



# The outcomes of gaining digital skills for young people's lives and wellbeing: A systematic evidence review

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## Abstract

Research and policy have invested in the prospect that gaining digital skills enhances children's and young people's outcomes. A systematic evidence review of research on digital skills among 12- to 17-year-olds identified 34 studies that used cross-sectional survey methods to examine the association of digital skills with tangible outcomes. Two-thirds concerned the association with online opportunities or other benefits. Another third examined online risks of harm. Findings showed a positive association between digital skills and online opportunities, information benefits, and orientation to technology. Greater digital skills were indirectly linked to greater exposure to online risks, although any link to harm was unclear. While technical skills were linked with mixed or even negative outcomes, information skills were linked with positive outcomes. There was little research on the outcomes of communication or creative digital skills. Future research should examine the dimensions of digital skills separately and encompass a wider range of outcomes.

## Keywords

Children and young people, digital skills, online opportunities, online risks, skill dimensions, systematic review, tangible outcomes, wellbeing

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## Introduction

The United Nations (UN) agency responsible for global measurement of the adoption of information and communication technologies (ICTs), the International Telecommunication Union (ITU), defines digital skills for the global population in terms of their putative outcomes: ‘the ability to use ICTs in ways that help individuals to achieve beneficial, high-quality outcomes in everyday life for themselves and others’ and that ‘reduce potential harm associated with more negative aspects of digital engagement’ (ITU, 2018: 23). In this, it serves the multiple and diverse interests of its members (most countries and many public and private sector stakeholders) who seek to thrive and compete in the digital age, including delivering the UN’s Sustainable Development Goals (SDGs). Reflecting this emphasis, the European policy agenda regarding the adult population is strongly outcomes focused (European Commission, 2016; Grizzle et al., 2013; Helsper, 2021; Morandini et al., 2020; Van Dijk and Van Deursen, 2014; Vuorikari et al., 2016), but policies around the world vary. Accordingly, researchers are examining whether and how gaining digital skills can help implement e-government initiatives, reskill workers for a changing labour market, promote domestic adoption of digital consumer goods and services and, most recently, support citizens in locating and evaluating trustworthy information (political, health and financial).

At the same time, many hopes are pinned on children and young people as a generation supposedly keen to learn about all things digital, as well as in need of digital skills to succeed in the ‘jobs of the future’ (European Commission, 2021b; Kiss, 2017; Organisation for Economic Co-operation and Development [OECD], 2018). Conveniently, they are also easier to reach with educational interventions than the general population (Cortesi et al., 2020), facilitating gains in digital skills, benefitting real-world outcomes and providing the means to target digital skills interventions on disadvantaged populations. Attention to young people adds some specific questions to the digital skills agenda – encompassing their particular motivations (such as to pursue creative or communicative opportunities; see Vaikutytė-Paškauskė et al., 2018), or the mediating role of parents and schools in the development of resilience to online risks of harm (O’Neill, 2013).

However, notwithstanding governmental and other efforts to embed digital skills and literacies in the school curriculum and promote digital learning at home, it is hard to locate clear expectations or an established evidence base that links children’s digital skills with outcomes (Livingstone et al., 2018) or evaluates whether expectations are met (Bulger and Davison, 2018). Although rarely specified in detail, the outcomes of gaining digital skills are most commonly discussed in relation to anticipated educational or employment-related benefits, as well as online safety, digital citizenship, ‘21st-century skills’ or ‘life skills’ (Buckingham, 2015; Davies and Eynon, 2018; Livingstone et al., 2019; Nascimbeni and Vosloo, 2019; Third et al., 2019; Van Laar et al., 2017).

Theory development is more advanced when it comes to the general population, with a notable focus of attention on the specific and tangible outcomes of gaining digital skills (Helsper et al., 2015; Van Deursen and Helsper, 2018). Conceptualized as the ‘third-level digital divide’, researchers propose that digital inequalities involve more than a binary opposition between those who do or those who do not have access to the Internet (the ‘first-level digital divide’), and also more than the promotion of digital skills (the

‘second-level digital divide’; see Hargittai, 2002). Indeed, promoting access and skills without attention to outcomes can reproduce social inequality and exacerbate prior exclusion (Van Deursen and Van Dijk, 2014). Specifically, whether concerning education, work, health or other areas, what matters is that individuals have the resources to deploy digital skills in ways that bring about tangible outcomes that benefit them (Van Deursen and Helsper, 2018).

By contrast with adults, where the starting point is assumed to be digital ignorance, children and young people are often assumed to be ‘digital natives’, a problematic implication being that young people will ‘pick up’ the digital skills they need spontaneously, without the need for resource-intensive interventions. Researchers had to dismantle this myth by showing that not only might young people lack valuable skills, but also that they may struggle to translate these into tangible outcomes, especially in situations of socio-economic disadvantage (Helsper and Eynon, 2010). Problematically for those promoting the digital skills agenda, research also found that the more children engage in online activities, gaining digital skills and enjoying the opportunities to benefit, the more they are likely to encounter some risk of harm (Helsper and Smahel, 2020; Livingstone et al., 2017). This raises the pressing question of whether digital skills can play a role in optimizing beneficial outcomes while minimizing rather than amplifying harmful ones (Livingstone et al., 2018).

A recently completed systematic evidence review identified the predictors and outcomes of digital skills among 12- to 17-year-olds (Haddon et al., 2020). This age group was selected due to its key relevance to digital skills curriculum development (European Commission, 2021a; Polizzi, 2020) and to inform forthcoming longitudinal research on children’s digital skills in Europe (Haddon et al., 2020). The evidence review revealed a plethora of approaches to the conception and measurement of digital skills, with some researchers conceiving of multiple dimensions of digital skills while others focused on particular dimensions, such as information literacy or computer programming. Adding to the complexity, these dimensions are inconsistently labelled, mixing digital activities (where the underlying skills are implicit but not measured, as in ‘I do X online’), digital self-efficacy (typically measured as claimed confidence, as in ‘I am good at X online’) and digital skills (typically measured as the self-reported ability to undertake specified digital tasks, as in ‘I know how to do X online’; see Helsper et al., 2021).

This article builds on the systematic evidence review to identify clearly the range of outcomes from gaining digital skills, and to explore the nature of the relationship between digital skills and outcomes. After screening out studies where the definition of digital skills was unclear or inconsistent, we added a new step by coding the dimensions of digital skills measured in each study to discover whether these dimensions are differently linked to particular outcomes. We used the four-dimension classification of digital skills identified in a recent analysis of the wide array of different measures commonly used within the youth literature (Helsper et al., 2021; Van Dijk and Van Deursen, 2014). Distinguished through analyses of skewness and kurtosis, confirmatory factor analysis, difficulty estimation and equivalence testing, and validated through cognitive interviews and pilot surveys, the four dimensions are defined in Table 1. Each dimension encompasses functional subskills and digital knowledge (or critical literacy), and all are important for wellbeing in a digital society (Helsper et al., 2021; Mascheroni et al., 2020).

