•									
Harmful Content	17	1					•																			
Security and Privacy	17	5		•					•		•	•									•					
Sexting	16	3																•		•		•				
Online Predators	15	1								•																
First Digital Divide	14	8	•		•	•		•				•		•					•							•
Revenge Porn	12	1																		•						

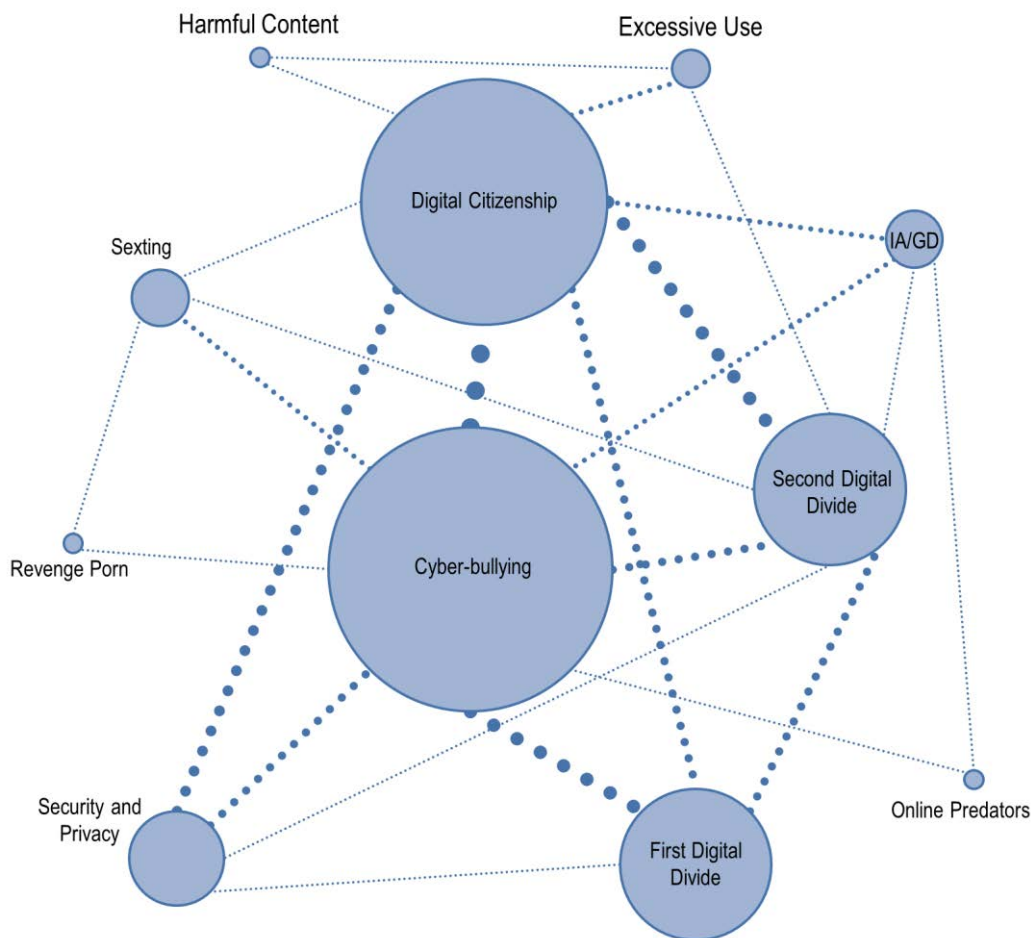
Note: 24 of 26 systems responded to this question. Number of challenges (depicted in light blue) was unlimited; most pressing (depicted with a white dot) was limited to three options.

*IA=Internet addiction, GD=Gaming disorder

Source: 21st Century Children Policy Questionnaire

Systems were generally concerned about how children conduct themselves online, with particular focus on developing digital citizenship, cyberbullying, and excessive social media and Internet use. Across countries, cyberbullying was the challenge most consistently at the forefront of the policy agenda, as reflected by the 15 systems that identified this as a “pressing challenge” in their context, highlighting the “perceived intensity” of the issue. Cyberbullying has implications not only for online outcomes, but can affect emotional well-being and academic outcomes of students. The intersectional nature of this challenge was highlighted by systems.

Figure 2.3. Links between most pressing challenges



Source: 21st Century Children Policy Questionnaire

Note: The width of the connectors reflects the number of times the respective challenges were selected together. The size of the circles reflects the number of times each challenge was selected as pressing.

