Organisation for Economic Co-operation and Development

EDU/WKP(2018)15

Unclassified **English - Or. English**

12 September 2018

DIRECTORATE FOR EDUCATION AND SKILLS

New technologies and 21st century children: Recent trends and outcomes

OECD Education Working Paper No. 179

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JT03435590

OECD EDUCATION WORKING PAPERS SERIES

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ACKNOWLEDGEMENTS

Much thanks and acknowledgement is given to Tracey Burns, Marc Fuster-Rabella, Francesca Gottschalk, Quynh Nguyen and Leonora Lynch-Stein for their valuable input into the scoping, drafting and editing of this working paper.

ABSTRACT

This paper provides a synthesis of the literature on and recent trends in new technologies and its effect on 21st century children (0-18 years old). It begins by providing an overview of recent trends in the access and use of new technologies as well as a summary of online opportunities and risks. It then explores a variety of factors, including economic, social and cultural status which underlie these trends and lead to online and offline inequalities. Building digital resilience is an important skill for 21st century children. Effective strategies to accomplish this include encouragement of active rather than passive Internet use, e-safety in the school curriculum, and teacher and parental Information and Communication Technology (ICT) support. A focus on younger children (primary school or younger) and the effects of new emerging technologies would be helpful for future research.

RÉSUMÉ

Cet article présente une synthèse de la littérature sur les tendances récentes en matière de nouvelles technologies et leurs répercussions sur les enfants du XXIe siècle (0-18 ans). Il propose tout d'abord un tour d'horizon des tendances récentes relatives à l'accès et à l'utilisation des nouvelles technologies, ainsi qu'un aperçu des opportunités et des risques en ligne. Il explore ensuite divers facteurs, notamment le statut économique, social et culturel qui sous-tendent ces tendances et conduisent à des inégalités en ligne et hors ligne. Le renforcement de la résilience numérique est une compétence importante pour les enfants du 21ème siècle. Les stratégies efficaces pour y parvenir comprennent l'encouragement de l'utilisation active plutôt que passive d'Internet, l'inclusion de la sécurité en ligne dans les programmes scolaires, et le soutien des enseignants et des parents aux TIC. Il serait utile pour les recherches à venir de mettre l'accent sur les jeunes enfants (niveau primaire ou préscolaire) et les effets des nouvelles technologies émergentes.

Table of contents

Tables

Figures

Boxes

1. Introduction

The use of the Internet is becoming ever more important in allowing everybody to wholly participate in society. Whether it is to acquire new skills, or connect with distant as well as near friends and family, children's opportunities increasingly depend on the Internet. Access to online information and services has become so important that several national governments, including those of Costa Rica, Estonia, Finland, France, Greece and Spain, have formally recognised Internet access as a human right (United Nations, 2011[1]; Reuters, 2009[2]; Parliament, 2008[3]). These legislative changes mirror changes in access: high-speed mobile Internet subscriptions in the OECD area grew by 93 million (or 7.6%) in the year to June 2017, reaching a mobile broadband penetration rate of over 100% for the first time (OECD, 2018[4]).

Not every child, unfortunately, benefits equally from online opportunities. There are still large disparities between and within countries and economies when it comes to digital access, skills and use, and these digital divides lead to unequal Information and Communication Technology (ICT) outcomes (Helsper, Van Deursen and Eynon, 2015[5]).

New technologies bring fundamental changes to the lives of 21st century children, who are the most frequent users of emerging digital and online services (OECD, 2016[6]). Children are growing up with digital platforms such as Instagram and YouTube, and know how to use a tablet before they are able to talk. Words like "binge-watch", "live-tweet", and "hyper-connected" reflect our increasingly virtual world, affecting the way children grow, learn, play and interact.

The more time children spend online, the more they are exposed to digital risks, such as cyberbullying, sexting and harmful user-generated content (Livingstone et al., 2011[7]). Despite the fact that relatively few children might actually experience severe harm resulting from online risk, the impact can be very significant. Building digital resilience is important for children, and both families and schools play a crucial role in this (Livingstone et al., 2017[8]). Likewise, smart toys and other innovations driven by connected technologies raise serious questions about the privacy and safety of children. Technology also affects how and what children learn in schools (Paniagua and Istance, 2018[9]).

This paper will discuss how technology affects children (0-18 years old) growing up in the 21st century. First, the major trends will be outlined, to better understand recent developments and emerging issues. Second, ICT outcomes will be discussed. Digital opportunities and risks that children are exposed to online will be covered, as well as the potential health risks. Third, digital divides related to ICTs will be outlined along with the mediating factors influencing these inequalities. The fourth section will describe the importance of children building digital resilience and the role of different stakeholders to achieve this. Finally, the challenges of developing policies that both safeguard and empower children in a digital world will be discussed, including suggestions for future research.

Note that the use of technology in and for education is beyond the scope of this paper. Access and use of ICT at the school level as well as the use of new technologies in early education will therefore not be discussed.

2. Trends

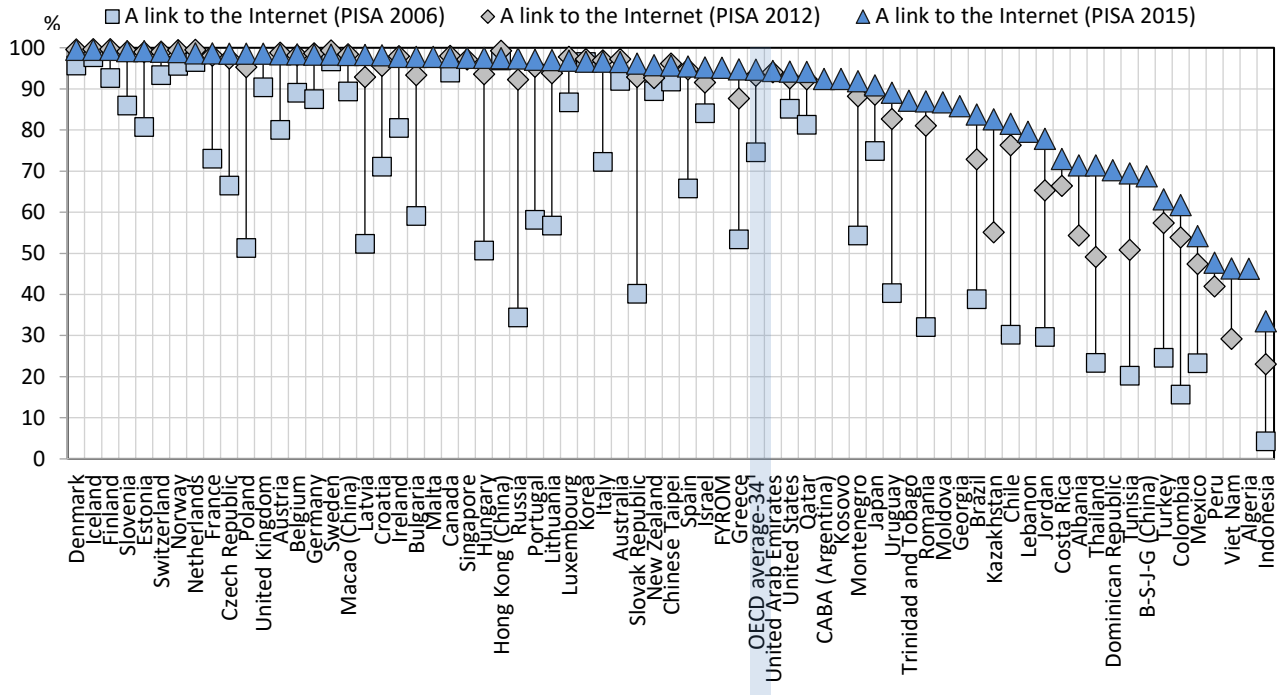
2.1. Always online

PISA[1] 2015 data showed that almost all 15 year olds in OECD countries (95%) have Internet access at home, an increase from 75% in 2006. However, large differences were observed across countries and economies (see Figure 1). In Denmark, Estonia, Finland, Iceland, Norway, Slovenia and Switzerland, almost all students reported having Internet access at home, while in Algeria, Indonesia, Peru and Vietnam, fewer than half of all students did (OECD, 2017[10]). Eurostat statistics showed similar outcomes of access inequality across European households: in 2016, only 64% of Bulgarian and 69% of Greek households had Internet access (Eurostat, 2016[11]). These results display a gap in Internet access between students in different countries.

These trends exist also for access to digital devices. By 2015, 91% of 15 year olds who took the PISA assessment 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[10]). Access to online and digital devices increased rapidly between 2012 and 2015. Across OECD countries, students' access to a tablet with Internet connection at home expanded by 30 percentage points. Access to a smartphone increased by 19 percentage points during this period. Again, large differences were reported across countries and economies. In Colombia, the Dominican Republic, Mexico and Peru, only two-thirds of students had access to a smartphone at home. More than 80% of students in Australia, Austria, Belgium, Denmark, Iceland, Luxembourg, the Netherlands and Portugal had access to a portable laptop at home, while this was less than 40% in Beijing-Shanghai-Jiangsu-Guangdong (China) (hereafter "B-S-J-G [China]"), the Dominican Republic and Peru (OECD, 2017[10]).

[1] The Programme for International Student assessment (PISA) is an international survey by the OECD which aims to evaluate education systems worldwide (OECD, 2018[194]).

Figure 1. Change from 2006 through 2012 and 2015 in students' access to the Internet at home



Note: "OECD average-34" includes all OECD countries with available data for both PISA 2006, PISA 2012 and PISA 2015.Countries and economies are ranked in descending order of the percentage of students who accessed the Internet at home in 2015.
Source: (OECD, 2017[10]) *PISA 2015 Results (Volume III) Students' Well-Being*, http://dx.doi.org/10.1787/9789264273856-en, Figure III.13.1 (accessed 20 May).

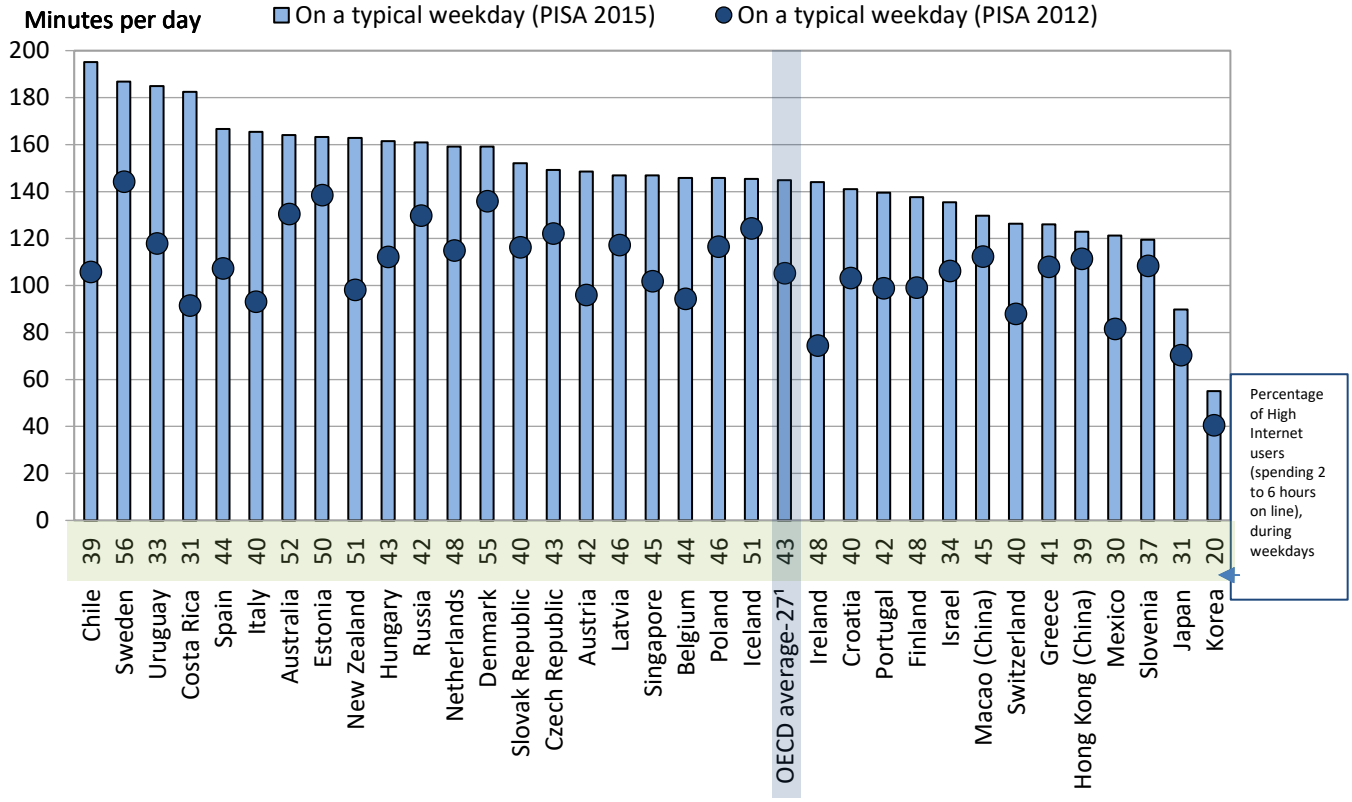
The increase in access—as shown above—also translates to increasing time spent online. PISA 2015 data revealed that, on average across OECD countries, students spent almost two and a half hours online outside of school on a typical weekday, and more than three hours on a typical weekend. Time spent online increased on average by about 40 minutes between 2012 and 2015, both on weekdays and weekends. In Chile and Costa Rica, time spent online even increased by one hour and 20 minutes (OECD, 2017[10]).