**Table 1.** The four dimensions of digital skills.

Dimension	Description
Technical and operational skills ('Tech')	The ability to manage and operate ICTs and the technical affordances of devices, platforms and apps, from 'button' knowledge to settings management to programming
Information navigation and processing skills ('Info')	The ability to find, select and critically evaluate digital sources of information
Communication and interaction skills ('Comm')	The ability to use different digital media and technological features to interact with others and build networks as well as to critically evaluate the impact of interpersonal mediated communication and interactions on others
Content creation and production skills ('Create')	The ability to create (quality) digital content and understand how it is produced and published and how it generates impact

Source: Adapted from Helsper et al. (2021: 15).

They can also be combined to generate more complex skills – for instance, the skills required for problem-solving online, or to protect one's privacy or safety online, participate in civic activities or cope with harmful experiences.

We formulated the following three research questions of significance for research and for policy and practice:

*RQ1.* What are the outcomes of young people's digital skills?

*RQ2.* Can the different dimensions of digital skills be linked to distinct outcomes?

*RQ3.* How does the research literature explain the outcomes of digital skills?

## Methods

We conducted a systematic evidence review (Gough et al., 2012; Grant and Booth, 2009; Sutherland, 2004) following the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocol (PRISMA-P) guidelines (Moher et al., 2015). The search protocol was registered on (repository and registration number anonymized) and designed to be comprehensive in its coverage of relevant databases and search terms, consistent in its application of the same search word strings across databases, and efficient in minimizing the number of irrelevant results.

The search involved two international research database aggregators, Web of Science and Scopus, supplemented with six specialized databases: International Bibliography of the Social Sciences, Communication and Mass Media Complete, ERIC, PsychINFO, Embase and SocINDEX. It was applied based on titles, keywords and abstracts to English language publications in the decade from January 2010 to January 2020 (when the search process began).

Four groups of search terms were selected, drawing on consultation with relevant experts and test searches of several databases: (1) child terms (to identify research with children and young people); (2) method terms (to identify empirical studies); (3) technology terms (to ensure relevance to the digital environment); and (4) skill terms (to match the focus of the review). Groups 3 and 4 were searched jointly using all possible combinations (e.g. 'digital\* skill\*', 'mobile\* competen\*', etc.; for a detailed description of the methodology, see Haddon et al., 2020). The final search string took the form: child terms AND methods terms AND a digital skill phrase (digital term + skill term).

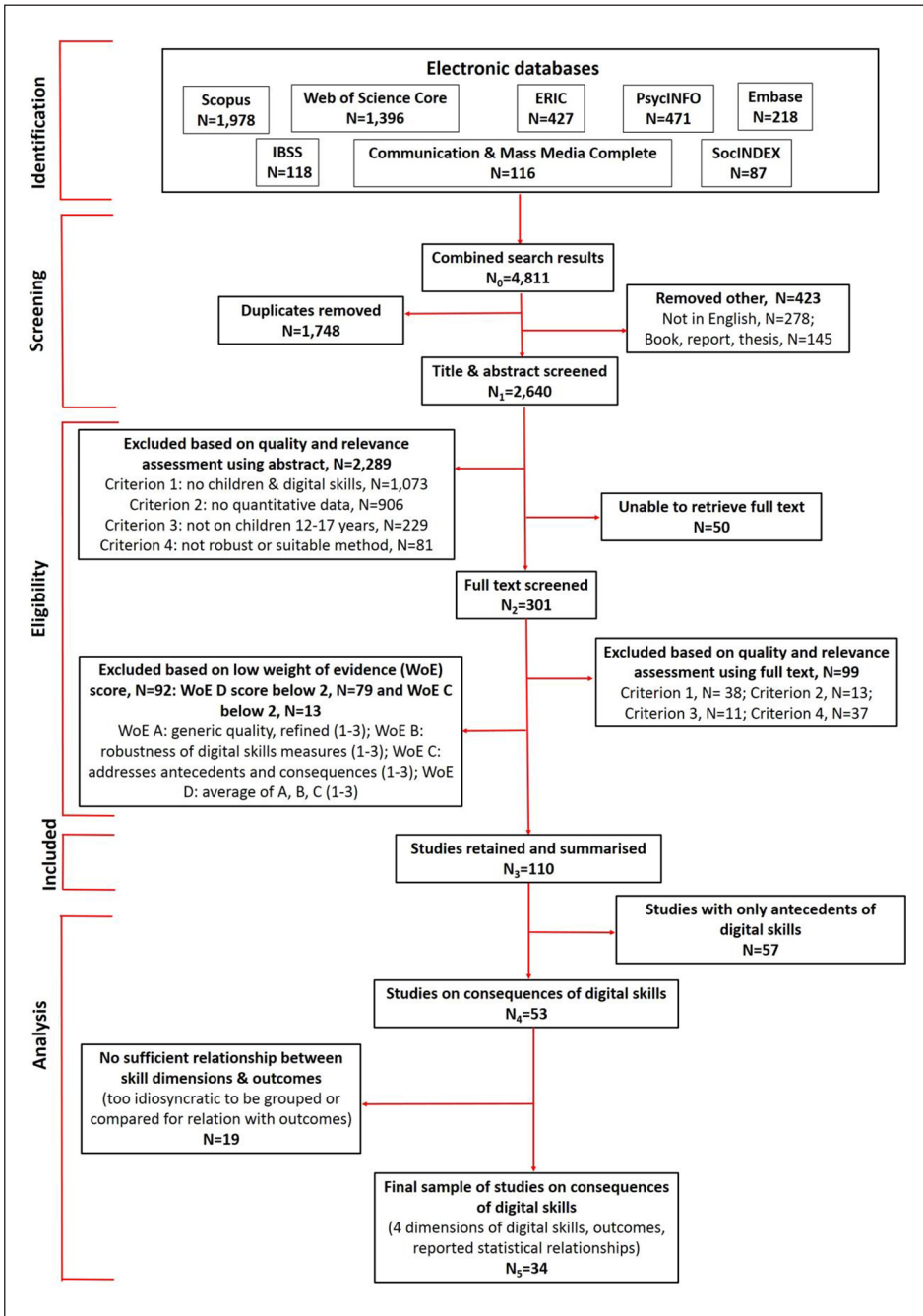
The initial 4811 search results (shown as  $N_0$  in Figure 1) were screened for duplicates, non-English sources and non-peer-reviewed publications, leaving 2640 studies to be screened for eligibility ( $N_1$ ). Screening for eligibility was based on the article title, abstract and keywords according to four criteria applied in the following order: (1) studies of children's digital skills, (2) using quantitative methods, (3) with children aged 12–17, and (4) sufficient methodological rigour (e.g. small sample surveys or pilot studies were excluded). This left 351 studies to be read in full, of which full text was available for 301 ( $N_2$ ). A further 99 did not meet the above four criteria based on reading the full text.