In order for children to conduct themselves online, there is a need for a certain level of digital skill. However, in many OECD countries there is an increasing gap between those who are highly versus lowly skilled in terms of ICT and online skills (Hooft Graafland, 2018_[13]). This was reflected in the responses, as the second digital divide was noted as a policy issue in 19 different systems, and as a priority in 8. Conversely, the first digital divide was noted to be less of a policy concern consistently across surveyed countries.

However, countries that noted the first digital divide as a challenge were also likely to state that it is pressing, suggesting a higher level of perceived intensity of this challenge across countries. Large countries and those with large rural populations reported facing the first digital divide as a pressing policy priority. Indeed, as noted previously, large differences exist within OECD countries regarding provision and quality of broadband.

It is clear from the most pressing challenges identified that there is overlap in concern among digital skills and behaviours, especially the second digital divide, cyberbullying and digital citizenship. Countries that indicated cyberbullying as a pressing challenge were also likely to indicate digital citizenship as a pressing challenge (see Figure 2.3). Digital citizenship encompasses factors such as access and inclusion, media and information literacy, ethics, and privacy and security (Council of Europe, 2019^[61]); therefore it is understandable that countries that are also concerned with children's online behaviours and outcomes are facing developing digital citizenship as a challenge. Often, programmes targeting other behaviours online, such as cyberbullying, feature a digital citizenship component. For example, Common Sense Media in 2012 developed a media education programme for digital citizenship education, with foci on topics such as cyberbullying, copyright and privacy (Common Sense Media, 2012^[62]). Digital citizenship education can be both a preventative and a reactive measure to online behavioural issues.

In sum

Digital technologies are a reality in the lives of children in the 21st century. The ways in which children seek out information, socialise, play and learn have all been affected by the rise of new technologies. The data suggests that children are going online more often, for longer, at younger ages, with more devices and for different purposes. Despite the opportunities the Internet affords, there are accompanying risks and not all children can benefit equally from potential opportunities online.

Despite the burgeoning body of research in this field, methodological issues, quality issues and difficulty discerning what outcomes are actually caused by children's use of digital technologies remain contentious. There are a myriad of topics requiring more research to fill the knowledge gaps, and to determine how to protect children effectively from emerging risks while encouraging them to take up all available opportunities.

Policy makers are cognisant of these challenges, and many countries are facing obstacles regarding access, different online risks and developing a generation of ethical online users. Many systems implement a range of policies and programmes targeted at these challenges, which will be explored further in this volume.

References

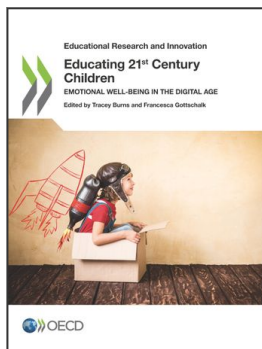
- Chaudron, S., R. Di Gioia and M. Gemo (2018), *Young Children (0-8) and Digital Technology, a Qualitative Study Across Europe*, European Union, <http://dx.doi.org/10.2760/294383>. [15]
- Cliff, N. (1983), "Some cautions concerning the application of causal modeling methods", *Multivariate Behavioral Research*, Vol. 18/1, pp. 115-126, http://dx.doi.org/10.1207/s15327906mbr1801_7. [55]
- Common Sense Media (2012), *K-12 Digital Literacy and Citizenship Curriculum: Scope and Sequency Tool*, <http://commonsensemedia.org/educators/scope-and-sequency>. [62]