Figure 1 shows the change between 2012 and 2015 in time spent online outside of school for different countries. On a typical weekend, students in Bulgaria, Chile, the Netherlands, Spain, Sweden and the United Kingdom spent on average more than three and a half hours online per day, while in B-S-J-G (China), Korea and Peru this was less than two hours. On weekdays in Brazil, Bulgaria, Chile, Costa Rica, Sweden, the United Kingdom and Uruguay, students spent on average more than three hours online, while those in B-S-J-G (China) and Korea spent less than one hour online. Only 0.3% of students among OECD countries reported that they had never used the Internet (OECD, 2017[10]).

On average across OECD countries, boys spent more time online than girls; 17 minutes more on a typical weekend day and 14 minutes more on a typical weekday (OECD, 2015[12]).

Figure 2. Change between 2012 and 2015 in time spent online outside of school

Minutes per days spent using the Internet



Note: "OECD average-27" includes all OECD countries with available data for both PISA 2012 and PISA 2015. As the answers were given on a categorical scale, it is not possible to compute exactly the average time students spend online. The number in this figure thus report a lower bound for the number of minutes students spend on online activities, whereby the answer "between one and two hours", for instance, is converted into "61 minutes at least". Only countries and economies with available data for both PISA cycles are shown. Countries and economies are ranked in descending order of the time per day spent using the Internet in 2015.
Source: (OECD, 2017[10]), *PISA 2015 Results (Volume III) Students' Well-Being*, http://dx.doi.org/10.1787/9789264273856-en , Figure III.13.3 (accessed on 20 May).

2.2. Younger and more connected

Over the last few years, there has been a significant increase in Internet usage by 0-8 year olds, partly because children start using digital devices at younger ages. On average across OECD countries, 18% of students in 2015 accessed the Internet for the first time before reaching an age of six, an increase of three percentage points since 2012 (OECD, 2017[10]). The introduction of touch screens and icon driven tablets has facilitated this emerging trend of very young children (toddlers and pre-schoolers) going online (Brown and Pecora, 2014[13]). A third of 3-4 year olds in the United Kingdom go online, and this share is even higher in countries such as the Netherlands (78%), Belgium (70%) and Sweden (70%) (Holloway et al., 2013[14]).

Time spent online by children was found to be significantly correlated with time spent online by parents, as well as the availability of technological devices in the home

environment (Nikken, 2017[15]). This shows that having digital devices at home may make children acquainted with technology from a very early age.

Likewise, children start owning devices (e.g. their first mobile phone) at an earlier age (Unicef, 2017[16]). Among 0-8 year olds in in the United States, 42% owned a tablet, an increase from 7% in 2013 and less than 1% in 2011 (Common Sense Media, 2017[17]). These trends are not uniform across countries. Over 20% of students in B-S-J-G (China), the Dominican Republic, Mexico and Peru were older than 13 when they accessed the Internet for the first time (OECD, 2017[10]). In general, in countries where more children use the Internet, children also go online younger. Moreover, boys and advantaged students are more likely to have early access to digital devices as compared to girls and disadvantaged students (OECD, 2016[18]; OECD, 2015[12]). Children using digital devices at younger ages can be concerning, as younger children are less resilient to risks that they encounter online (Holloway et al., 2013[14]).

Children are now more likely to go online via personal digital devices such as mobile phones and laptops. A recent study conducted by Global Kids Online showed that on average 80% of children access the Internet via a smartphone or tablet (Byrne et al., 2016[19]). Moreover, an increasing number of children take their phones and other digital devices into their bedrooms (49%), where there is no or less parental supervision (Livingstone et al., 2011[20]). This implies that watching programmes and videos is increasingly becoming a more private and individual activity. Adolescents also seek to keep social information from their parents and educators. Snapchat sells itself as a place where nothing is permanent, enabling users to send texts, images, and videos with increased privacy. Traditional social networks sites (SNSs) such as Facebook are becoming less popular among adolescents, while the contrary is true for platforms such as Snapchat and Instagram, where adults are less present (Martin et al., 2018[21]).

2.3. When free time becomes screen-time

The share of children who frequently use the Internet for leisure activities has increased significantly. PISA 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. 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. Socio-economically advantaged students in OECD countries were 5 percentage points more likely to participate in one of the three online activities (chatting, participating in social networks, playing videogames) than disadvantaged students (OECD, 2017[10]).

Playing online games is significantly more popular among boys: across OECD countries, 75% of 15-year-old boys played one-player games regularly, and more than 13% played every day. 70% of 15-year-old boys played collaborative online games regularly, and almost 20% did so every day. Girls, on the other hand, showed a very different pattern of responses. Over 56% of 15-year-old girls never or hardly ever play one-player games, and over 71% did not or hardly play collaborative online games (OECD, 2015[12]).

Children also use the Internet at home for gaining information and informal learning. Across OECD countries, 88% of students reported that the Internet was a great resource to obtain information. Moreover, 49% of students agreed that they used the Internet to exchange solutions to problems with others (OECD, 2017[10]). PISA 2012 data showed that 63% of 15 year olds used the Internet at least once a week to read the news and 66%

to obtain practical information. Socio-economically advantaged students were more likely to do so compared to socio-economically disadvantaged students, who played more online games and chatted online (OECD, 2016[18]).

2.4. Internet use and well-being

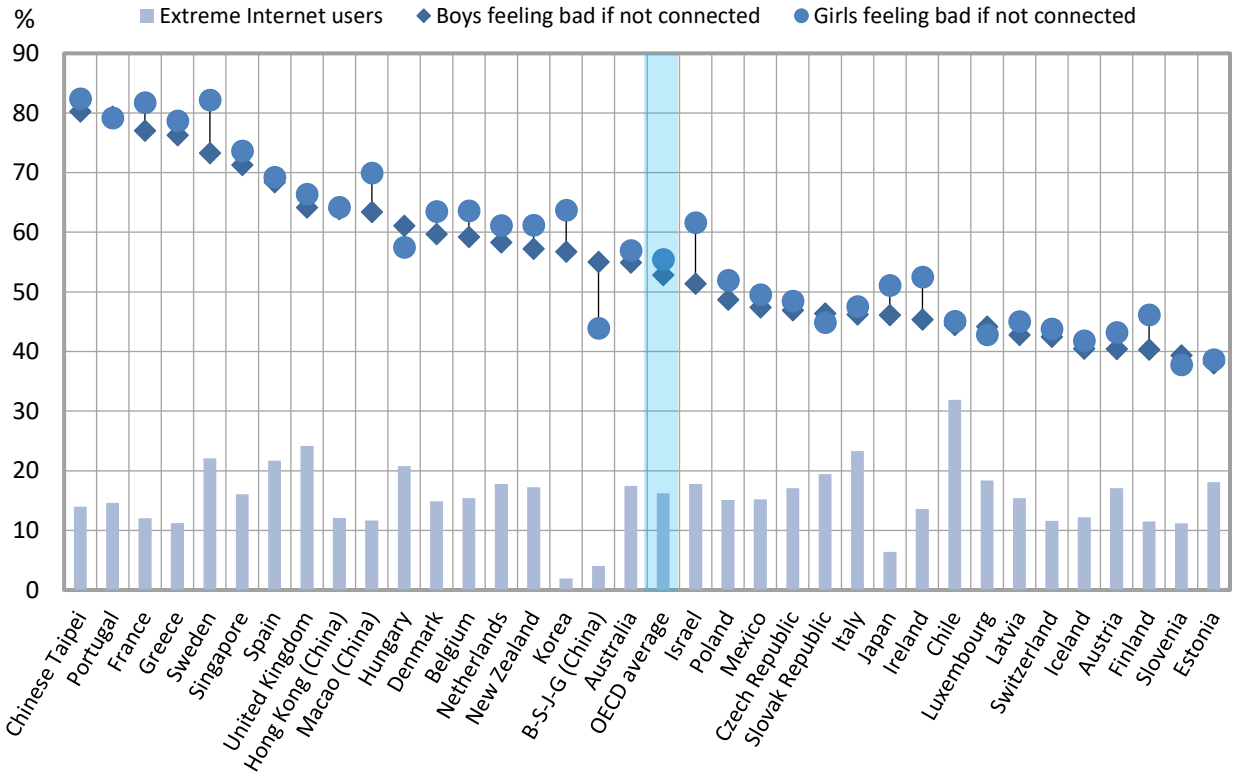
This use of the Internet can come at a cost. Figure 3 shows that an increasing number of children feel bad when they cannot be online, which can have a negative impact on their well-being. On average, 54% of students who took the 2015 PISA assessment reported that they felt bad when no Internet connection was available. In Chinese Taipei, France, Greece, Portugal and Sweden this share was even higher than 77%. On average, girls were more likely to feel bad if they were unconnected to the Internet in comparison to boys. However, in Israel, Russia and Sweden the opposite gender pattern was observed (OECD, 2017[10]). In European countries, socio-economically advantaged students were less likely to report that they felt bad without available Internet connection, compared to disadvantaged students. The opposite pattern was observed in countries with large disparities in Internet access, such as Colombia, Mexico and Thailand (OECD, 2017[10]).

PISA defines children as "extreme Internet users" when they spend more than 6 hours online per day outside school. In 2015, 16% of 15 year olds among OECD countries could be considered "extreme Internet users" during weekdays, and 26% during weekends. "Extreme Internet users" reported less life satisfaction and were more likely to be bullied at school (OECD, 2017[10]). Moreover, 17% of "extreme Internet users" reported feeling lonely at school, as compared to 13% of "high Internet users[2]", 12% of "moderate Internet users" and 14% of "low Internet users". Likewise, "Extreme Internet users" performed worse across all subjects in the PISA test, even after accounting for differences in socio-economic backgrounds. "Extreme Internet users" also had lower expectations of further education and were more likely to arrive late for school in the two weeks prior to the PISA test (OECD, 2017[10]).

[2] PISA defines categories of Internet users based on how much time students spend online, outside of school, during a typical weekday. Low Internet users: one hour or less; moderate Internet users: 1 to 2 hours; high Internet users: 2 to 6 hours; extreme Internet users: more than 6 hours (OECD, 2017, p. 55[10]).

Figure 3. Children feeling bad if not connected and percentage of extreme Internet users

Feeling bad measured by percentage of students who reported "agree" or "strongly agree"



Note: Countries and economies are ranked in descending order of the percentage of girls who feel bad if there is no Internet connection available.
Source: (OECD, 2018[22])"A brave new world: Technology and education*", Trends Shaping Education Spotlights*, No. 15, Figure 4 (accessed on 20 May).

3. Opportunities and risks

The more time children spend online, the greater their exposure to online opportunities and risks are. These go hand in hand, as children must encounter and explore online risks in order to learn and develop digital skills. Attempts to minimise risks can limit children's online opportunities, while efforts to maximise opportunities can also increase digital risks (Livingstone et al., 2011[20]). The following section will discuss opportunities and risks that children face online. These will be categorised according to the motives of those providing online contents and in relation to the child. The first category covers content opportunities and risks, where the child is a recipient of mass-produced content. The second category describes contact opportunities and risks, where the child is a participant in an online interaction, often driven by adults. In the third category, conduct

opportunities and risks are outlined, where the child is an actor – perpetrator or victim - in an interactive situation in which he or she may be the initiator (Livingstone and Haddon, 2009[23]).

3.1. Content: Child as recipient

3.1.1. Access to information

The Internet gives children access to global information. Not only is the quantity of information available now much larger and more widely accessible, information is also diversified into a variety of formats and types, for instance email, voicemail, traditional websites, blogs, and wikis (Bawden and Robinson, 2009[24]). Search engines have made it easier than ever before to search and find relevant knowledge on the ''Web''. In searching for words, children can instantly select and access the most relevant information among the overload of content available online (OECD, 2018[25]).