The remaining 202 studies were evaluated using a weight of evidence (WoE) framework. This assessed the following:

- (a) Quality of the research methods: a global assessment based on such features as controls for confounding associations, randomized representative sampling, longitudinal designs, approach to testing hypotheses and whether reporting distinguishes children from adults or by age group.
- (b) Capacity to answer the review question: whether the definition of digital skills distinguished among dimensions (e.g. information, social, technical) and whether each was measured with reliability and validity; whether there is a model which explains how the dimensions fit together.
- (c) Relevance for the review question: this was operationalized in relation to how the study specifically generated evidence on the predictors or outcomes of digital skills.

Each study was given a score of 1=poor, 2=fair and 3=good for criteria a, b and c, and then assigned an average score (D) between 1 and 3. This resulted in 92 exclusions (average WoE score below 2), leaving 110 ( $N_3$ ) empirical studies to be coded for evidence regarding the predictors and outcomes of skills.

Of the 110 studies, 53 ( $N_4$ ) included the outcomes of having digital skills (the remainder concerned predictors of digital skills only and are not considered here). These studies were coded according to the dimensions of digital skills measured (technical, information, communication and creation skills) and their relationships with outcome measures. Those studies that did not include clear information about the relation between skills and outcomes were excluded. So, too, were studies that, while they described themselves as concerning digital skills, used a global self-efficacy measure (e.g. Yu et al., 2018), inferred digital skills from a measure of online behaviour (e.g. Khan et al., 2014) or other



**Figure I.** Flow diagram of the screening and quality appraisal process.

measures (e.g. treating attending lessons on digital media as a proxy for skills; see Kahne and Bowyer, 2019). Also excluded was one study where the country and not the individual was the level of analysis (Picatoste et al., 2018). This left 34 studies for analysis ( $N_5$ ). These 34 studies were relevant and of high quality, with WoE scores between 2 and 3: 2 ( $n=6$ ); 2.33 ( $n=9$ ); 2.66 ( $n=12$ ) and 3 ( $n=8$ ; see Table 2).

Note that all 34 studies were based on surveys, although three also included performance (or task-based assessment) tests. This has two consequences. First, digital skills tend to be measured using self-report. Just three studies used performance tests (see Table 2). Social desirability biases can be addressed in part by question phrasing (Helsper et al., 2021 v). It was for this reason that we paid particular attention to the measures used, selecting only the more robust (as explained earlier). Beyond this, we can only observe the preference of researchers in this field for self-report measures over performance tests. Haddon et al. (2020) observe that this is particularly the case in researching outcomes rather than predictors of digital skills, adding that where both methods are used, the results tend to concur except in relation to gender (where boys claim more skills in self-report surveys).

Second, although our focus is on the outcomes of digital skills, with the studies selected based on their authors' positioning the measured factors as outcomes, caution is required as they do not actually test causal relationships. Rather, all used a cross-sectional research design, reporting correlations that could potentially be interpreted as bidirectional or reversed, or according to plausible but generally untested confounding factors. In what follows, we first examine the associations between measures of digital skills and their claimed outcomes. In interpreting the findings, we paid attention throughout to the specific age groups studied, and the country in which data were collected (shown in Table 2). We could not, however, discern any systematic relationships that might confound the results reported below. We again attend to demographic and other variables when we examine more closely the studies that constructed statistical models from predictors to outcomes, to see whether multivariate analysis can offer further nuance to the understanding of how digital skills relates to outcomes.

## Results and discussion

### *The outcomes of digital skills for children and young people*

In answer to RQ1, approximately two-thirds of the studies examined the association between digital skills and online opportunities and other benefits, while another third examined online risks of harm. The results summarized in Table 3 are discussed below.

**Online opportunities.** The breadth of digital activities is considered an important measure of digital and social inclusion. Some studies measured a broader set of activities (#12, #21, #27, #50, #79) while others took a more specific focus (#6 on social activities, #10 on creative activities). In all studies, the association with digital skills was positive: greater digital skills are associated with more online activities. Since these studies include a diversity of different measures of both skills and opportunities, the absence of null or contradictory findings suggests a consistent and robust result. The evidence offers empirical support for the promotion of digital skills by policy programmes, education



**Table 2.** The 34 studies on outcomes of youth digital skills.

Study	Reference	Research methods	Country of data collection
6	Areepattamannil and Khine (2017)	Survey of 56,209 13- to 16-year-olds (WoE: 3)	20 high-income countries around the world
10	Balea (2016)	Secondary analysis of a survey of 595 11- to 16-year-olds (WoE: 2)	Romania
11	Bernadas and Soriano (2019)	Survey of 300 11- to 25-year-olds (WoE: 2.33)	Philippines
12	Cabello-Hutt et al. (2018)	Survey of 1694 9- to 17-year-olds (WoE: 2.66)	Brazil
13	Christoph et al. (2015)	Survey and performance test of 445 14- to 17-year-olds (WoE: 2.66)	Germany
19	Eynon and Malmberg (2012)	Survey of 669 12-, 14- and 17- to 19-year-olds (WoE: 2.66)	UK
21	Fizeşan (2012)	Survey of 1609 9- to 16-year-olds (WoE: 2.66)	Romania, Bulgaria
27	Helsper and Eynon (2013)	Secondary analysis of a survey of 2057 14-year-olds and above (WoE: 3)	The United Kingdom
32	Kaarakainen (2019)	Survey and performance test of 3206 15- to 22-year-olds (WoE: 3)	Finland
41	Kim and Yang (2016)	Survey of 238 16- to 17-year-olds (WoE: 2)	South Korea
43	Kumazaki et al. (2011)	Survey of 4308 6- to 18-year-olds (WoE: 2.33)	Japan
46	Leung and Lee (2012a)	Survey of 718 9- to 19-year-olds (WoE: 2.66)	Hong Kong
47	Leung and Lee (2012b)	Survey of 718 9- to 19-year-olds (WoE: 2.66)	Hong Kong
49	Lin et al. (2019)	Secondary analysis of a survey of 11,997 15-year-olds (WoE: 2)	Singapore, Finland

(Continued)



**Table 2.** (Continued)

Study	Reference	Research methods	Country of data collection
50	Livingstone and Helsper (2010)	Survey of 789 10- to 19-year-olds (WoE: 2.66)	The United Kingdom
55	Mannerström et al. (2018)	Survey of 932 17- to 18-year-olds (WoE: 2.33)	Finland
60	Metzger et al. (2013)	Survey of 2747 11- to 18-year-olds (WoE: 2.66)	The United States
62	Moon and Bai (2020)	Survey of 2584 13- to 18-year-olds (WoE: 2)	South Korea
63	Neumark et al. (2013)	Survey of 7028 12- to 19-year-olds (WoE: 2.33)	Israel
65	Notten and Nikken (2016)	Survey of 8554 14- to 16-year-olds (WoE: 2.33)	25 European countries
79	Rodríguez-de-Dios et al. (2018)	Survey of 1446 12- to 18-year-olds (WoE: 3)	Spain
82	Santos et al. (2019)	Survey of 808 12- to 17-year-olds and above (WoE: 3)	Portugal
83	Scherer et al. (2017)	Survey and performance test of 2426 14- to 16-year-olds (WoE: 2.66)	Norway
86	Schorr (2019)	Survey of 134 14- to 18-year-olds (WoE: 2)	Germany
88	Shin et al. (2012)	Survey of 381 9- to 12-year-olds (WoE: 2.33)	South Korea
90	Sonck and de Haan (2013)	Survey of 19,406 11- to 16-year-olds (WoE: 3)	25 European countries
94	Staude-Müller et al. (2012).	Survey of 9760 10- to 15-year-olds (WoE: 2)	Germany
95	Teimouri et al. (2018)	Survey of 420 9- to 16-year-olds (WoE: 3)	Malaysia