- Council of Europe (2019), *Digital Citizenship Education Handbook*, Council of Europe Publishing, Strasbourg. [61]
- DiMaggio, P. and F. Garip (2012), “Network effects and social inequality”, *Annual Review of Sociology*, Vol. 38/1, pp. 93-118, <http://dx.doi.org/10.1146/annurev.soc.012809.102545>. [38]
- Druga, S. et al. (2017), ““Hey Google is it OK if I eat you?””, *Proceedings of the 2017 Conference on Interaction Design and Children - IDC '17*, <http://dx.doi.org/10.1145/3078072.3084330>. [33]
- Eurostat (2018), *Digital Economy and Society Statistics - Households and Individuals*, https://ec.europa.eu/eurostat/statistics-explained/index.php/Digital_economy_and_society_statistics_-_households_and_individuals#Internet_access. [8]
- Eurostat (2017), *Being Young in Europe Today - Digital World*, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Being_young_in_Europe_today_-_digital_world#A_digital_age_divide. [9]
- Ferguson, C. (2017), “Everything in moderation: Moderate use of screens unassociated with child behavior problems”, *Psychiatric Quarterly*, Vol. 88/4, pp. 797-805, <http://dx.doi.org/10.1007/s11126-016-9486-3>. [56]
- Gonzales, A. (2016), “The contemporary US digital divide: From initial access to technology maintenance”, *Information, Communication & Society*, Vol. 19/2, pp. 234-248, <http://dx.doi.org/10.1080/1369118X.2015.1050438>. [39]
- Gottschalk, F. (2019), “Impacts of technology use on children: Exploring literature on the brain, cognition and well-being”, *OECD Education Working Papers*, No. 195, OECD Publishing, Paris, <https://dx.doi.org/10.1787/8296464e-en>. [54]
- Hargittai, E. (2002), “Second-level digital divide: Differences in people’s online skills”, *First Monday*, Vol. 7/4, <http://dx.doi.org/10.5210/fm.v7i4.942>. [40]
- Helsper, E. and R. Eynon (2010), “Digital natives: Where is the evidence?”, *British Educational Research Journal*, Vol. 36/3, pp. 503-520, <http://dx.doi.org/10.1080/01411920902989227>. [16]
- Helsper, E., A. Van Deursen and R. Eynon (2015), *Tangible Outcomes of Internet Use: From Digital Skills to Tangible Outcomes Project Report*, <http://oii.ox.ac.uk/research/projects/?id=112>. [5]
- Holloway, D. and L. Green (2016), “The Internet of toys”, *Communication Research and Practice*, Vol. 2/4, pp. 506-519, <http://dx.doi.org/10.1080/22041451.2016.1266124>. [32]
- Hooft Graafland, J. (2018), “New technologies and 21st century children: Recent trends and outcomes”, *OECD Education Working Papers*, No. 179, OECD Publishing, Paris, <https://dx.doi.org/10.1787/e071a505-en>. [13]
- Hopkins, L., F. Brookes and J. Green (2013), “Books, bytes and brains: The implications of new knowledge for children’s early literacy learning”, *Australasian Journal of Early Childhood*, Vol. 38/1, pp. 23-28. [12]
- Kardefelt-Winther, D. (2017), “How does the time children spend using digital technology impact their mental well-being, social relationships and physical activity? An evidence-focused literature review”, *Innocenti Discussion Paper 2017-02*, UNICEF Office of Research – Innocenti, Florence, <https://unicef-irc.org/publications/pdf/Children-digital-technology-wellbeing.pdf>. [49]

- Lenhart, A. (2015), *Teens, social media & technology: Overview 2015*, Pew Research Center, [28]
<http://pewinternet.org/2015/04/09/teens-social-media-technology-2015/>.
- Livingstone, S. et al. (2018), *In the Digital Home, How Do Parents Support Their Children and Who Supports Them? Parenting for a Digital Future: Survey Report 1*, LSE, London. [20]
- Livingstone, S. and M. Bulger (2014), “A global research agenda for children’s rights in the digital age”, *Journal of Children and Media*, Vol. 8/4, pp. 317-335, [48]
<http://dx.doi.org/10.1080/17482798.2014.961496>.
- Livingstone, S. et al. (2011), *EU Kids Online: Final Report 2011*, EU Kids Online, London, [50]
<http://eprints.lse.ac.uk/id/eprint/45490>.
- Livingstone, S. et al. (2011), *Risks and Safety on the Internet: The Perspective of European Children: Full Findings and Policy Implications From the EU Kids Online Survey of 9-16 Year Olds and Their Parents in 25 Countries*, LSE: EU Kids online, <http://eprints.lse.ac.uk/33731/>. [4]
- Livingstone, S. and E. Helsper (2007), “Gradations in digital inclusion: Children, young people and the digital divide”, *New Media & Society*, Vol. 9/4, <http://dx.doi.org/10.1177/1461444807080335>. [44]
- Livingstone, S. et al. (2017), “Maximizing opportunities and minimizing risks for children online: The role of digital skills in emerging strategies of parental mediation”, *Journal of Communication*, Vol. 67/1, pp. 82-105, <http://dx.doi.org/10.1111/jcom.12277>. [52]
- Manches, A. et al. (2015), “Three questions about the Internet of things and children”, *TechTrends*, Vol. 59/1, pp. 76-83, <http://dx.doi.org/10.1007/s11528-014-0824-8>. [30]
- Marsh, J. et al. (2018), “Play and creativity in young children’s use of apps”, *British Journal of Educational Technology*, Vol. 49/5, <http://dx.doi.org/10.1111/bjet.12622>. [22]
- Marsh, J. et al. (2015), *Exploring Play and Creativity in Pre-schoolers’ Use of Apps: Final Project Report*, www.techandplay.org. [10]
- Mascheroni, G. and D. Holloway (2017), *The Internet of Toys: A Report on Media and Social Discourses Around Young Children and IoT*, DigiLitEY, <https://publicatt.unicatt.it/handle/10807/103759#.XOVrr8gzZpg>. [31]
- Mascheroni, G. and K. Ólafsson (2014), *Net Children Go Mobile: Risks and Opportunities*, Educatt, Milano, <http://netchildrengomobile.eu>. [24]
- Middaugh, E., L. Clark and P. Ballard (2017), “Digital media, participatory politics, and positive youth development”, *Pediatrics*, Vol. 140/Suppl 2, pp. S127-S131, <http://dx.doi.org/10.1542/peds.2016-1758Q>. [53]
- Mills, K. (2014), “Effects of Internet use on the adolescent brain: Despite popular claims, experimental evidence remains scarce”, *Trends in Cognitive Sciences*, Vol. 18/8, pp. 385-387, <http://dx.doi.org/10.1016/J.TICS.2014.04.011>. [60]
- Nevski, E. and A. Siibak (2016), “The role of parents and parental mediation on 0–3-year olds’ digital play with smart devices: Estonian parents’ attitudes and practices”, *Early Years*, Vol. 36/3, pp. 227-241, <http://dx.doi.org/10.1080/09575146.2016.1161601>. [21]
- OECD (2019), *Going Digital: Shaping Policies, Improving Lives*, OECD Publishing, Paris, <https://dx.doi.org/10.1787/9789264312012-en>. [34]