Using the Internet to search for information has become a common practice. The Internet, for example, has become an important source of health information. E-health can provide many opportunities to children and adults (Livingstone, Mascheroni and Staksrud, 2017[26]). Between 2008 and 2013, online searches for health information went up by 13% on average in OECD countries (OECD, 2016[6]). Beyond searching for information, more advantaged technologies can provide automatically generated summaries, plagiarism checks and language translations (OECD, 2018[25]). The overload of information available to children results in them using online content differently. Scanning and skimming texts to quickly detect useful information is a rising practise among Internet users (Rosenwald, 2014[27]).

However, the enormous amount of information that children are faced with online may also have negative implications. First, because anyone can produce and upload materials, the quality of online content is not necessarily guaranteed. This can become problematic if children are unable to distinguish fiction from fact and cannot critically verify online sources, leading to misinformed children (OECD, 2017[28]). Only 42% of Italian 9-17 year olds reported they found it easy to check if online information is true (Mascheroni and Ólafsson, 2018[29]).

Moreover, when it comes to search engines, there are concerns that the order and composition of search results are manipulated by search engine providers, a phenomenon known as the Search Engine Manipulation Effect (SEME) (Epstein and Robertson, 2015[30]). Another concern is the number of fake posts or so-called "evil unicorns" that pop up on the Internet and find their way into search results (Bergen, 2017[31]). Lastly, with social media increasingly being used as an information source, students risk becoming isolated in so-called 'echo chambers' with like-minded individuals, limiting critical thinking and checking sources (Krasodomski-Jones, 2016[32]).

Research has shown that children need support from teachers to develop the skills needed to critically evaluate information online (Hatlevik and Hatlevik, 2018[33]). A study among Norwegian teachers, examining approaches to foster students' evaluation of digital information, found that approximately 70% reported giving importance to developing student's skills to assess the accuracy, credibility and relevance of information online. However, only 50% of Norwegian teachers reported helping students develop the skill to evaluate multiple sources of information online (Hatlevik and Hatlevik, 2018[33]). This can become problematic, as many students prefer to use fast and easy to use websites

(e.g. Wikipedia) and often select information from only few sources (Blikstad-Balas, 2016[34]).

3.1.2. Learning and support

The market for online products and services in the education sector is expanding, providing students with more and better learning opportunities. The revolution of ICTs has significantly reduced the costs of these opportunities; many online educational resources (e.g. courses, textbooks, video material and instructions) can now be accessed for free. This allows disadvantaged students to participate in e-learning and to access a wide range of learning content (Unicef, 2017[16]). Moreover, the Internet can facilitate students' job searching process, for instance through professional social networking platforms (e.g. LinkedIn), where students can connect with potential employers (Unicef, 2017[16]).

Children may also use the Internet to get advice regarding personal, health or sexual issues. Traditional barriers to seeking help are reduced online and now there are many supportive communities on the Internet. For lesbian, gay, bisexual, transgender and queer (LGBTQ) youth, for example, the Internet can be a great source to learn more about their community and LGBTQ-related health issues, which is often not provided in schools or at home (GLSEN, CiPHR and CCRC, 2013[35]). Similarly, there are websites offering anonymous support to children with depressed feelings or suicidal thoughts. Beyond support, online treatments are becoming a more common practise. A meta-analysis found that computer- and Internet-based cognitive behavioural treatments can be effective for treating symptoms of anxiety and depression in children and adolescents (Ebert et al., 2015[36]).

3.1.3. Aggressive, sexual and commercial content

Another significant risk for children when browsing the Internet is potential encounters with aggressive, sexual/pornographic or dangerous content. The EU Kids Online survey, carried out among children in 25 European countries, showed that 21% of 11-16 year olds had encountered one or more websites with potentially harmful user-generated content online in the previous year. This included hate messages (12%), pro-eating disorder sites (10%), self-harm sites (7%), drug taking sites (7%) and suicide sites (5%). Moreover, 14% of 9-16 year olds had seen images that were "obviously sexual – for example, showing people naked or people having sex". Among those who had seen sexual images, 25% were upset by this (Livingstone et al., 2011[7]). Similar results were found among 10-17 year olds in the United States (Jones, Mitchell and Finkelhor, 2012[37]). Most of the encountered online content was not sexually explicit – 11% had seen nudity, 8% had seen genitals, 8% had seen someone having sex and 2% had seen violent sex (Livingstone et al., 2011[7]).

Children may unintentionally encounter pornographic content online through, for example, receiving spam emails, pop-up advertisements, mistyping URLs or when searching online (Peter and Valkenburg, 2016[38]). Note that it is still common for children to encounter sexual images elsewhere: for instance on television, videos or DVDs (12%), or in magazines or books (7%). Overall, exposure to online sexual content increases with age, and boys are more likely to come across sexual images in comparison with girls (Livingstone et al., 2011[7]). The prevalence of intentional pornography use among children varies largely between studies due to different definitions and measurements, but overall boys are more likely to be pornography users than girls are

(Peter and Valkenburg, 2016[38]). Besides aggressive and sexual content, children may receive unwanted commercial content, including advertising, spam and sponsorship (Livingstone et al., 2011[7]).

Content opportunities and risks reflect a one-to-many mode of online communication. This means that children may frequently encounter content risks online, yet they are in most cases not too dangerous. Although it is important to teach children digital resilience related to content risk, parents and educators should keep in mind that relatively few children are upset after encountering such risks.

3.2. Contact: Child as participant

With the growing popularity of social network platforms, children's online activities are becoming more interactive. Although participating in online interactions can be a great opportunity for children to meet new peers, it does not come without risks. Both contact opportunities and risks are discussed below.

3.2.1. Staying in touch

Participating on SNSs is a common activity among children. Increasing access to mobile devices enables them to be permanently connected to their online social networks, continually receiving messages on their screen, checking their social news feed or posting personal updates (Mcdool et al., 2016[39]). 38% of 9-12 year olds and 77% of 13-16 year olds reported having their own profile on an SNS (Livingstone et al., 2011[20]), and 84% of 15 year olds agreed that "it is very useful to have social networks on the Internet" (OECD, 2017[10]). Social networking happens on social media (e.g. Facebook, Instagram, Snapchat and YouTube) as well as virtual gameplay platforms (e.g. World of Warcraft, The Sims, League of Legends and Clash of Clans).

Social networking is increasingly used by children to develop and maintain interpersonal relationships (Mcdool et al., 2016[39]). As the Internet removes physical distance constraints, propinquity is greater with virtual communication in comparison to face-to-face communication, making it easier for children to stay in touch with their friends and family (Miller and Morris, 2016[40]). A survey with respondents from Australia, Canada, the Czech Republic, France, Germany, Italy, New Zealand, Spain, the United Kingdom and the United States found that 47% of 8-9 year olds used the Internet to talk to their offline friends (AVG, 2015[41]). 13-17 year olds in the United States reported connecting with their offline friends at least every few days through texting (75%), instant messaging (53%), social media (51%), email (20%), video chat (21%), video games (29%) and messaging apps (25%) (Pew Research Center, 2015[42]).

Most research agrees that SNSs may have a positive effect on the social capital of children (Mcdool et al., 2016[39]; Wood, Bukowski and Lis, 2016[43]). Peer relations tend to benefit from SNSs through stronger feelings of connectivity (Spies Shapiro and Margolin, 2014[44]; Wood, Bukowski and Lis, 2016[43]). For example, 78% of American online gamers (aged 13-17) reported that they felt more connected to their offline friends if they played online games with them (Pew Research Center, 2015[42]). Similarly, social media can help teenagers to feel more connected to their friends' daily lives and feelings, and can be used to seek support. Communicating with offline friends through SNSs can also reduce self-reported levels of loneliness (Yang and Brown, 2013[45]). For boys, SNSs appear to stimulate their self-disclosure, which can lead to higher levels of well-being (Valkenburg and Peter, 2009[46]).

3.2.2. Meeting new people online

In addition to maintaining offline social ties through SNSs, adolescents are also making friends online (Unicef, 2017[16]). 50% of adolescents agreed that they "find it easier to be myself on the Internet" and 40% have "looked for new friends on the Internet" (Livingstone et al., 2011[20]). According to a global poll conducted in 25 countries, 59% of 18 year olds think that meeting new people online is important for them (UNICEF, 2016[47]).

SNSs facilitate homophily – the tendency of people to connect with similar others – through user 'profiles' (listing interests, hobbies, etc.), making it easier for users to meet like-minded people (Amichai-Hamburger, Kingsbury and Schneider, 2013[48]; Ito et al., 2008[49]). Girls are more likely to make new friends through social media platforms, while boys do so while playing online video games. An American survey found that 57% of 13-17 year olds had met a new friend online, and 29% had even made more than five new friends on the Internet. Most of these online friendships remain virtual; only 20% of teens reported that they had met face-to-face with an online friend (Pew Research Center, 2015[42]). If SNSs are used to make new friends, peer-related loneliness may be reduced (Wood, Bukowski and Lis, 2016[43]).

Adolescents also use online communication for identity development. Through taking 'selfies', for example, adolescents find out how peers see them (Vincent, 2015[50]). Particularly the anonymity of the Internet facilitates identity exploration and experimentation (e.g. pretending to be an older or more macho/beautiful/flirtatious person) (Subrahmanyam and Greenfield, 2008[51]). Motives for identity experiments may include self-exploration, social compensation and social facilitation (Valkenburg, Schouten and Peter, 2005[52]). Although most researchers agree that the Internet provides many opportunities for identity exploration, evidence to what extent adolescents engage in identity experiments is mixed (Subrahmanyam and Greenfield, 2008[51])

While only few adolescents meet their romantic partner online, technology is massively used for flirting: about half of adolescents in the United States use friendship requests, 'likes' or comments as a way to express attraction to someone, and nearly one-third send flirtatious messages online. Social media platforms enable teenagers to publicly show affection and to seek support or approval from peers through 'likes'. Although most adolescents agree that breaking up should occur in an offline setting, nearly one-third have been broken up with by text message (Pew Research Center, 2015[53]). Another study conducted in the United States found that LGBTQ adolescents were more likely to find a romantic partner online than non-LGBTQ adolescents (Korchmaros, Ybarra and Mitchell, 2015[54]).

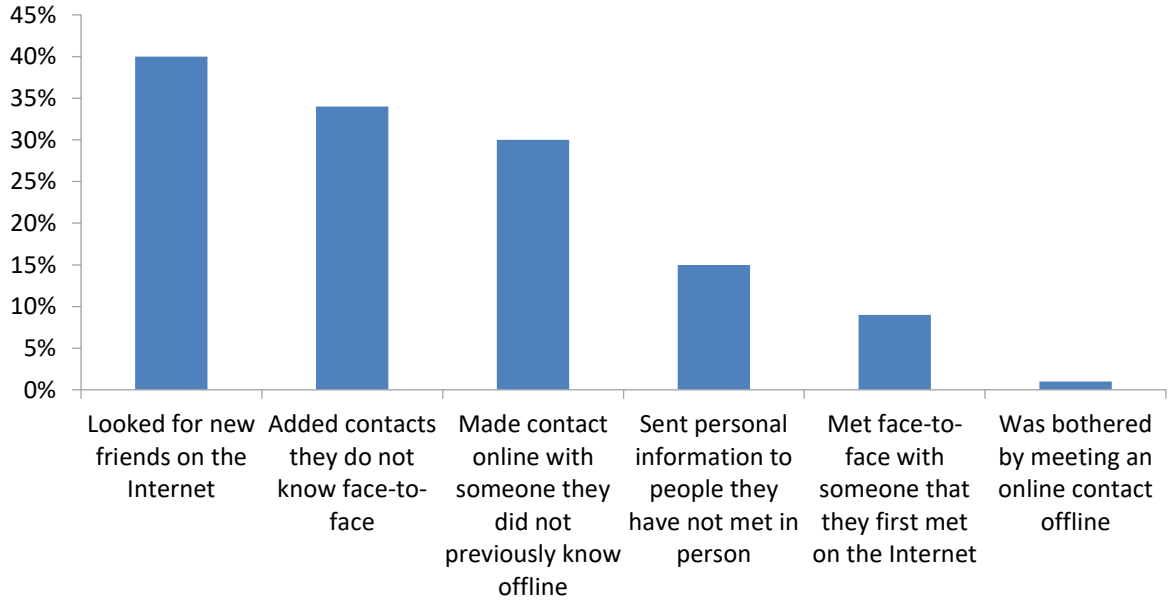
Although meeting new people online can be a great opportunity for children to make new friends or find a romantic partner, it does not come without risks. Adolescents tend to be less careful about whom they interact with online (Wood, Bukowski and Lis, 2016[43]). A study conducted among 8-12 year olds across 29 countries[3] found that 10% went on to meet in real life those strangers who they had communicated with online (DQ Institute, 2018[55]).

[3]Countries: Argentina, Australia, People's Republic of China, Dominican Republic and El Salvador, Ecuador, Egypt, India, Indonesia, Italy, Japan, Korea, Malaysia, Mexico, Nepal, New Zealand, Nigeria, Oman, Peru, Philippines, Singapore, South Africa, Spain, Thailand, United Kingdom, United States, Uruguay and Viet Nam.