(Continued)

**Table 2.** (Continued)

Study	Reference	Research methods	Country of data collection
96	Tirado-Morueta et al. (2017)	Survey of 3754 16- to 18-year-olds (WoE: 3)	Ecuador
99	Vandoninck et al. (2010)	Survey of 815 15- to 19-year-olds (WoE: 2.66)	Belgium, (Flanders)
100	Vandoninck et al. (2013)	Survey of 25,142 9- to 16-year-olds (WoE: 2.33)	25 European countries
101	Wegmann et al. (2015)	Survey of 334 14- to 29-year-olds (WoE: 2.66)	Germany
102	Weston et al. (2019)	Survey of 494 14- to 18-year-olds (WoE: 2.66)	The United States
110	Ziya et al. (2010)	Survey of 4942 15-year-olds (WoE: 2.33)	Turkey

WoE: weight of evidence.

All studies used self-reported digital skills measures; some also used performance tests.

curricula and parental investment, all aiming to provide children and young people with the digital skills that support diverse forms of digital engagement, bringing direct benefits and encouraging the development of additional digital and life skills. Previous research has hypothesized that online activities are ranked in terms of accessibility and appeal, such that children first gain basic skills by beginning with everyday activities (e.g. watching videos or playing games online). Then, as they gain skills, they progress up the so-called ladder of online opportunities towards more complex activities, such as creative content creation and civic participation (Livingstone et al., 2019). However, we found a little research examining which activities were mainly linked to gaining digital skills or the order in which they were undertaken.

**Informational benefits.** Particularly in relation to informational benefits, studies made discernible efforts to match the dimension of digital skill to relevant learning outcomes. For instance, study #19 found that children's ability to seek information online predicted seeking online information for homework (although not for more everyday life purposes). In study #60, children with better Internet skills were found to think more often about information credibility and, possibly in consequence, more likely to believe that the information they find online is credible. Relatedly, study #96 found that having greater information and evaluation skills benefitted children's academic performance. The authors also found that information skills are supported by operational information skills, suggesting a learning pathway from access through operational skills to information skills and thence to

**Table 3.** Types of outcomes of digital skills.

Outcomes	Studies	Summary of measures used
Online opportunities	6, 10, 12, 21, 27, 50, 79	Number/range of online opportunities such as commenting, communication, gaming, schoolwork, information-seeking, listening to music, content creation
Informational benefits	19, 60, 63, 83, 96	Orientation to/activities relating to information-seeking online, computer information literacy
Orientation to technology	13, 32, 86, 102	Motivation to use computers, better performance in computer tasks, interest in pursuing a career in ICTs
Academic grades	46, 82, 110	Measures of academic grades
Coping behaviours	11, 100	Online privacy protection behaviour; adoption of proactive responses to online risks
Civic participation	41, 62	Interest in political issues and engagement in civic and political participation on- and offline
Miscellaneous benefits	49, 55	Environmental awareness and interest; life satisfaction
Online risks of harm	12, 43, 46, 47, 50, 65, 79, 88, 90, 94, 95, 99, 101	Exposure to potentially harmful content, contact, conduct and contract risks; excessive internet use; willingness to disclose personal information

ICT: information and communication technology.

A few studies appear in more than one outcome category (#46, 79).

creativity and improved academic grades. Study #63 focused on seeking health information as an outcome, again finding a positive association with digital skills. Somewhat puzzlingly, since its methods included performance testing, study #83 found no relation between basic or advanced digital skills and a standard educational measure of ‘computer information literacy’.

*Orientation to technology.* While research has shown that young people with better access to ICTs at home or school, or with more positive attitudes towards ICTs, have greater digital skills (Haddon et al., 2020), fewer studies ask whether greater digital skills are linked to a more positive orientation to technology. Four studies (#13, #32, #86, #102) found that technology skills bring such benefits, albeit in ways that are differentiated by

gender. Two of these studies measured digital skills using performance tests: study #13 found that greater digital skills are associated with interest and competence in using computers; study #32 found that 'the likelihood of students choosing the ICT field increased significantly along with greater competence in both medium-related skills and programming skills' (Karakainen, 2019: 120). In study #86, like most other studies based on a self-reported measure of digital skills, the association found between greater computer skills and ICT-related career aspirations is stronger for girls than boys. The authors suggest that gaining digital skills, including through educational interventions, can partially compensate for gendered socialization practices that tend to dissuade girls from such aspirations. Study #102, relatedly, shows how improving young women's technical digital skills improves their chance of persisting in computer science and technology-related majors.

*Academic grades.* A primary rationale for educating children to improve their digital skills is to enhance their learning outcomes. Arguing that digital skills today are akin to reading, writing and arithmetic – the so-called fourth 'R' of basic literacy – schools increasingly include digital skills in the curriculum. Therefore, it is surprising that we identified only three studies that addressed the relation between digital skills and learning outcomes (#46, #82, #110). The results were equivocal. In studies #46 and #82, greater digital skills were associated with better academic grades, albeit varying by the dimension of digital skills (as discussed later). One study mainly found negative results, suggesting that greater programming skills can undermine children's mathematical ability (#110) – here, the authors suggested that adverse outcomes arise when the skills are both time-consuming to learn and unrelated to the desired learning outcome.

*Coping behaviours.* Given the prevalence of online risks in children's everyday experience, a few studies inquired into how children and young people cope with actual or potentially harmful experiences (Dodge et al., 2012). Digital skills were positively linked to coping behaviours online (such as privacy behaviour, deleting unwelcome messages, blocking senders – studies #11 and #100). For example, study #100 showed that more digitally literate children were more likely to delete messages and block senders when experiencing cyberbullying or unwelcome sexting. Moreover, children with fewer skills were more upset and less able to cope with sexual images and cyberbullying. Indications that skills can support better coping with risk surely merit further exploration.

*Civic participation.* Both the policy agenda and academic debate anticipate that Internet use facilitates youth participation in community, civic and political life (Cortesi et al., 2020), even countering young people's declining political participation (Loader et al., 2016). Two studies (#41, #62) examined this relationship, and the results were complex. In study #41, 'Internet information literacy' was significantly and positively associated with measures of alternative participation (such as boycotts, rallies and joining online campaigns) and with political efficacy but was not associated with institutional participation (such as voting, civil complaints or visits to government websites). Furthermore, 'Internet skills literacy' measures were unrelated to participation and negatively related to political efficacy. Study #62 reported a positive relationship between digital skills and

online civic engagement activities but mediated by interest in the news. Such findings hint at a promising direction for future research, namely, identifying factors (of digital or non-digital nature) mediating between digital skills and participation outcomes.