- OECD (2019), *Measuring Distance to the SDG Targets 2019: An Assessment of Where OECD Countries Stand*, OECD Publishing, Paris, <https://dx.doi.org/10.1787/a8caf3fa-en>. [1]
- OECD (2019), *Measuring the Digital Transformation: A Roadmap for the Future*, OECD Publishing, Paris, <https://dx.doi.org/10.1787/9789264311992-en>. [11]
- OECD (2019), *Trends Shaping Education 2019*, OECD Publishing, Paris, https://dx.doi.org/10.1787/trends_edu-2019-en. [2]
- OECD (2018), “A brave new world: Technology and education”, *Trends Shaping Education Spotlights*, No. 15, OECD Publishing, Paris, <https://dx.doi.org/10.1787/9b181d3c-en>. [46]
- OECD (2017), *PISA 2015 Results (Volume III): Students’ Well-being*, PISA, OECD Publishing, Paris, <https://dx.doi.org/10.1787/9789264273856-en>. [7]
- OECD (2017), *Starting Strong V: Transitions from Early Childhood Education and Care to Primary Education*, Starting Strong, OECD Publishing, Paris, <https://dx.doi.org/10.1787/9789264276253-en>. [19]
- OECD (2016), *PISA 2015 Results (Volume II): Policies and Practices for Successful Schools*, PISA, OECD Publishing, Paris, <https://dx.doi.org/10.1787/9789264267510-en>. [43]
- OECD (2016), *Policy Brief on the Future of Work: Skills for a Digital World*, <http://oecd.org/els/emp/Skills-for-a-Digital-World.pdf>. [41]
- OECD (2016), *Trends Shaping Education 2016*, OECD Publishing, Paris, https://dx.doi.org/10.1787/trends_edu-2016-en. [3]
- OECD (2015), *Students, Computers and Learning: Making the Connection*, PISA, OECD Publishing, Paris, <https://dx.doi.org/10.1787/9789264239555-en>. [25]
- OECD (2014), “Infinite connections: Education and new technologies”, *Trends Shaping Education Spotlights*, No. 5, OECD Publishing, Paris, <https://dx.doi.org/10.1787/79ac3b84-en>. [47]
- OECD (2012), *Connected Minds: Technology and Today’s Learners*, Educational Research and Innovation, OECD Publishing, Paris, <https://dx.doi.org/10.1787/9789264111011-en>. [18]
- Ofcom (2019), *Children and Parents: Media Use and Attitudes Report 2018*, https://ofcom.org.uk/_data/assets/pdf_file/0024/134907/Children-and-Parents-Media-Use-and-Attitudes-2018.pdf. [14]
- Orben, A. and A. Przybylski (2019), “The association between adolescent well-being and digital technology use”, *Nature Human Behaviour*, Vol. 3/2, pp. 173-182, <http://dx.doi.org/10.1038/s41562-018-0506-1>. [59]
- Pascual-Espada, J. et al. (2011), “Virtual objects on the Internet of things”, *International Journal of Interactive Multimedia and Artificial Intelligence*, Vol. 1/Special Issue on Computer Science and Software Engineering, <https://ijimai.org/journal/node/184>. [29]
- Pedró, F. et al. (2019), “Artificial intelligence in education: Challenges and opportunities for sustainable development”, UNESCO, Paris, <https://unesdoc.unesco.org/ark:/48223/pf0000366994>. [35]