Figure 4 shows the responses of 9-16 year olds on a number of different probes. 30% of 9-16 year olds had met someone online that they did not know previously; 15% had sent "personal information to someone that I have never met face-to-face". In addition, 9% met face-to-face with someone they had met online and among those, one in nine were upset by this. Age differences were substantial: the oldest children (15-16 years old) were eight times more likely to go to such a face-to-face meeting compared to younger children (9-10 years old) (Livingstone et al., 2011[7]).

Figure 4. Children participating in risky online activities

Percentages based on self-reported answers of 9-16 year olds in the EU Kids Online Survey



Source: Adapted from (Livingstone et al., 2011[7]), "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", http://eprints.lse.ac.uk/id/eprint/33731 (accessed on 14 February).

A follow-up study in Bulgaria showed that these percentages have increased over time, particularly for 15-17 year olds. Between 2010 and 2016, the share of Bulgarian 15-17 year olds who have communicated online with someone they did not previously know increased from 46 to 59%. Over the same period, the share of 9-17 year olds who had met in person somebody they first met online increased from 8 to 21%. Among 15-17 year olds this share increased from 16 to 39%. Interestingly, the majority of children (73%) felt pleased by meeting an online contact offline and, compared to 2010, less children were harmed by this experience (Hajdinjak et al., 2017[56]).

If children's online privacy settings are poorly managed, they can risk unwanted online interactions, which increase the possibility of grooming[4], harassment and sexual abuse by adults, and personal data misuse (Lupton and Williamson, 2017[57]). A study conducted in

[4] Grooming is defined by "the process by which a child is befriended by a would-be abuser in an attempt to gain the child's confidence and trust, enabling them to get the child to acquiesce to abusive activity" (Gillespie, 2002, p. 411[202]).

the United States showed that 9% of 10-17 year olds had experienced online sexual solicitation in the past year (Jones, Mitchell and Finkelhor, 2012[37]). The EU Kids Online survey found that 15% of 11-16 year olds "had seen or received sexual messages in the past 12 months". Among the children who had received sexual messages, less than one-third were bothered by it (of which the majority were girls). Moreover, 9% of 11-16 year olds had experienced some form of personal data misuse in the past year. 7% reported that someone had used their password or pretended to be them, 4% reported personal information abuse and 1% reported that they had lost money by being cheated online (Livingstone et al., 2011[7]). A meta-analysis, examining eligible studies between 1990 and 2016, found that approximately 20% of youth had been exposed to unwanted sexual content online and 11% experienced unwanted online sexual solicitation. 25% of youth reported being extremely bothered by these experiences (Madigan et al., 2018[58]).

3.2.3. Social networking and well-being

Social networking can also create conflict. About half of all 13-17 year olds in a Pew Research Center survey reported that they had experienced "drama among their friends" on social media platforms. Besides, social networking may have negative consequences on children's well-being, although evidence is mixed (Best, Manktelow and Taylor, 2014[59]). While face-to-face communication is necessarily qualitative, social networks allow for more quantitative communication (in the form of 'likes'). This quantitative form of contact can cause adolescents to be increasingly worried about the number of 'likes', 'favourites', or 'retweets' they get on their posts. 40% of 13-17 year olds in the United States reported feeling pressured to only post popular or flattering content (Pew Research Center, 2015[42]). This is not surprising, as receiving 'one-click' feedback (such as 'likes' or 'pokes') activates the part of the brain that is involved in explicit pleasure and addiction (Sherman et al., 2016[60]). However, this behaviour can be potentially harmful, as receiving 'one-click' feedback is associated with reduced well-being (e.g. lower self-esteem, increased anxiety and depressed feelings) among adolescents, although the directionality of the effect is not clear (Burke and Kraut, 2016[61]; Kross et al., 2013[62]).

Likewise, passive social media use – browsing through posts of peers without interacting – might increase feelings of envy and decrease self-esteem (Unicef, 2017[16]; Burke and Kraut, 2016[61]). 21% of 13-17 year olds in the United States reported that seeing posts from friends on social media made them feel bad about their own life (Pew Research Center, 2015[42]). Interestingly, scrolling through one's own profile has been shown to positively affect self-esteem (Gonzales and Hancock, 2011[63]). When adolescents use social platforms to compensate for their offline social skills, they are more likely to experience social loneliness (Teppers et al., 2013[64]). Motives for the use of social networks are thus important to determine the consequences on social well-being.

Interestingly, various studies observed gender differences in the social and psychological impacts of SNS use on adolescents (Wood, Bukowski and Lis, 2016[43]; Valkenburg and Peter, 2009[46]). When comparing Australian male students with a SNS profile to male students without one, the ones with a SNS profile had a significantly higher social self-concept. However, female students with a SNS profile reported higher levels of depressed feelings and lower levels of self-esteem in comparison with their female peers without SNS profiles (Blomfield Neira and Barber, 2014[65]). Moreover, female adolescents appear to have more negative emotional and behavioural reactions to teases on Facebook than male adolescents (Barnett et al., 2013[66]).

Box 1. The Internet and interpersonal skills and friendships

What is the effect of electronic communication on children's interpersonal skills and well-being? Research has shifted over the past decades:

- The displacement theory argues that online interaction replaces face-to-face interaction, which in turn leads to reduced social involvement and psychological well-being among children who use the Internet (Kraut et al., 1998[67]). Although this theory received early support, it has been criticised as being simplistic by more recent studies, which highlight the positive effects of the Internet on children's social capital.
- The "rich get richer" theory states that children with more social skills and networks will benefit more from online communication than those without (Kraut et al., 2001[68]; Unicef, 2017[16]).
- The social compensation hypothesis predicts that online communication benefits socially anxious and lonely children most as the Internet reduces social boundaries, thus facilitating making friends online (Bonetti, Campbell and Gilmore, 2010[69]). Lonely teens are also more likely to use social networks to make new friends rather than maintaining existing friendships.
- Finally, the stimulation hypothesis suggests that the impact of children's online behaviour is mostly positive for all children and that particularly communication with existing friends is improved (Unicef, 2017[16]; Valkenburg and Peter, 2007[70]; Miller and Morris, 2016[40]). A recent study, conducted among children in the United States, found a positive relation between children's computer use and the number of friends they communicated with offline (Fairlie and Kalil, 2017[71]). Another study, using Health Behaviour in School-aged Children (HBSC) data across nine countries, showed that 11-15 year olds who communicated more through electronic media reported higher life satisfaction. However, above a certain threshold this relationship became negative (Boniel-Nissim et al., 2015[72])

Although the displacement theory no longer receives much support, researchers do not agree on one hypothesis. More long-term research is needed which also takes into account the type of electronic communication or social network.

3.2.4. Data misuse

The collection and use of children's personal data through the Internet is a growing concern. Children are often unaware of online privacy risks and therefore inadequately manage their online security. By signing up for online accounts or free applications, which often ask for personal details, children voluntarily contribute to corporate data collection. Moreover, users are increasingly willing to share personal information in return for 'likes' (Darling, 2015[73]).

Although sharing private information might provide children with more personalised goods and services online, it places their online privacy at serious risk. When children's personal information is combined with data about how they interact with online services, it becomes extremely valuable to third party advertisers (Unicef, 2017[74]). A Pew Research Center survey showed that 81% of parents of 13-17 year olds surveyed in the United States reported being concerned about "how much information advertisers can learn about their child's online behaviour" (Pew Research Center, 2012[75]). Through behavioural targeting and advertising, companies are able to manipulate children's online environment and bias their behaviour and choices. Besides corporations, governments are also collecting children's online personal data (Unicef, 2017[16]).

Likewise, parents can be a potential source of children's data misuse. Parents increasingly start building digital footprints for their children, even before they are born (e.g. parents announcing their pregnancy on social media platforms and apps tracking the movement and heart rate of their foetus). One study found that "81% of children under the age of two currently have some kind of digital profile or footprint, with images of them posted online" (AVG, 2015, p. 2[41]). As the Internet makes sure every image, post, or message is permanently stored online, this digital history can be potentially harmful for a child in the longer term (Martin et al., 2018[21]). Parents should be aware of this risk and carefully manage their privacy settings. Moreover, parents increasingly use software to track their child's online behaviour and even physical location. Although close monitoring is considered good parenting, it raises questions about children's privacy online (Brown and Pecora, 2014[13]). While parental controls might be useful for young children, it can limit the development of adolescents' sexual, religious and political identity (Unicef, 2017[74]).

Box 2. The future of authentication: Biometric technology

Currently, many applications make use of biometrics to quickly and reliably identify and authenticate an individual. Most smartphones can be unlocked with one's fingerprint, and voice and facial recognition are increasingly being used by applications on smart devices. Google and Facebook are frontrunners when it comes to facial-recognition algorithms, used to label and organise pictures. Facebook can tell with 97% accuracy whether two faces belong to the same person (Computerworld, 2015[76]) and may even notify users when they appear in photos they have not been tagged in yet (Facebook, 2017[77]).

As the use of biometrics in the public domain is relatively new, there are growing concerns about the risks to children's privacy imposed by biometric data. The uniqueness of biometric data makes it more sensitive as compared to other types of personal data (Unicef, 2017[74]). The General Data Protection Regulation (GDPR) recently addressed the privacy issue of biometric data for European Member States (EU GDPR, 2018[78]). The United States has no federal law to regulate the use of biometric data, but several states (Illinois, Texas, and Washington) have adopted privacy laws (Gemalto, 2018[79]). However, biometric data can also be used to protect children's privacy online. For example, it has been proven useful in detecting and analysing child sex abuse images online (Unicef, 2017[74]).

3.3. Conduct: Child as actor

Participatory activities (e.g. blogging, file-sharing, visiting chatrooms and spending time in a virtual world) are the most advanced and creative activities children can engage in online. Children practising these activities enjoy many opportunities for exploration, expression and empowerment, and this should therefore be stimulated (Middaugh, Clark and Ballard, 2017[80]). These opportunities do not come without risks, however. Conduct risks reflect a peer-to-peer mode of online communication and include, for instance, cyberbullying (Livingstone et al., 2011[7]). Both conduct opportunities and risks are discussed in this section.

3.3.1. Self-initiated and participatory activities

The Internet enables children to not only access and use a variety of resources online, but also to create user-generated content themselves. Being able to produce and share content on the Web gives children the opportunity to contribute to existing knowledge through collaborative knowledge building (van den Broek, 2012[81]). Children can, for instance, practice a language using online video blogs or collaboratively writing a wiki[5] (Palaigeorgiou and Grammatikopoulou, 2016[82]). The EU Kids Online survey showed that children used the Internet to post messages (31%) or photos, videos or music (39%) to share with others, to participate in file-sharing sites (18%), and to write a blog or online diary (11%). User-generated content creation is important for children's identity, sociality, creativity and civic participation (Livingstone and Haddon, 2009[23]). However,

[5] "A wiki is a website that allows users to add, remove and otherwise edit and change content (usually text)" The online encyclopaedia Wikipedia is the most well-known website hosting wikis.

these participatory activities are still less common among children in comparison with more passive activities, such as watching video clips (76%) or playing Internet games (83%) (Livingstone et al., 2011[7]).

Digital media has an important role in fostering youth civic engagement. Civic engagement includes activities such as volunteering, activism, voting and raising awareness (Middaugh, Clark and Ballard, 2017[80]). Social platforms enable young adults to create and connect communities that foster collaboration and information sharing. Through blogs and social networks adolescents are able to influence their peers and local community on important social issues (Unicef, 2017[16]). Participating in such activities can support youth development and is a positive example of online engagement (Vincent, 2015[50]).

Digital media reduces the distance between information and action. For example, online information can be provided with a direct link that allows readers to donate money or sign a petition (Middaugh, Clark and Ballard, 2017[80]). As a result, social media and digital networks are increasingly being used for social movements, activism and participatory politics (Cammaerts, 2015[83]). The Amyotrophic Lateral Sclerosis (ALS) Ice Bucket Challenge for example, that went viral on social media in the summer of 2014, raised massive awareness of the devastating disease and raised $115 million for ALS research (ALS Association, 2017[84]). Social media was used as a tool for political movement and revolution during the Arab Spring and in the 15-M, Occupy and *Nuit debout* movements (Gerbaudo, 2012[85]). More recently, American students used social media to speak out in the national debate about gun laws and mass shootings (The Guardian, 2018[86]).