*Miscellaneous benefits.* Completing the picture for beneficial outcomes, we note that study #49 found a positive association between digital skills and environmental awareness in Singapore but not in Finland, and study #55 examined the relationship between digital skills and life satisfaction, finding none.

*Online risks of harm.* Children and young people's exposure to potentially harmful online content, contact, conduct or contract risks attracts attention from researchers, policy-makers and the public alike (Livingstone et al., 2018). Many call for digital skills education to build children's resilience to mitigate online or offline vulnerability to risks of harm, as well as to encourage their coping behaviours, as discussed earlier. However, does gaining digital skills act as a protective factor, reducing experiences of harm? Thirteen studies addressed this question. As with online opportunities, a standard method is to count how many and how often children have encountered a wide range of different risks. Other studies tend to focus their attention on just one or a few risks.

Taking the former approach, studies #47, #79, #88, #95 and #99 reported a broadly positive association between digital skills and online risks, suggesting that greater digital skills are related to more online risks being encountered, with some qualifications (e.g. study #47, as discussed below). Study #43 also found a positive association, focusing on the perpetration of cyberbullying among secondary school students. In study #88, greater digital skills were linked to a greater willingness to disclose personal information than adopt more self-protective behaviour. The authors suggest that more digitally skilled young people explore more widely online, encountering opportunities that require information disclosure as well as more online risks. Furthermore, the main finding of a positive association between skills and risks may arise because, as discussed earlier, more skills are linked to more online opportunities (as discussed in studies #12 and #50), including risky opportunities (such as looking for new friends online, sending personal information or photos, adding 'strangers', pretending to be someone else; see Livingstone, 2008, 2013); as shown by studies #95 and #65.

Study #90 not only found a positive link between digital skills and online risks but also that children with more skills reported less harm after exposure to risks compared with less skilled children. However, this finding disappeared when statistical controls were applied, and the overall variance explained was low even with individual and country factors included in the statistical model. Study #94 pursued the theme of harm, finding that more digitally skilled young people experienced less distress (such as feeling frightened or depressed) after online victimization. The possibility that gaining digital skills might reduce harm while not restricting children's online experiences needs further testing.

Two studies considered Internet 'addiction', with contradictory findings. Study #46 found a complex but broadly positive association, with particular outcomes (preoccupation, withdrawal, loss of control) correlated with particular dimensions of digital skills. Study #101 finds the reverse: greater digital skills reduced the negative consequences of excessive social media use. The authors suggest a link between digital skills and self-regulation in the digital environment, which seems worthy of further investigation.

### *The relationships between the dimensions of digital skills and outcomes*

The outcomes of children's and young people's digital skills appear complex, encompassing both positive and negative relationships. While the public expectation is that gaining digital skills enables young people to minimize the risks and optimize the benefits of Internet use, facilitating overall wellbeing (Dienlin, 2020; Ryff, 1989), the evidence suggests that it results in both online opportunities and risks. Given the diversity of digital skills measures employed in the literature, RQ2 asked whether a more nuanced picture could emerge if we examined outcomes according to specific dimensions of digital skills.

This inquiry was impeded by the common practice of combining separate measures into a composite score before statistical analysis. In Table 4, the shaded studies were most useful because they examined either a single dimension of digital skills or the separate associations of multiple skills dimensions.

Ten studies, including two that used performance tests (#13, #32), examined technical and operational ('Tech') skills separately from other skill dimensions. The results are mixed, with as many apparently undesirable as beneficial outcomes. Specifically, these skills were associated with a positive orientation to technology (#13, #32) and online opportunities (#27), but also more online risk (#46, #47). They were unrelated to life satisfaction (#55) or civic participation (#62), even showing a negative link to civic participation (#41), and either a positive (#46) or negative (#110) link to academic grades.

The seven studies examining the distinctive associations of information skills found them to be generally linked with beneficial outcomes. They were linked to more civic participation (#41), online opportunities (#27), higher academic grades (#46, #110) and more information-seeking for homework (although not everyday life information needs; #19); and to reduced online risk (#47) and more privacy-enhancing behaviour online (#11). Finally, they were unrelated to online addiction (#46).

While communication skills appear rarely to be examined separately, the evidence suggests positive outcomes – on online opportunities (especially social engagement; #27) and coping with online risks (#101), although there was no association on academic grades (#110). The results from the few studies of creative skills were mixed: positive associations on online opportunities (especially creative engagement; #47) but also increased online risk (#46, #47) and a null (#46) or negative (#110) association with academic grades.

It is harder to conclude from the studies that construct a composite skill measure, as we cannot know if the different skill dimensions work additively or interact somehow. Two studies grouped information, communication and creative skills into a single measure, finding a positive relationship with civic participation (#62) and no relation to orientation to technology (#32). All other measured combinations included technical skills together with one or more of the others. This decision appears unwise given the mixed profile of outcomes linked to technical skills.

Eight studies combined technical and information skills, finding both a positive association with online opportunities (#12, #21, #50, #63), information benefits (#62) and academic grades (#82), as well as greater online risk (#12, #65, #88). A more consistent and positive pattern is observed from the combination of technical, information and

**Table 4.** Outcomes of digital skills, by dimensions of digital skills measured.

Study	Dimensions of digital skills	Outcomes	Association
13	Tech	Orientation to technology	Positive statistical association – more motivation/interest in computers, also better computer performance
49	Tech	Miscellaneous benefits	Positive association in one country tested but not significant in the second – more environmental awareness
55	Tech	Miscellaneous benefits	No significant association with life satisfaction
41	Tech + info (tested separately)	Civic participation	Negative association with Tech skills but a positive association with Info skills – more civic and political participation activities
46	Tech + info + create (tested separately)	Online risks of harm Academic grades	Positive association with Tech skills and Create but not Info – linked to more online addiction Positive association with Tech and Info but not Create skills and better academic grades
47	Tech + info + create (tested separately)	Online risks of harm	Positive association with Tech and Create skills, and negative association with Info and greater exposure to online risk
27	Tech + info + create + comm (tested separately)	Online opportunities	Positive associations between all four dimensions and online opportunities, although weaker for Tech and Info skills than for Create and Comm skills on social and creative digital engagement; also, Comm skills were more strongly linked to social engagement and Create skills to creative engagement outcomes
110	Tech + info + create + comm (tested separately)	Academic grades	Positive association of Info and negative association of Tech and Create skills with better maths scores, though not significant for Comm