- Peter, J. and P. Valkenburg (2006), “Adolescents’ internet use: Testing the ‘disappearing digital divide’ versus the ‘emerging digital differentiation’ approach”, *Poetics*, Vol. 34/4-5, pp. 293-305, <http://dx.doi.org/10.1016/J.POETIC.2006.05.005>. [23]
- Pew Research Center (2018), *Teens, Social Media and Technology 2018*. [27]
- Przybylski, A. and N. Weinstein (2017), “A large-scale test of the Goldilocks Hypothesis”, *Psychological Science*, Vol. 28/2, pp. 204-215, <http://dx.doi.org/10.1177/0956797616678438>. [57]
- Przybylski, A. and N. Weinstein (2017), “Digital screen time limits and young children’s psychological well-being: Evidence from a population-based study”, *Child Development*, <http://dx.doi.org/10.1111/cdev.13007>. [58]
- Rideout, V. (2015), *The Common Sense Census: Media Use by Tweens and Teens*, Common Sense. [26]
- Robinson, L. et al. (2015), “Digital inequalities and why they matter”, *Information Communication and Society*, Vol. 18/5, pp. 569-582, <http://dx.doi.org/10.1080/1369118X.2015.1012532>. [37]
- Rutter, M. (2007), “Resilience, competence, and coping”, *Child Abuse & Neglect*, Vol. 31/3, pp. 205-209, <http://dx.doi.org/10.1016/J.CHIABU.2007.02.001>. [51]
- Selwyn, N. (2009), “The digital native-myth and reality”, *Aslib Proceedings: New Information Perspectives*, Vol. 61/4, pp. 364-379, <http://dx.doi.org/10.1108/00012530910973776>. [17]
- Staksrud, E. et al. (2009), *What Do We Know About Children’s Use of Online Technologies? A Report on Data Availability and Research Gaps in Europe*, EU Kids Online, LSE, <http://eprints.lse.ac.uk/24367/>. [45]
- Uncapher, M. et al. (2017), “Media multitasking and cognitive, psychological, neural, and learning differences”, *Pediatrics*, Vol. 140/Supplement 2, pp. S62-S66, <http://dx.doi.org/10.1542/PEDS.2016-1758D>. [36]
- UNICEF (2017), *The State of the World’s Children: Children in a Digital World*, https://unicef.org/publications/index_101992.html. [42]
- United Nations Assembly (1989), *Convention on the Rights of the Child*, United Nations Human Rights Office of the High Commissioner, New York, NY, <https://digitalcommons.ilr.cornell.edu/cgi/viewcontent.cgi?article=1007&context=child>. [6]



From:
Educating 21st Century Children
Emotional Well-being in the Digital Age

Access the complete publication at:
<https://doi.org/10.1787/b7f33425-en>

Please cite this chapter as:

Burns, Tracey and Francesca Gottschalk (eds.) (2019), "Children and digital technologies: Trends and outcomes", in *Educating 21st Century Children: Emotional Well-being in the Digital Age*, OECD Publishing, Paris.

DOI: <https://doi.org/10.1787/71b7058a-en>

This work is published under the responsibility of the Secretary-General of the OECD. The opinions expressed and arguments employed herein do not necessarily reflect the official views of OECD member countries.

This document and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

You can copy, download or print OECD content for your own use, and you can include excerpts from OECD publications, databases and multimedia products in your own documents, presentations, blogs, websites and teaching materials, provided that suitable acknowledgment of OECD as source and copyright owner is given. All requests for public or commercial use and translation rights should be submitted to rights@oecd.org. Requests for permission to photocopy portions of this material for public or commercial use shall be addressed directly to the Copyright Clearance Center (CCC) at info@copyright.com or the Centre français d'exploitation du droit de copie (CFC) at contact@cfcopies.com.