Self-initiated behaviour online can also be risky. For children growing up in a digital age, boundaries between public and private may be unclear and this can become problematic when technology influences adolescent sexual behaviour. A study conducted among 8-12 year olds across 29 countries worldwide found that 17% had been involved in online sexual behaviours, including having sexual conversations with online strangers and proactively downloading or sending online sexual content (DQ Institute, 2018[55]). Sexting, for example, refers to the exchange of sexual messages and is a rising online phenomenon as mobile devices are becoming more accessible (Kosenko, Luurs and Binder, 2017[87]). In the American Sex and Tech survey, 39% of 13-19 year olds reported that they "had sent or posted sexually suggestive messages", 20% "had sent or posted nude or semi-nude photos of themselves", and 38% reported that "the act of sexting someone made dating or hooking up with that person more likely" (Kosenko, Luurs and Binder, 2017[87]). The EU Kids Online survey found that 3% of 11-16 year olds had sent or posted a sexual message in the past 12 months (Livingstone et al., 2011[7]).

Sexting can potentially be very harmful to children's privacy, as sexual pictures can quickly spread online and remain on the Internet permanently. Besides, it may contribute to new norms of feminine and masculine desirability online. While for boys, possessing and exchanging explicit images of female peers adds to their status and image among peers, girls participating in sexting potentially risk their sexual reputation (e.g. being called a 'slut') (Ringrose et al., 2013[88]). Among Italian 11-17 year olds, 67% of girls were very upset after receiving sexually suggestive messages. By contrast, 29% of boys were happy after receiving such messages (Mascheroni and Ólafsson, 2018[29]). This highlights gender inequity issues related to sexting that can be harmful to children in the short and long run. Another common phenomenon that is of growing concern is revenge porn - the distribution of explicit images of former partners online without their consent (OECD, 2016[6]).

3.3.2. Cyberbullying

A significant concern among parents and educators is cyberbullying. Cyberbullying is defined as "an aggressive, intentional act carried out by a group or individual, *using electronic forms of contact,* repeatedly and over time against a victim who cannot easily defend him or herself" (Smith et al., 2008, p. 376[89]). It can take many different forms, including online harassment, flaming, outing, exclusion, trickery, impersonation, cyber-stalking and sexting (Willard, 2007[90]). As new technologies and platforms are emerging, the means for cyberbullying are diversifying (Livingstone and Smith, 2014[91]). Incidences of cyberbullying vary largely between studies due to different definitions and measurements of cyberbullying (Görzig and Ólafsson, 2011[92]). Cyberbullying victimisation has a significant impact on an individual's psychological and physical health, potentially decreasing life satisfaction and increasing depression and drug and alcohol use among the victim (Ybarra and Mitchell, 2004[93]; Kowalski et al., 2014[94]; Martin et al., 2018[21]). Victims and bullies are more likely to feel sad, angry, or anxious, to skip school and to be less focused in class (Tokunaga, 2010[95]).

Recent HBSC (Health Behaviour in School-aged Children) data from 43 countries showed that up to 12% of 11-15 year olds reported being a victim of cyberbullying at least twice a month (World Health Organization, 2016[96]). The 2010 EU Kids Online survey showed that 6% of 9-16 year olds had been bullied online in the past 12 months, and two-thirds of this figure reported being upset about it. When in 2014 the survey was repeated across seven countries, the proportion of children being bullied online had increased to 12% (Mascheroni and Ólafsson, 2014[97]). However, there is no clear evidence that cyberbullying is increasing over time. Although rising access of children to online and digital resources increases the potential for cyberbullying, online awareness efforts and controls have also increased. Note that cyberbullying still occurs less frequently compared to traditional bullying (World Health Organization, 2016[96]; Livingstone et al., 2011[7]).

There are two features that make cyberbullying significantly different from traditional bullying: anonymity and accessibility. Anonymity minimises the perpetrator's fear of punishment and stimulates more aggressive and punitive behaviour. Ybarra and Mitchell (2004[93]) conducted a survey across American adolescents and found that only 31% of cyberbullying victims knew the identity of their perpetrator. However, 84% of perpetrators knew their online victim in person. Anonymity can thus contribute to a power imbalance in cyberbullying that makes it harder for the victim to respond effectively (Livingstone and Smith, 2014[91]; Smith et al., 2008[89]). Moreover, the lack of supervision on social networks makes it harder to control cyberbullying. While traditional bullying mostly takes place at school, the accessibility of cyberbullying enables perpetrators to attack their victims at any time and in any place, making it harder for victims to escape (Agatston, Kowalski and Limber, 2007[98]). Cyberbullying 'power' is identified with digital literacy rather than with physical or social characteristics (Görzig and Ólafsson, 2011[92]). As physical appearance matters less with cyberbullying, more girls are involved in cyberbullying (as victims and as perpetrators) as compared to traditional bullying (Smith, 2013[99]; Ybarra and Mitchell, 2004[93]).

It is hard to determine if cyberbullying creates more harm when compared to traditional bullying. The permanence of videos, images and texts online, and the speed of the Internet at which harmful content can reach large audiences, might cause greater psychological harm in victims. However, cyberbullying can also be seen as an extension of traditional bullying, as many traditional bullies also tend to cyberbully (Olweus,

2012[100]; Biesta, 2009[101]; Kowalski et al., 2014[94]; Görzig and Ólafsson, 2011[92]). Likewise, victims of cyberbullying are likely to be victims of face-to-face bullying too (Smith et al., 2008[89]; Schneider et al., 2012[102]; Kowalski, Morgan and Limber, 2012[103]; Salmivalli, Sainio and Hodges, 2013[104]). This shows a clear relation between online and offline vulnerability.

3.4. Comparing risks

The ranking of risks experienced by children online seems to be similar across European countries. As Table 1 shows, giving out personal information is the most common risky behaviour among 9-16 year olds, followed by seeing pornography online. Online risk appears to increase with age: teenagers are more likely to encounter risk online in comparison with younger children. However, it is important to keep in mind that even though younger children are less exposed to online risk, they may experience more harm resulting from risk as they are less able to cope with it (Livingstone et al., 2011[7]).

Another potential danger is the overconfidence of adolescents online that nothing bad will happen to them. The majority (80%) of 18 year olds participating in a global poll were aware that going online comes with risks and dangers, and 90% reported knowing "how to avoid dangerous or risky situations online" (UNICEF, 2016[47]). Potential overconfidence may lead to more risky online behaviour among adolescents.

Table 1. Ranking of risk incidence

Based on self-reported answers of 9-16 year olds in the EU Kids Online Survey

1	Giving out personal information
2	Seeing sexual images/pornography online
3	Seeing violent or hateful content
4	Being bullied/receiving unwanted sexual comments
5	Meeting an online contact offline

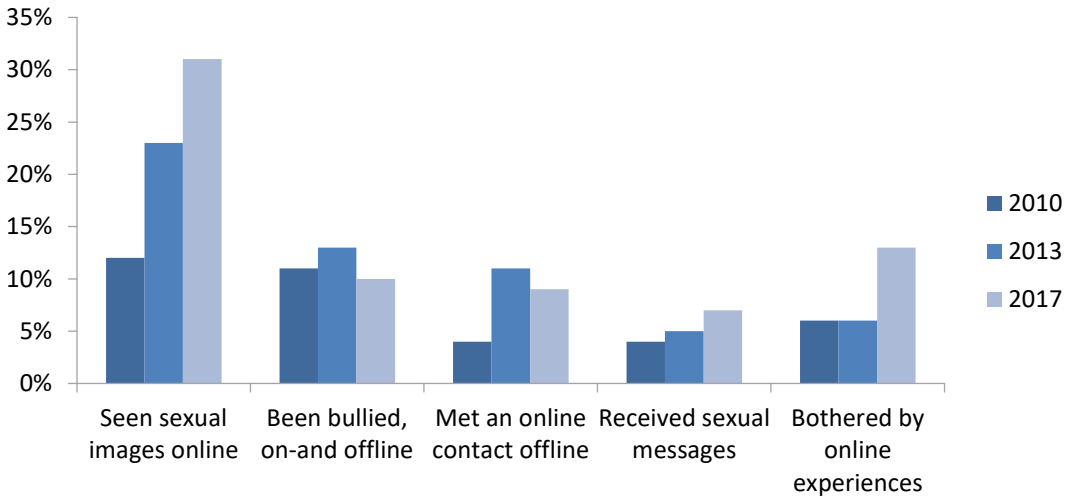
Note: Strictly speaking, giving out personal information is not a risk in itself but rather a behaviour likely to lead to risks.
Source: Adapted from Livingstone, S. et al. (2011[7]) "Risks and safety on the internet: The perspective of European children: full findings and policy implications from the EU Kids Online survey of 9-16 year olds and their parents in 25 countries", http://eprints.lse.ac.uk/id/eprint/33731 (accessed on 14 February).

EU Kids Online is currently doing a follow-up survey; with Italian results are already being available. Figure 5 shows the trend of several online risks over the last decade among Italian 9-17 year olds. Overall, twice as many children in 2017 felt upset by something they had experienced online as compared to 2010. Both the risk of seeing sexual images online and receiving sexual messages has increased. Interestingly, the number of children who have been bullied on- and offline has remained relatively stable. Nevertheless, among those who have been bullied, 79% felt very or fairly upset - indicating that bullying can be a very harmful experience for a child. Similarly, seeing hateful content and receiving sexual messages can cause serious harm to children (Mascheroni and Ólafsson, 2018[29]).

Likewise, a follow-up study in 2016 in Bulgaria showed that 15% of children have experienced something on the Internet that bothered or upset them, up from 9% in 2010 (Hajdinjak et al., 2017[56])

Figure 5. Comparing risks over time

Based on self-reported answers of Italian 9-17 year olds in the follow-up EU Kids Online Survey.



Note: Italian data only; new results are coming for all countries in 2018/19.
Source: Adapted from Mascheroni, G. Ólafsson, K. (2018[29]), *Accesso, usi, rischi e opportunità di internet per i ragazzi italiani. I risultati di EU Kids Online 2017*, http://globalkidsonline.net/wp-content/uploads/2017/10/EU-Kids-Online-Italy-report-06-2018.pdf.

3.5. Health consequences of extreme screen-time

A meta-analysis on the effects of watching television on children's social interactions concluded that "television has the potential to foster positive social interactions, reduce aggression and encourage viewers to be more tolerant and helpful" (Mares and Woodard, 2005, p. 316[105]). This seems to contradict the long-held belief that television worsened social isolation and violent behaviour among impressionable youth. Likewise, the radio was accused of causing sleeplessness and comic books were blamed for provoking immoral behaviour among children. Although concerns about emerging technologies are not new, today's digital developments are of a different magnitude (Drotner and Livingstone, 2008[106]). With the rapid digitalisation it becomes more difficult to turn off connectivity and to monitor children's online behaviour (Unicef, 2017[16]). This can lead to excessive screen-time for children, potentially causing risks to their physical and mental health (Aston, 2018[107]; Choi, 2018[108]).

There are concerns about screen-time replacing children's physical activity (Aston, 2018[107]). A study carried out among 11-15 year olds in Europe and the United States predicted that increasing daily screen-time by two hours decreased physical activity on average by about 30 minutes. However, differences were observed with age, nationality,

gender and type of activity. Gaming and watching TV were negatively related to physical activity, while the opposite pattern was observed for regular computer use (Melkevik et al., 2010[109]). It might be possible that those children who gamed frequently were already physically inactive, and that this was not a consequence of the screen-time. Overall, evidence on the effect of screen-time on physical activity remains unclear and screen-time is unlikely to directly influence physical activity as many other factors (e.g. sport facilities, safe neighbourhoods, parental support) play a role too (World Health Organization, 2017[110]; Laurson et al., 2014[111]; Unicef, 2017[16]).

Excessive screen-time appears to highly affect sleep quality (Aston, 2018[107]). Nowadays, almost all adolescents sleep with electronic devices in their bedrooms. 77% of 13-18 year olds in the United States reported sleeping with their cell phone next to their beds and 56% reported sending text messages in the hour before trying to go sleep every night or almost every night (National Sleep Foundation, 2011[112]). In the United Kingdom, 85% of youth reported using technology before sleeping (Reiter and Rosen, 2014[113]). Screen-based activities, especially in the evening and night, are directly related to reduced sleep quality (Hale and Guan, 2015[114]; Reiter and Rosen, 2014[113]; Iannotti et al., 2009[115]). Screen-time often delays bedtimes, shortening sleeping hours, and bright screen light can delay melatonin secretion (a sleep-promoting hormone) (Higuchi et al., 2005[116]). Moreover, online content might cause psychological and physiological awakening, making it hard to fall and stay asleep (Hale and Guan, 2015[114]). Interactive screen-time (computer use, video games and mobile devices) is more harmful to sleep quality in comparison with passive screen-time (television watching) (Hale and Guan, 2015[114]). Reduced sleep quality can lead to anxiety, depression and lower levels of self-esteem among adolescents (Alfano et al., 2009[117]) and can thus deteriorate children's emotional well-being (Choi, 2018[108]).