*(Continued)*



**Table 4.** (Continued)

Study	Dimensions of digital skills	Outcomes	Association
19	Info	Informational benefits	Positive association of Info with online information-seeking for homework; no association with online information-seeking in everyday life
11	Info	Coping behaviours	Positive association – more privacy-enhancing behaviour online
101	Comm	Online risks of harm	Positive association – on ability to regulate own behaviour and cope with risk online
32	Tech skills tested separately from Info; Comm and Create skills (combined)	Orientation to technology	Positive association of Tech skills only – more likely to want a job in ICTs in the future, especially for boys
62	Tech skills tested separately from Info; Comm and Create skills (combined)	Civic participation	Positive association for the combined score only – more civic outcomes, but not significant for Tech skills
12	Tech + info (combined)	Online opportunities Online risks of harm	Positive association – more online activities Positive indirect link – more online risks (through opportunities)
21	Tech + info (combined)	Online opportunities	Positive association – more online activities
50	Tech + info (combined)	Online opportunities Online risks of harm	Positive association – more online activities Positive indirect link – more online risks (through opportunities)
60	Tech + info (combined)	Informational benefits	Positive association – more attention to and concern about the credibility of online information
63	Tech + info (combined)	Informational benefits	Positive association – more health information-seeking
82	Tech + info (combined)	Academic grades	Positive association – better school performance
88	Tech + info (combined)	Online risks of harm	Positive association – more willingness to disclose personal information

(Continued)

**Table 4.** (Continued)

Study	Dimensions of digital skills	Outcomes	Association
65	Tech + info (combined)	Online risks of harm	Positive association – more online risk
96	Tech + comm (combined)	Informational benefits	Positive association – more academic benefit gained from the Internet
90	Tech + comm (combined)	Online risks of harm	Positive association – more online risk but negative association on harm
94	Tech + comm (combined)	Online risks of harm	Negative association – less harm from online experiences
95	Tech + comm (combined)	Online risks of harm	Positive association – more online risk
100	Tech + comm (combined)	Coping behaviours	Positive association – better coping with online risks
86	Tech + create (combined)	Orientation to technology	Positive association, especially among girls – more interest in ICTs profession
102	Tech + create (combined)	Orientation to technology	Positive association – more persistence in studying computer science at college, especially among girls/young women
99	Tech + create (combined)	Online risks of harm	Positive association – more online risk
43	Tech + create (combined)	Online risks of harm	Positive association – more likely to bully others online and offline
6	Tech + info + create (combined and tested for basic and advanced skills)	Online opportunities	Positive association – more online social communication
83	Tech + info + create (combined)	Informational benefits	Positive association on informational benefits – greater learning opportunities
10	Tech + info + comm (combined)	Online opportunities	Positive association – more online activities undertaken, including creative activities
79	Tech + info + comm (combined)	Online opportunities Online risks of harm	Positive association – more online activities Positive association – more online risks

ICT: information and communication technology.

either communication or creative skills – with positive links to online opportunities (#6, #10, #79), information benefits (#83) and civic participation (#62). However, study #79 also shows a link with online risk (possibly for reasons noted earlier).

By contrast, technical skills combined with communication or creative but not information skills have more mixed outcomes. Five studies combined technical and communication skills, finding more online risks (#90, #95) yet less harm associated with risk (#90, #94), better coping with online risk (#100) and information benefits (#96). We cannot be sure, but it is noteworthy that, when tested separately, communication but not technical skills are linked to coping with online risk. Finally, four studies suggested that the combination of technical and creative skills is linked to both a positive orientation to technology (#86, #102) and to more online risk (#99, #43).

### *Explaining the outcomes of digital skills*

Eleven studies tested specific pathways from the predictors of digital skills to their outcomes, using statistical models that vary in complexity, while all relying on cross-sectional survey research methods (see Table 5). The predictors variously include personal attributes (age, gender and personality); social context (socioeconomic status [SES], parental education, parental mediation, teacher or peer support); and ICT environment (diversity of connectivity, availability at home, age of first Internet use). These are usually linked to one or two outcomes, with digital skills positioned in the models as a predictor, mediator or outcome, depending on the authors' approach. Age, SES, parental education, parental mediation and ICT availability at home are generally strongly associated with digital skills.

Model building reveals important interrelations that studies reliant on univariate statistical analysis can miss (RQ3). For instance, several studies found that age, gender and SES are associated with children's digital skills and then show how these factors explain online opportunities (#12, #21, #27, #50). Specifically, boys, and those who are older or more advantaged, report greater digital skills and enjoy better online opportunities. While demographic factors themselves offer little prospect of change, they can help target interventions, aiming digital skills education at younger girls and those from economically disadvantaged backgrounds to help compensate for entrenched digital inequalities (Helsper, 2021).

Studies that measure the differential influence of separate dimensions of digital skills on online opportunities (#27, #96) suggest further nuance, with possible relevance for educators teaching digital skills. For example, study #96, which operationalizes digital skills as a progression from basic operational skills to more advanced skills, shows that the role of operational skills and academic outcomes is both direct and indirect (mediated by advanced digital skills). Study #27 reveals variations in how digital skills mediate the influence of sociodemographic factors on different online opportunities, depending on the dimension of digital skills and the type of opportunities examined.

Also promising for policymakers and practitioners are findings that point to malleable predictors of digital skills. Study #79 showed that parental mediation engenders better skills and, thereby, more online opportunities, while study #82 found a similar pathway leading to better academic grades. Studies #12, #21 and #50 found that an ICTs-rich

**Table 5.** Models (ordered by outcomes).

Study	Antecedents	Dimensions of digital skills	Role of skills	Outcomes
21	Personal attributes (age, gender) Social context (parental education, parental mediation, parent age) ICTs environment (age of first use, number/type of devices used to go online and number of locations where Internet access is available)	Tech + info (combined)	Outcome and predictor	Online opportunities
27	Personal attributes (age, gender) Social context (SES)	Tech + info + comm + create (separate tests)	Outcome, predictor and mediator	Online opportunities
19	Social context (parental mediation, peer support) ICT environment (availability at home)	Info	Outcome, predictor and mediator	Informational benefits
96	Social context (SES) ICT environment (availability at home)	Tech + comm (combined)	Outcome and predictor	Informational benefits
12	Personal attributes (age, gender) Social context (parental education) ICT environment (availability at home)	Tech + info (combined)	Outcome, predictor and mediator	Online opportunities; online risks of harm
50	Personal attributes (age, gender) Social context (parental education) ICT environment (availability at home and age of first Internet use)	Tech + info (combined)	Outcome, predictor and mediator	Online opportunities; online risks of harm
79	Social context (parental mediation)	Tech + info + comm (combined)	Outcome, predictor and mediator	Online opportunities; online risks of harm
99	Personal attributes (age, gender, personality) Social context (parental mediation, SES)	Tech + create (combined)	Outcome and predictor	Online risks of harm

*(Continued)*

**Table 5.** (Continued)

Study	Antecedents	Dimensions of digital skills	Role of skills	Outcomes
11	ICT environment (diversity of connectivity)	Info	Outcome, predictor and mediator	Coping behaviours
82	Social context (parent/teacher support)	Tech + info (combined)	Outcome, predictor and mediator	Academic grades
55	Personal attributes (motivations and commitment to identity formation)	Tech	Outcome and mediator	Miscellaneous benefits

ICT: information and communication technology; SES: socioeconomic status.

home (variously measured) benefits digital skills and, in turn, online opportunities. As study #50 further shows, the relationship between use and opportunities is indirect, mediated by that between use and skills. In other words, those who use the Internet more and are higher in skills take up more opportunities than those who use it an equivalent amount but are lower in skills. Study #11 also found that better digital access benefits skills, with benefits in turn for children's online coping. Study #19 confirms both these findings: both parental mediation and ICTs availability at home were linked to informational benefits for children, mediated by information-related digital skills. Since both parental mediation and domestic access to technology can be enhanced through awareness-raising and digital access policies, these studies point the way to improving children's outcomes by supporting their digital skills. Without such interventions, however, study #96 shows how the digital divide might become more entrenched. It found that higher SES combined with a richer ICTs environment at home leads first to better digital skills and thence to more online information-seeking that, doubtless, brings further academic benefits for the already advantaged.

Study #27 develops a complex model, finding not only a linear path from demographic factors to digital skills and from digital skills to outcomes, but also that inequalities such as the child's gender and parental education predict changes in outcomes when digital skills are taken into account. Notably, when digital skills were included in the model, some relationships lost strength, but the relationship between SES and online opportunities was unchanged. This suggests that, if ways are found to improve children's digital skills, they will likely benefit from greater online opportunities, even though structurally, they remain disadvantaged (because there is a direct association of inequality on outcomes unmediated by digital skills). In other words, it may be that the digital divide can be overcome, even if social divisions are harder to change.

Can the models illuminate the generally and, arguably, problematic positive association between online opportunities and online risks? In studies #12 and #50, statistical analysis suggested that digital skills only predict risks indirectly through their direct link

to online opportunities. Specifically, study #12 found that the relationship between skills and risks was mediated by online opportunities, while study #50 found that opportunities precede risks – children are online and engage in various activities before they encounter risks. Relatedly, study #79 found that the relationship between skills and risks was weaker than that between skills and opportunities. Study #99 did not include online opportunities as an outcome. Only one study (#50) measures frequency of Internet use and time spent online, finding that both are positively associated with online opportunities, but the link between use and risks is indirect, through opportunities.

However, the present analysis suggests qualification of its finding that multiple predictors (demographics, personality and parental mediation) lead first to better digital skills and then to more online risk.

What of the role of parental mediation? Study #12 found that digital skills mediate between active parental mediation and online opportunities; specifically, active parental mediation in the form of co-use, talk and support has only an indirect relationship with online opportunities through its relationship with digital skills, but it has a direct negative link to exposure to online risks. Conversely, restrictive mediation – rules aimed at limiting the time spent online or prohibiting certain online activities – is negatively correlated with both digital skills and online opportunities but has a weaker negative link to risks. This suggests that not only does restrictive mediation narrow online opportunities; it also appears to be of a little efficacy in reducing exposure to online risks. Parents' ability to mediate their child's Internet use effectively is influenced by other factors, including parents' education, age and own ICT use, thus demonstrating the importance of variables related to the child's family environment. These findings have implications for parental awareness-raising campaigns which could focus on the benefits of enabling mediation.

## Conclusion

Although many studies have examined the outcomes of children's and young people's digital skills in recent years, it has proved difficult to draw conclusions because the plethora of definitions and methodologies create challenges in comparing study findings. The first research question inquired into the outcomes of young people's digital skills. We found that most research on the outcomes of digital skills concerns the range of online opportunities or risks encountered by children and young people, leaving much to be explored regarding specific outcomes such as academic grades. Greater digital skills are linked to more online opportunities and information benefits, with some different findings by gender. For other beneficial outcomes (e.g. orientation to technology, academic grades, coping behaviours and civic participation), the findings are mixed, with too few studies to draw reliable conclusions. However, a fair body of research also suggests that greater digital skills are linked, directly or indirectly, to more exposure to online risks, although the implications for harm remain unclear. Although not examined here, it should also be noted that outcomes in one domain are not necessarily correlated with outcomes in another (Van Deursen et al., 2017), so more research is needed that examines multiple outcomes, and for research designs that can go beyond correlations to examine causal relationships. Note, too, that all the studies measured proximal outcomes,

with none that examined longer term outcomes or that used holistic measures of wellbeing (except for one study that found no relationship between digital skills and overall life satisfaction; #55).

Second, we asked whether the different dimensions of digital skills are linked to distinct outcomes. The findings suggest that these dimensions are indeed linked to different outcomes, and not always beneficially. Indeed, teaching or promoting technical skills alone emerges as a problematic strategy. This is particularly worrying given the substantial focus on technical skills in IT education in many countries, especially if coupled with an insufficient emphasis on critical or evaluation aspects of digital skills (see, for example, Polizzi, 2020 for a discussion of the UK curriculum). By contrast, the findings for gaining information skills alone are much more promising, for these are found to be generally linked to beneficial outcomes. Also positive for young people's outcomes, the review found, are certain combinations of digital skills dimensions, provided that gaining information skills is included in the mix. However, more research is needed to examine the association of specific skills dimensions on different outcomes. Given that different outcomes are linked to different skill dimensions, the future use of composite digital skill measures is not recommended.

Third, we sought to understand how the research literature explains the outcomes of digital skills. On examining the subset of studies that constructed multivariate models linking predictors to digital skills and thence to outcomes, we found no common approach or agreed hypotheses guiding such models. Taken together, the results of these studies show that digital skills play a decisive role in mediating the relation between predictors (generally factors relating to digital and social inequality) and the outcomes discussed earlier. They also suggest ways in which future interventions could seek to enhance and equalize beneficial outcomes for children, notably through enhanced access to ICTs resources at home, and by raising public awareness of enabling parental mediation strategies.

In the light of substantial societal investment in children's and young people's access to ICTs and the digital skills (or digital literacy education) to use technologies for present and future benefits, we recommend that future research examining the relationship between children's digital access, activities and outcomes should include measures of digital skills. In this regard, weak measures of digital skills are a concern, and future research should use stronger measures of digital skills (Helsper et al., 2021), including greater use of performance tests, and measures that differentiate among different dimensions of digital skills. This could guide policy interventions that encompass and look beyond short-term outcomes to address the future needs of an increasingly digital society, while also helping to prevent those in a more disadvantaged position from being 'systematically more likely to suffer harm due to the digitization of society' (Helsper, 2021: 179–180). Finally, while this study has concentrated on a fairly narrow age range, future research could usefully disaggregate the digital engagement of children of different ages, to examine the possible learning and other benefits of digital skills in tandem with an account of how digital skills unfold across the full span of child development.