Children are increasingly accessing more than one item or stream of content at the same time, a phenomenon called media multitasking. Between 2009 and 2013, the average number of activities that individuals performed online has increased by 16%. On average, Internet users perform seven activities at any one time (OECD, 2016[6]). Norwegians for example even reported carrying out eight activities at the same time - including checking emails, sending texts on social networks, reading blogs and scanning news (OECD, 2014[118]). 40% of American teenagers reported that they used another digital device while using the computer most of the time, and 26% did so sometimes (Foundation, 2010[119]). A Stanford University study showed that high media multitaskers were more easily distracted and were worse at ignoring irrelevant information, leading to difficulties in fundamental information processing (Ophir, Nass and Wagner, 2009[120]). Neurological research supports these findings and suggests that multitasking is in fact fast-switching between tasks, as our brain capacity is limited, and this leads to decreased efficiency and more distraction (OECD, 2012[121]). One study found that, on average, students studied less than six minutes before they got distracted by a technological device (Rosen, Mark Carrier and Cheever, 2013[122]). Multitasking may thus lead to decreased academic performance (Wood et al., 2012[123]; Junco and Cotten, 2012[124]) and well-being (Pea et al., 2012[125]), including higher levels of anxiety and depression (Becker, Alzahabi and Hopwood, 2013[126]).

Using ICT extensively may also cause physical discomfort (Scherer and Hatlevik, 2017[127]). Palmer, Cicarelli, Falmer and Parson (2013[128]) studied ICT-related discomfort among Australian 12-15 year olds and found that 86% of participants reported pain in the head/neck, legs, back or shoulders from using ICT. However, no statistical correlation was found between reported discomfort and ICT exposure. Similarly, Coleman, Straker

and Ciccarelli (2009[129]) found that discomfort among children was related to using computers or watching TV. Interestingly, the most frequent reported causes of discomfort were ''bad posture'' and ''doing too much of a certain activity'', indicating that children are aware of the potential negative physical effects of using ICT extensively.

Although excessive screen-time can be harmful, it is important to keep in mind that moderate screen-time is not necessarily bad and can even be beneficial. Following the Goldilocks theory, moderate use of technology can have a positive impact on children's well-being in a digital world (Przybylski and Weinstein, 2017[130]). This indicates that screen-time itself does not necessarily have a negative effect; it depends on what children are doing online and their motivations behind it. Besides, more evidence-based research is needed to fully understand the consequences of screen-time on children (Scherer and Hatlevik, 2017[127]) Moving beyond the screen

Many concerns focus on the effects of screen-time, but emerging digital technologies are already moving beyond the screen. New devices (embedded with technologies such as Internet of things, virtual reality, artificial intelligence and machine learning) are emerging rapidly. Autonomous technologies (technologies with the ability to function without being told what to do) are becoming more prevalent in children's lives, enabling them to interact with artificial 'peers' that appear to have feelings, narrowing the gap between machines and living things (Druga et al., 2017[131]). These technological developments bring new opportunities as well as risks to children.

Research on children's interaction with social robotic devices is growing. Toddlers (18-24 months) seem to be able to build relationships with robotic devices similarly to those with humans (Tanaka, Cicourel and Movellan, 2007[132]). Kahn et al. (2006[133]) found that preschool children could get emotionally engaged with an advanced robotic pet (AIBO), and that they agreed that the robotic pet had feelings (46%), could not be left alone for a week (74%), and should not be hit (69%). Bernstein and Crowley (2008[134]) found similar results, but noted that it is difficult to determine whether children are responding ontologically (taking into account the technical capabilities of the robot) or psychologically (relying on their own belief about the robot's features) to the questions asked. Children might be aware that robots cannot feel emotions, but still "perceive emotions on a robot's behalf" (Bernstein and Crowley, 2008[134]). Voice, tone and interactive engagement are important features influencing how children perceive and interact with robotic devices (Druga et al., 2017[131]).

As child-robot interaction evolves, artificial 'peers' may become more important in supporting children's development and informal education outside school (Ryokai, Lee and Breitbart, 2009[135]; Barker and Ansorge, 2007[136]). Different studies investigated the effectiveness of social robots on children's learning (Darling, 2015[73]). Artificial buddy Sam, for example, was found to be successful in improving young children's literacy learning. "By taking turns with Sam and by listening to Sam's stories, the children's stories became more sophisticated and explicit through the use of quoted speech and spatial and temporal expressions" (Ryokai, Vaucelle and Cassell, 2002, p. 359[137]). The so-called NAO robot (a humanoid robot) has been successful in engaging children with autism spectrum disorders in communication, socialisation and playful behaviour (Shamsuddin et al., 2012[138]). This shows the potential of robots to support disabled children to participate in society as much as possible.

However, children's growing use of robotic assistants such as Alexa (Amazon) and Siri (Apple) to carry out basic tasks (e.g. to play a specific song or to look something up on the internet) also raises concerns. Because voice recognition devices accept orders

without a "please" or "thank you", parents and educators are worried that digital assistants provoke rudeness in young children (The Guardian, 2017[139]). Rudeness and abusive behaviour towards social robots is not uncommon among children. A Japanese study found that many children misbehaved towards a social robot working in a public place, calling it bad names, blocking its way and even sometimes kicking or pushing it (Brščić et al., 2015[140]). Interestingly, most children did perceive the robot as a human-like entity and did not want to intentionally hurt it, but did so out of curiosity, enjoyment or peer pressure (Nomura et al., 2017[141]). This underlines the importance for parents and educators to teach children societal standards when interacting with robots.

In general, robotic technology designed to stimulate learning and engagement is most effective when anthropomorphic framing is used. Anthropomorphic framing, for example giving a robot a name and a personified backstory, can stimulate users' empathy. Moreover, it can increase user's tolerance for malfunction ("this robot made a mistake" vs. "this dumb robot cannot even do what I am asking for!") (Darling, 2015[73]).

4. Inequalities

4.1. Digital divides

As the world becomes more digitalised, the divide between those who are able to benefit from technological developments and those who are not is growing. Overcoming digital exclusion is a major and complex challenge in which education plays an important role. This section outlines the different aspects of digital divides.

4.1.1. Access, skills, use and motivation

As the digital world is expanding, 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 other ICTs (OECD, 2017[10]). As more people are gaining access, "second-level digital divides"—focusing on inequalities in skills and usage patterns— are becoming increasingly more important (van Dursen and Helsper, 2015[142]).

Digital skills go beyond *only* knowing how to use a computer and Internet technology, and can be classified into four broad categories (Helsper, Van Deursen and Eynon, 2016[143]):

- Operational skills encompass the basic technical skills needed to use the Internet and other computer equipment.
- Information-navigation skills contain cognitive skills needed to search, find and understand information on the Internet and to verify and evaluate sources.
- Social skills relate to the ability to communicate and interact online and build digital social capital.
- Creative skills are the skills needed to create and share quality content online.

Operational and information-navigation skills encompass Web 1.0 activities (e.g. websites, emails and newsletters) while social and creative skills relate to Web 2.0 activities (e.g. blogs, wikis, podcasts and RSS feeds) (Van Deursen et al., 2017[144]). Most digital skills are learned through practice. However, the concept of digital skills changes over time, as new technologies are rapidly evolving. This means that possessing digital skills at a certain moment in time does not guarantee possessing those skills in the future. Skills must therefore not only be acquired, but also constantly updated (UNESCO, 2018[145]).

Children's level of digital skills (i.e. operational, information-navigation and creative) is affected by the quantity and quality of their digital experience. The International Association for the Evaluation of Educational Achievement (IEA) found that one additional year of computer use significantly increased children's digital literacy, and this was in particular the case for less developed countries (e.g. Turkey, Thailand) (Fraillon et al., 2014[146]). Children thus appear to benefit from using digital devices at an early age. This is interesting, given the worries about increasing screen-time for young children. Besides, children with higher levels of safety skills are more likely to be better at critical thinking, which is a valuable digital skill. This indicates that teaching children online safety entails them with other digital skills and thus more opportunities online (Byrne et al., 2016[19]).

Moreover, experience with ICT seems to positively affect students' self-efficacy (i.e. confidence in and perceived usefulness of using technology) (Hatlevik et al., 2018[147]). According to Bandura (1994[148]), self-efficacy is a direct determinant of one's actions and achievements. This means that children with high perceived digital capabilities are more likely to engage in more complex online activities, which may lead to more beneficial offline outcomes (Hatlevik et al., 2018[147]).

Usage patterns refer to the type of activities that people perform online (i.e. information, personal development, social interaction or leisure). Some types of Internet use (e.g. personal development) may lead to more beneficial outcomes than others (e.g. leisure) (Van Deursen et al., 2017[144]). Several socio-demographic variables, such as gender, age, education and Internet experience, contribute to usage differences. Younger children, for example, are less likely to buy products online or search for health information as compared to older users. Similarly, people with higher levels of education are more likely to use the Internet for information and research (Van Deursen and Van Dijk, 2014[149]). Besides access, skills and use, people's attitude towards the Internet and motivation to use ICT should also be taken into account, as these are fundamental to using it. All four digital divide aspects (i.e. access, skills, use and motivation) interact with each other. For example, motivation appears to directly influence access, operational and information-navigation skills and usage diversity (Van Deursen and Van Dijk, 2015[150]).

4.1.2. Offline outcomes

In countries with near-universal Internet access, a "third-level digital divide"—focusing on inequalities in material benefits and outcomes— is becoming more noticeable. The third-level digital divide refers to the idea that equal access, skills and use may not necessarily result in equal offline outcomes. It concerns "disparities in the returns from Internet use within populations of users who exhibit broadly similar usage profiles and enjoy relatively autonomous and unfettered access to ICTs and the Internet infrastructure" showed that among Dutch people with similar usage patterns, individuals with higher social status achieved more beneficial offline outcomes out of Internet use than their

lower-status counterparts. This indicates that the Internet may be seen as a "magnifier of existing offline inequalities", beyond the intensity of Internet use.

4.2. Mediating factors

Digital inequalities are related to contextual factors, such as children's economic, social and cultural status (ESCS), gender and psychological vulnerabilities. These factors have consequences for the opportunities and risks that children encounter online.

4.2.1. Economic, social and cultural status

Digital access is related to students' ESCS: in almost all participating countries in PISA 2012, advantaged students[6] had access to the Internet at home, while among disadvantaged students large differences were observed. In Denmark, Finland, Hong Kong-China, Iceland, the Netherlands, Norway, Sweden and Switzerland, over 98% of disadvantaged students had Internet access at home. However, these percentages were much lower for disadvantaged students in Turkey (50%), Mexico (45%), Jordan (40%), Chile (38%) and Costa Rica (38%) (OECD, 2016[151]). Still, progress has been made: in all countries, the access gap between advantaged and disadvantaged students has been shrinking.

ESCS is not related to the average amount of time students across PISA countries spend online. In 2012, in half of the countries with available data, disadvantaged students even spent more time online than advantaged students. In Belgium, Denmark, Finland, Germany, Hong Kong-China, Iceland, Korea, Norway, Shanghai-China, Sweden, Switzerland and Chinese Taipei, disadvantaged students spent on average 15 minutes more online on a typical day at the weekend in comparison with advantaged students (OECD, 2016[151]).

However, digital skills and use of the Internet is related to students' ESCS. Outside school, disadvantaged students tend to prefer using the Internet for chatting rather than sending emails. They are also less likely to use the Internet to read the news (55%) or to obtain practical information (56%) in comparison with advantaged students (60% and 74%, respectively). Indeed, 93% of advantaged students reported that the Internet is a good resource to obtain information, as compared to 84% of disadvantaged students (OECD, 2017[10]). This might be explained by their often more limited reading and navigation skills, as compared to advantaged students. Interestingly, both advantaged and disadvantaged students are equally likely to play online videogames (OECD, 2016[151]). The EU Kids Online survey also showed that children from wealthier families engaged in a wider range of activities online (Livingstone et al., 2011[7]).

Besides the consumption of ready-made, mass-produced content, the Internet enables children to create their own content online (Livingstone and Haddon, 2009[23]). Content creation can be categorised according to three types: skilled content (e.g. writing a blog, maintaining a personal website, posting writing and other creative content), social and entertainment content (e.g. posting pictures, uploading video or music files) and political content (e.g. sending messages with political or social content, commenting on political

[6] Advantaged students are defined as those students in the top quarter of *the PISA index of economic, social and cultural status (ESCS)*. Disadvantaged students are students in the bottom quarter of ESCS (OECD, 2016[151]).

or social issues online) (Blank, 2013[152]). Blank (2013[152]) found that the type of content created by users is related to their social status. Users with lower status are more likely to produce social and entertainment content, while political content is mostly produced by higher educated users. As political content creation tends to be related to more beneficial offline outcomes, this may increase digital inequalities.

These differences show that even though advantaged and disadvantaged students may have equal access to online resources, this does not necessarily imply equal offline opportunities. Disadvantaged students may not be aware of how to take advantage of technology resources (e.g. MOOCs [Massive open online courses], financial services or job searching platforms) or lack the skills, motivation and engagement required to turn online opportunities into offline opportunities (Hatlevik et al., 2018[147]).

Moreover, Helsper (2017[153]) underlines the importance of quality support from family, friends and teachers. Young people with similar digital access and skills, but with different social support networks and digital environments, tend to have different offline ICT outcomes. A study conducted in the Netherlands found that those who are in most need of digital support (because they experience most problems online) seem to find it most difficult to get quality support, strengthening the digital divide among those who need help in using the Internet and those who do not (Helsper and van Deursen, 2017[154]). In addition, children who lack parental support because their parents do not use the Internet (25%) are more likely to incur harm when they come across online risks (Livingstone et al., 2011[20]). Becker (2013[126]) found that disadvantaged children are more likely to have digitally illiterate parents.

4.2.2. Gender and psychological vulnerabilities

Although there still is a digital gender gap, inequalities related to Internet access and use seem to be declining in most countries. However, there are gender differences in encountering online risk: in general, boys are more likely to come across violent or sexual content online and to give out personal information. This may be explained by the fact that boys prefer different activities online. On the other hand, girls are more likely to become upset after encountering aggressive or pornographic content, online contact with strangers, or receiving sexual messages or requests (Livingstone and Haddon, 2009[23]).

Moreover, boys are more likely than girls to become "extreme Internet users". Factors proposed to explain this difference include the higher percentage of boys playing online games, the higher likelihood of boys developing addiction-related behaviour, as well as boys being targeted by advertisers of potentially addictive applications (Anderson, Steen and Stavropoulos, 2017[155]).

Psychological factors also influence extreme Internet use. Children who experience anxiety, depression, psychological distress or have symptoms of attention deficit hyperactivity disorder (ADHD) or autism spectrum disorder (ASD), are more likely to be "extreme Internet users" (Anderson, Steen and Stavropoulos, 2017[155]). Note that some of these indicators can also be consequences of extreme Internet use. Personal characteristics such as extroversion and neuroticism are also positively related to extreme Internet use. Overall, the EU Kids Online survey showed that children with psychological difficulties[7] encountered more online risks than the average and were more upset about

[7] Psychological differences were measured by the cross-nationally standardised Strength and Difficulty Questionnaire (SDQ) (Livingstone, 2011[200]).

this (Livingstone et al., 2011[20]). Additionally, children who were more digitally confident or seeking sensation were more likely to take contact risks, including meeting new online contacts offline (Livingstone and Helsper, 2013[156]).

With more children going online, closing digital divides is becoming an increasingly important challenge. Although gender differences seem to be disappearing, inequalities in ESCS persist in most countries and greatly influence offline outcomes resulting from Internet use (Livingstone et al., 2011[20]). Therefore, focus must be on all aspects related to digital divides in order to close the gap.

5. Building digital resilience: the role of families and schools

Children are more vulnerable to risks on the Internet in comparison with adults, yet they spend more time online. This raises the need to teach children digital resilience, with both families and schools having an important role in this. What is the level of acceptable risk children should face online? How can children's online vulnerability be protected, without limiting their freedom of expression?

To answer these questions, it is important to keep in mind that risk in itself is not necessarily bad, and that children need to be exposed to risk in order to build digital resilience (Unicef, 2017[16]; Livingstone et al., 2011[20]). One complicating factor is that even though children might encounter similar online risks, they can experience very different outcomes in terms of harm (UNESCO, 2015[157]). Whether outcomes of online activities are beneficial or harmful often depends on the context of a child (Livingstone et al., 2011[20]). Children who are vulnerable offline are more likely to be vulnerable online, as well as being more likely to report harm resulting from online risks (Unicef, 2017[16]; Kardefelt-Winther, 2017[158]).

Despite the fact that relatively few children might actually experience severe harm resulting from online risk, the impact can nevertheless be very significant. Digital access should be guided and children should be made aware of potential online risks. This section discusses the role of families and schools in teaching children digital resilience.

5.1. Families

In 2017, parents of children (aged 5-15) who used the Internet in the United Kingdom were more worried about the time their child spends online (39%) and the content he or she encounters (35%) than in 2015 (29% and 25% respectively). In addition, cyberbullying concerns increased significantly to 40% (from 30% in 2016 respectively) (Ofcom, 2017[159]). Parents and caregivers appear to be more worried about younger children and girls, even though older children and boys are more likely to encounter risks online. Moreover, parental concern regarding their children's safety online seems to be lower among those who use the Internet themselves (Livingstone et al., 2011[20]). Policy measures that encourage Internet use among adults could therefore be effective in reducing parental worries.

Another significant factor affecting parental concern is the media. An analysis of media coverage regarding children and the Internet showed that most press covers risks (64%) rather than opportunities (18%). The most widely covered risks across countries are pornography and cyberbullying (Livingstone et al., 2011[20]). This may lead to a disproportionate focus of public attention and research on online risks rather than opportunities.

5.1.1. Mediating strategies

With children increasingly accessing their digital devices in their bedrooms, parental regulation comes to be more difficult. Yet, as children go online at an ever-younger age, parents and caregivers play a more important role in educating children on technology (Duerager and Livingstone, 2012[160]). Effective mediation decreases the change of children experiencing harm from online risks or becoming "extreme Internet users" (Anderson, Steen and Stavropoulos, 2017[155]; Livingstone and Smith, 2014[91]). Parents and caregivers try to maximise opportunities for their child online while minimising risks, resulting in different parental mediation strategies. 89% of parents in the EU Kids Online survey imposed rules and restrictions, 82% talked with their child about Internet use and online behaviour and 59% reported to stay nearby when their child is online (Duerager and Livingstone, 2012[160]).

According to Livingstone et al. (2017[8]), these actions can be captured into two broad strategies: enabling and restrictive mediation. Parents and caregivers who are relatively digitally skilled are more likely to take an enabling approach to Internet use, providing their child with more online opportunities but also risks. Parents and caregivers with lower digital skills are more likely to adopt restrictive mediation, keeping their child safer from online risks but at the cost of fewer digital opportunities (Livingstone et al., 2017[8]). As modern children need to responsively embrace technologies to benefit from digitalisation, enabling mediation appears to be more suitable and effective (Middaugh, Clark and Ballard, 2017[80]). Initiatives that support parents and caregivers in better understanding technology could help them adapt an enabling mediation strategy. Overall, younger children receive more parental mediation. Besides, girls receive more restrictive mediation as compared to boys. Furthermore, more digitally skilled children perceive less parental mediation.

Besides adopting an active or restrictive mediation approach, parents can monitor what their child does online and/or use technology tools for regulation. Monitoring children's online behaviour is less popular among parents in Europe as compared to other strategies (e.g. imposing rules or talking to the child), most likely as it implies less trust. Only 45% of parents (of 13-16 year olds) had checked which website their child visited and 25% had looked through the text messages on their child's messaging account (Duerager and Livingstone, 2012[160]). Among parents in the United States these numbers were much higher (60% and 48% respectively) (Pew Research Center, 2012[75]). Installing software to prevent spam, junk mail or viruses is the most common form of technical mediation used by parents (75%). Other technical tools, for instance to limit Internet time, to keep track of websites visited or to filter particular websites are significantly less common (Duerager and Livingstone, 2012[160]; Pew Research Center, 2016[161]).

5.2. Schools

Schools play a key role in supporting safe and responsible Internet use. They can contribute to students' online safety in a number of ways. The challenge for schools lies

in its ability to eliminate the negative uses of the Internet and digital devices while maintaining their contributions to teaching, learning and social connection (Subrahmanyam and Greenfield, 2008[51]). Children should be taught how to manage rather than avoid risks online (Middaugh, Clark and Ballard, 2017[80]). This section discusses the best approaches used by schools to support students in their digital use.

5.2.1. School organisation and policies

A whole school approach, where teachers and support staff are able to recognise, respond and resolve online safety issues, is found to be effective in protecting and supporting students in their use of technology (Ofsted, 2014[162]). For such an approach, teacher and support staff engaging in training on online risks and their implications is essential. Trainings therefore should be provided on a regular basis, as digital technology is changing rapidly and it is important for teachers to stay up-to-date with new developments. Parents and students can also get involved to strengthen the school's capacity to deal with online safety issues.

Besides a whole school approach, online safety policies and procedures are important to keep children safe online (Safer Internet Centre, 2018[163]). A survey conducted in the United Kingdom showed that only 5% of schools did not have an online safety policy in place. Yet for those schools that did, students were not always well informed about this: only 74% of students were aware that they had an online safety policy at school. Besides, few students were involved in writing online safety policies (Ofsted, 2014[162]). Listening to children and engaging them in the development of online safety policies is important, as children know best what new risks they are experiencing online.

Effective policies and procedures promote responsible and safe online practise for both students and staff (e.g. children knowing how to report an online safety incident, schools handling students' personal data in a safe and secure manner). Note that good policies are designed to support students' online learning rather than just preventing or limiting access. Policies and procedures should be up-to-date and integrated with other existing policies around anti-bullying, behaviour and safeguarding (Safer Internet Centre, 2018[163]).

Policies and rules to prevent cyberbullying should not be seen separately but rather within the context of traditional bullying. Many studies have showed strong correlations between traditional bullying and cyberbullying (Livingstone, Stoilova and Kelly, 2016[164]; Baldry, Farrington and Sorrentino, 2015[165]). Successful interventions to tackle traditional bullying may therefore also reduce cyberbullying (Livingstone, Stoilova and Kelly, 2016[164]). Effective policies for bullying clearly describe what behaviour is and is not accepted online and at school, and what consequences there are for violating these rules (StopBullying, 2017[166]).

5.2.2. E-safety in the curriculum

Including online safety within the school's curriculum is important for children to become safe and responsible users of technologies (Hinduja and Patchin, 2018[167]). A survey conducted in the United Kingdom showed that 25% of secondary students could not recall "if they had been taught about online safety over the last 12 months" (UK Safer Internet Centre, 2015[168]). Moreover, most schools use assemblies and ICT lessons to provide online safety education, which focus on teaching children functional digital skills and providing them with one-way online safety messages, as opposed to interactive and dynamic pedagogy (Harrison-Evans and Krasodomski-Jones, 2017[169]).

Due to a lack of evaluative evidence, it is unclear how effective such strategies are in supporting positive and safe online behaviour. In addition, there is a growing belief that schools should focus more on teaching children digital citizenship responsibilities. Children with moral and ethical sensitivity are more likely to engage in positive online behaviour, while the contrary is true for children with lower levels of moral sensitivity (Harrison-Evans and Krasodomski-Jones, 2017[169]). Digital citizenship education can support a positive and safe school environment, where children know what behaviour is accepted and what is not (Hinduja and Patchin, 2018[167]). Peer support programmes or mentoring schemes can also be effective in enhancing online safety in schools as peers have a substantial influence on each other. 44% of European 9-16 year olds reported having received Internet safety advice from their friends (Livingstone et al., 2011[20]). Moreover, 78% of 11-16 year olds believe "young people have the power to create a kinder online community" (UK Safer Internet Centre, 2015[170]).

Learning about online safety should include the risks of sexting. Education on sexting (and other online sexual risks) may be included within the school's sex and relationship education (SRE) programme. Best practices in SRE include adopting a 'sex-positive' approach (i.e. acknowledging the pleasures of sex), discussing the importance of healthy relationships and emotions, and incorporating content that relates to the modern world (Pound et al., 2017[171]). These best practices also apply to sexting education. Emphasising social risks (e.g. peer aggression or damaged reputation if an image goes viral) may contribute to ''slut-shaming'' and victim blaming, while focusing on education and career risks (e.g. rejection from educational or career opportunities if image goes viral) may create unnecessary fear as images are rarely uploaded to public websites (Hasinoff, 2012[172]). Instead, educators should focus on harm-reduction strategies that teach children empathy and digital privacy. This could include, for example, a classroom discussion about the benefits and risks of sharing sexy 'selfies'. If children know how to navigate sexual risk and trust they will be less likely to get involved in acts of sexual violation (e.g. forwarding a sexual image of someone without permission) (Hasinoff, 2016[173]).

Box 3. Technology use in classrooms

In order for children to completely benefit from digitalisation, teaching online safety is not enough: schools and teachers need to support children's digital skills development. However, digital technologies are currently used at relatively low-levels in classrooms and mostly to support basic teaching (e.g. using PowerPoint to present a lesson) or replace traditional teaching-learning processes (Gil-Flores, Rodríguez-Santero and Torres-Gordillo, 2017[174]). For example, in 2012, 42% of students used school computers at least weekly to browse the Internet for schoolwork (replacing the activity of offline research), while only 11% did so to play simulations (OECD, 2016[18]). The challenge for teachers lies in using technologies to innovate teaching and education while still maintaining a focus on excellent pedagogy (Paniagua and Istance, 2018[9]).

To meet this challenge, teachers need to be provided with appropriate software and training that provides technological knowledge and teaches them how to incorporate this in their lessons. This is currently not the case on average: ICT skills for teaching is consisted rated as one of teachers' most pressing professional development needs (OECD, 2014[175]). There are some interesting initiatives: Hong Kong has already developed a successful framework for ICT training for teachers of preschool, primary and secondary education (UNESCO, 2018[145]). By the end of 2018, South Korea will have provided training in software education to 60 000 elementary school teachers (30% of the total) (OECD, 2018[22]). For more country specific information on ICT use in classrooms: www.eun.org/resources/country-reports.

5.2.3. School communication with families

With children getting more unlimited and unrestricted access to the Internet and digital devices after finishing their school day, it is important that online safety education continues at home. Therefore it is essential for schools to not only educate children but also parents and caregivers. Parents lacking communication techniques or digital knowledge may respond to safety incidents (e.g. cyberbullying) by taking the phone of the child away. This can prevent potentially harmed children from approaching their parents to seek help (Fenaughty and Harré, 2013[176]). Developing relationships with families is important to build a safe community between home and school. Technology can be used as a tool to improve parent-teacher communication (Choi, 2018[108]). Through online platforms parents can be informed about their child's attendance, performance and behaviour at school (Escueta et al., 2017[177]).

5.3. Peers

Besides seeking help from parents and teachers, children turn to each other when they need support, yet the effectiveness of peer mediation remains little researched (Livingstone et al., 2011[7]). 44% of European 9-16 year olds reported having received Internet safety advice from peers (as compared to 63% receiving advice from parents and 58% from teachers) and 35% reported having given such advice to friends. Practical peer mediation appears to be even more common: 64% received help when they had trouble doing or finding something online (Livingstone et al., 2011[7]).

Peer mediation can positively affect children's digital literacy and the type of activities they engage in online. Mainly through peers, children learn about new opportunities online. However, participating in creative online activities seems to depend less on peer support and more on children's individual priorities (Dinh et al., 2016[178]).

Box 4. Internet safety helplines

Children who seek anonymous support can contact national helplines. Within the Insafe network (consisting of 31 countries), helplines provide children (and to a lesser extent parents and educators) with information, advice and emotional support on online safety issues. Most helplines can increasingly be accessed through diverse means, including telephone, email, Skype, chat rooms and online (Dinh et al., 2016[178])

During the last quarter of 2017, 10 809 people contacted a helpline, 69% of whom were teenagers. Reasons for contacting helplines included cyberbullying (16%), relationships/sexuality (11%), sexting (8%), abuse of privacy (7%) and excessive use (6%) (Better Internet for Kids, 2018[179]). Note that Internet safety helplines do not replace mediation of Internet use practised by parents, teachers or peers. Helplines should rather be seen as a first point of contact for immediate support (Dinh et al., 2016[178])

6. Developing policy

Developing policies that both safeguard and empower children in a digital world is challenging. This section outlines different regulation strategies, as well as effective policy characteristics and recommendations. Also discussed are the gaps in our evidence base about children's lives online that make it difficult to design policies that address risks and make the most of opportunities to benefit all children.

6.1. Regulation strategies

Policy makers are increasingly addressing risks that children are exposed to online. This is either done through re-assessing existing policies or by formulating new policies. A number of OECD countries, including Australia, Canada, Japan and the United Kingdom, have come up with national strategies or policy frameworks concerning children's safety online (OECD, 2012[180]). In addition to national policy frameworks, regional ones have also emerged, for instance the Safer Internet Programme (now referred to as Better Internet for Kids) that was launched in 1999 in the European Union (European Commission, 2013[181]). Policy strategies can include legal, self- and co-regulation, and technical measures, as well as tools to raise awareness and education, and provide positive content and child safety zones (OECD, 2012[180]).

For the majority of risks that exist both online and offline, existing laws and regulations apply and no additional laws are needed. For such risks, most countries enhance general laws so that what is illegal offline also becomes illegal online. For example, a majority of countries have now updated their national regulation regarding child-inappropriate content to include the Internet. In other cases, countries do adopt new legislation. In 2007, a new law was issued in France to make 'happy slapping'—filming and distributing acts of violence online (mostly carried out by youth)—a crime. In the United States, an additional law was adopted in 2003 on misleading domain names online. Some countries (e.g. Australia, France, Ireland, Japan, New Zealand, Norway and the United Kingdom) have issued legislation related to cyber-grooming. In Japan, for example, it is now illegal by law to arrange dates with minors through online dating websites. As technological developments are outpacing legal definitions, countries are increasingly adopting tech-neutral policies, using words such as "in all media" rather than "on the Internet" (OECD, 2012[180]).

An alternative to direct governmental regulation to protect children online is self- and co-regulation or using technologies. Self- and co-regulation measures influence the behaviour of market actors (e.g. search engine operators, social media companies), who voluntarily show social responsibility, through codes of conduct, best practices or industry guidelines. SNSs, for instance, may contribute to online child safety by improving default privacy settings, introducing accessible "report abuse" buttons, or setting age limits for creating user accounts. Technological measures include filtering technologies (to keep children away from certain risks), age or identity verification systems (to prevent children from using specific websites) and walled gardens (to create child safety zones on the Internet). Other used policy tools are awareness campaigns that address online risks and opportunities as well as positive content provision for children. Internet literacy is also increasingly becoming integrated in national educational systems (OECD, 2012[180]).

6.2. Common characteristics of successful policies

Besides protecting children from online harm, policy makers should support children in their digital skill development. UNESCO (2018[145]) compared five international studies on digital skills and identified two types of policies required to obtain an environment where children can successfully develop digital skills. First, policy makers should focus on non-sectoral policies that support a digital environment and second, on sectoral policies related to education. Successful non-sectoral policies include those that improve technological infrastructure, digitisation of businesses and the nature of online content.

Technological infrastructure refers to physical infrastructure and telecommunications networks (e.g. the costs, quality and speed of Internet access) and is essential for developing digital skills. Corporate digitisation also contributes to skills development as education systems tend to adjust their teaching to meet the labour-market requirements. If businesses demand more digital skills, students are more likely to develop these in school. Finally, the richness of online content can be a driver of digital skill development. In larger language communities (e.g. France, Germany, Spain, the United Kingdom and the United States) there is more positive online content for children available in their local language in comparison with smaller language communities (e.g. Czech Republic, Greece and Slovenia) (Livingstone and Haddon, 2009[23]). Those children are likely to have more online opportunities and better digital skills (UNESCO, 2018[145]).

Successful educational policies that foster the development of children's digital skills are those that provide ICT in schools, training for teachers, and support the integration of technologies into school curricula. These strategies should be supported by a wider focus on digital technology within a country. The Republic of Korea and Singapore are good examples of how educational policies can successfully lead to higher levels of digital skills among schoolchildren. The growth strategy of the Republic of Korea includes massive investments in the so-called Smart Education Initiative (SEI) since 2009 to digitalise education. Since 1997, Singapore has an ICT Master Plan for Education that reflects educational policies related to improving children's digital skills. Other countries have adapted educational policies that go beyond teaching children basic technical skills. For example in the United Kingdom, coding is now part of children's compulsory education. Students in Denmark can use the Internet while taking certain school examinations, with the aim of supporting learning to process and critically evaluate content rather than learning by heart. In Norway, all students have to take a national digital skills evaluation test (UNESCO, 2018[145]).

6.3. Considerations for policy development

Even though children nowadays seem to understand technology better than adults do, they need digital guidance on how to use technology in a responsible and positive way. Adults who understand online safety and are able to use technology seem to be more successful in guiding children's digital use. Therefore, it is crucial that parents and teachers receive information on online safety and advice on how to help children manage online risks (Livingstone, Davidson and Bryce, 2017[182]). Schools play an important role in providing such information and training to both parents and teachers. Besides, Internet use among adults should be encouraged, rather than only focusing on younger generations (Livingstone et al., 2011[20]).

Likewise, children need to be stimulated to become content creators and not just receivers (Livingstone, Davidson and Bryce, 2017[182]). The Internet offers many opportunities for creativity and civic engagement. Yet, relatively few children (20%) take up these opportunities (Byrne et al., 2016[19]). Most children still use the Internet for ready-made mass-produced content, such as watching online video clips or listening to music. User-generated content creation is becoming increasingly important for children's self-expression, creativity and civic participation, and should be encouraged both at school and at home (Livingstone et al., 2011[20]). SNSs can be used as a tool to support content creation, as such platforms make it easier to upload and share content online. As empirical research has shown that children's socio-economic background and their level of digital skills are related, special efforts should be made to overcome these inequalities (Hatlevik, Gudðmundsdóttir and Loi, 2015[183]).

It is important to take children's voices into account when developing policies or guidelines concerning Internet use. Children are the most frequent users of digital media and know best what new risks they are experiencing online. Policy makers and education practitioners should therefore actively listen to children and engage them in an ongoing conversion about how to use technologies in a responsible way (Third et al., 2014[184]).

Finally, policy solutions to common challenges should be based on robust evidence. Although seemingly self-evident, this is not always the case, especially regarding current fears that technology is harmful for children (Mills, 2016[185]; George and Odgers, 2015[186]). For example, recommendations of the American Academy of Pediatrics (AAP) regarding screen exposure for 2-5 year olds have been critiqued as misleading and lacking

in evidence (Przybylski and Weinstein, 2017[187]). The AAP recommends parents to limit young children's media use to one hour or less per day (AAP, 2016[188]), despite the fact that there is no empirical evidence that demonstrates that discouraging screen-time for younger children is beneficial (Przybylski and Weinstein, 2017[187]). Policy makers should encourage quantitative and qualitative research, as this is vital to support claims regarding the impact of new technologies on children's behaviour and development (Byrne and Burton, 2017[189]).

6.4. Areas for further research

While many studies have examined the trends as well as the opportunities and risks of digital technologies among children and adolescents, there are still areas of uncertainty. First, more research on younger children is needed. Previous studies and data on children and technology mostly focused on older children and adolescents. It is difficult to understand the effect of technology on younger children (primary school age or younger) without robust evidence-based research covering this specific group (Livingstone et al., 2011[20]). This gap in the evidence base is becoming particularly problematic as children are going online at ever-younger ages.

Secondly, future research should examine online opportunities, rather than only focusing on online risks. Particularly in countries with relatively low Internet use, this gap in evidence tends to be substantial (Livingstone et al., 2011[20]). The Internet provides children with many opportunities related to self-expression, creativity and civic participation (Livingstone, Davidson and Bryce, 2017[182]). Yet, relatively little is known about how children use the Internet and take advantage of these online opportunities.

Although there is substantial research on online risk, certain risks remain little studied or require deepening. For example, research on cyberbullying is growing, but relatively little is known about cyber-bystanders (Livingstone, Mascheroni and Staksrud, 2017[26]). Cyber-bystanders are witnesses of someone else's bullying online, and as cyberbullying often takes place on social network platforms, many children have been in this position. Responses of cyber-bystanders can be very significant and should be examined in future research (Mascheroni and Ólafsson, 2018[29]). Other risks that need further exploration include privacy or personal data abuse, embedded or viral marketing, addiction, self-harm and cyber-hate (Livingstone et al., 2011[20]; Livingstone, Mascheroni and Staksrud, 2017[26]).

Lastly, future research must evolve with technology. Most of the current body of literature focuses on opportunities and risks related to the fixed Internet. However, children increasingly use mobile electronic or smart devices (e.g. Internet of Things devices) to go online and connect, and participate in interactive and peer-to-peer online activities. These trends have significant implications for parental mediation, privacy and online safety awareness, yet are still to be explored through research.

7. Conclusion

Internet use among children is increasing: children spend more time online and start using digital devices at ever-younger ages. At the same time, children's online access is becoming "more personal, more private and less supervised" (Unicef, 2017, p. 64[16]). The Internet provides children with many opportunities, yet it does not come without risks.

Although risks do not necessarily result in harm, it is important to understand what can potentially cause harm to children online. Despite increased Internet accessibility and use, socio-economic disparities persist among children (Livingstone, Mascheroni and Staksrud, 2017[26]). Overcoming digital inequalities is a major and complex challenge in which education plays an important role. With more children going online, the necessity for both families and schools to teach children digital resilience increases.

Developing policies that both safeguard and empower children in a digital world is challenging. OECD countries have adapted different strategies regarding the use of new technologies for children and some examples of good practice and policy have been identified. Effective policies encourage children to become active rather than passive technology users, but also support parents and educators in their Internet use. There are a number of areas in which more evidence is needed in order to be able to develop policy solutions to common challenges. For example, future research should consider covering younger children (primary school age or younger) as well as examining the effects of new emerging technologies.

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