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## References

- Areepattamannil S and Khine MS (2017) Early adolescents' use of information and communication technologies (ICT) for social communication in 20 countries: examining the roles of ICT-related behavioral and motivational characteristics. *Computers in Human Behavior* 73: 263–272.
- Balea B (2016) Digital natives or not? How do Romanian adolescents cross the boundaries of internet common use. *Studia Universitatis Babes-Bolyai Sociologia* 61(1): 59–76.
- Bernadas JMAC and Soriano CR (2019) Online privacy behavior among youth in the Global South. *Journal of Information, Communication and Ethics in Society* 17(1): 17–30.
- Buckingham D (2015) Defining digital literacy. *Nordic Journal of Digital Literacy (Jubileumsnummer)* 10: 21–35.
- Bulger M and Davison P (2018) The promises, challenges and futures of media literacy. *Journal of Media Literacy Education* 10(1): 1–21.
- Cabello-Hutt T, Cabello P and Claro M (2018) Online opportunities and risks for children and adolescents: the role of digital skills, age, gender and parental mediation in Brazil. *New Media and Society* 20(7): 2411–2431.
- Christoph G, Goldhammer F, Zylka J, et al. (2015) Adolescents' computer performance: the role of self-concept and motivational aspects. *Computers and Education* 81: 1–12.
- Cortesi S, Hasse A, Lombana-Bermudez A, et al. (2020) *Youth and Digital Citizenship+ (Plus)*. Berkman Klein Center for Internet and Society. Available at: <https://cyber.harvard.edu/publication/2020/youth-and-digital-citizenship-plus>
- Davies HC and Eynon R (2018) Is digital upskilling the next generation our 'pipeline to prosperity'? *New Media & Society* 20(11): 3961–3979.
- Dienlin T (2020) The impact of digital technology use on adolescent wellbeing. *Dialogues in Clinical Neuroscience* 22(2): 135–142.
- Dodge R, Daly A, Huyton J, et al. (2012) The challenge of defining wellbeing. *International Journal of Wellbeing* 2(3): 222–235.
- European Commission (2016) *COM(2016)381: A New Skills Agenda for Europe*. Available at: <https://ec.europa.eu/transparency/regdoc/rep/1/2016/EN/1-2016-381-EN-F1-1.PDF>
- European Commission (2021a) 2nd survey of schools: ICT in education. Available at: <https://digital-strategy.ec.europa.eu/en/library/2nd-survey-schools-ict-education-0>
- European Commission (2021b) *COM(2021)118: 2030 Digital Compass*. Available at: [https://ec.europa.eu/info/sites/default/files/communication-digital-compass-2030\\_en.pdf](https://ec.europa.eu/info/sites/default/files/communication-digital-compass-2030_en.pdf)
- Eynon R and Malmberg LE (2012) Understanding the online information-seeking behaviours of young people: the role of networks of support. *Journal of Computer Assisted Learning* 28(6): 514–529.
- Fizeşan B (2012) Digital engagement among Eastern European children. *Studia Universitatis Babes-Bolyai Sociologia* 57(1): 83–99.
- Gough D, Oliver S and Thomas J (2012) *An Introduction to Systematic Reviews*. London: SAGE.
- Grant MJ and Booth A (2009) A typology of reviews. *Health Information and Libraries Journal* 26: 91–108.

- Grizzle A, Moore P, Dezuanni M, et al. (2013) *Media and Information Literacy*. UNESCO. Available at: <https://unesdoc.unesco.org/ark:/48223/pf0000225606>
- Haddon L, Cino D, Doyle MA, et al. (2020) *Children's and Young People's Digital Skills: A Systematic Evidence Review*. Zenodo. Available at: <https://zenodo.org/record/4160176#.YSSYqY4zbIU>
- Hargittai EJ (2002) Second-level digital divide. *First Monday* 7(4). Available at: <https://firstmonday.org/article/view/942/864>
- Helsper EJ (2021) *The Digital Disconnect*. London: SAGE.
- Helsper EJ and Eynon R (2010) Distinct skill pathways to digital engagement. *European Journal of Communication* 28(6): 696–713.
- Helsper EJ and Eynon R (2013) Distinct skill pathways-digital engagement. *European Journal of Communication* 28(6): 696–713.
- Helsper EJ and Smahel D (2020) Excessive internet use by young Europeans. *Information, Communication and Society* 23(9): 1255–1273.
- Helsper EJ, Van Deursen AJAM and Eynon R (2015) *Tangible Outcomes of Internet Use. From Digital Skills to Tangible Outcomes*. Available at: [www.oii.ox.ac.uk/research/projects/?id=112](http://www.oii.ox.ac.uk/research/projects/?id=112)
- Helsper EJ, Schneider LS, Van Deursen AJAM, et al. (2021) *The Youth Digital Skills Indicator. ySKILLS*. Available at: <https://zenodo.org/record/4608010>
- International Telecommunication Union (ITU) (2018) *Measuring the Information Society Report, Volume 1*. ITU Publications. Available at: [www.itu.int/en/ITU-D/Statistics/Documents/publications/misr2018/MISR-2018-Vol-1-E.pdf](http://www.itu.int/en/ITU-D/Statistics/Documents/publications/misr2018/MISR-2018-Vol-1-E.pdf)
- Kaarakainen MT (2019) ICT intentions and digital abilities of future labor market entrants in Finland. *Nordic Journal of Working Life Studies* 9(2): 105–126.
- Kahne J and Bowyer B (2019) Can media literacy education increase digital engagement in politics? *Learning, Media and Technology* 44(2): 211–224.
- Khan ML, Wohn DY and Ellison NB (2014) Actual friends matter. *Computers and Education* 79: 138–147.
- Kim EM and Yang S (2016) Internet literacy and digital natives' civic engagement: internet skill literacy or internet information literacy? *Journal of Youth Studies* 19(4): 438–456.
- Kiss M (2017) *Digital Skills in the EU Labour Market*. European Union. Available at: <https://op.europa.eu/en/publication-detail/-/publication/cb9ff359-e2c9-11e6-ad7c-01aa75ed71a1/language-en/format-PDF/source-192953558>
- Kumazaki A, Suzuki K, Katsura R, et al. (2011) The effects of netiquette and ICT skills on school-bullying and cyber-bullying: the two-wave panel study of Japanese elementary, secondary, and high school students. *Procedia-Social and Behavioral Sciences* 29: 735–741.
- Leung L and Lee PS (2012a) Impact of internet literacy, internet addiction symptoms, and internet activities on academic performance. *Social Science Computer Review* 30(4): 403–418.
- Leung L and Lee PS (2012b) The influences of information literacy, internet addiction and parenting styles on internet risks. *New Media & Society* 14(1): 117–136.
- Lin PY, Chai CS and Jong MSY (2019) A PISA-2015 comparative meta-analysis between Singapore and Finland: relations of students' interest in science, perceived ICT competence, and environmental awareness and optimism. *International Journal of Environmental Research and Public Health* 16(24): 5157.
- Livingstone S (2008) Taking risky opportunities in youthful content creation. *New Media & Society* 10(3): 393–411.
- Livingstone S (2013) Online risk, harm and vulnerability. *Journal of Communication Studies* 18(35): 13–28.
- Livingstone S and Helsper EJ (2010) Balancing opportunities and risks in teenagers' use of the internet: the role of online skills and internet self-efficacy. *New Media & Society* 12(2): 309–329.

- Livingstone S, Kardefelt-Winther D, Kanchev P, et al. (2019) *Is there a ladder of children's online participation?* Innocenti Research Briefs no.2019-02. Florence: UNICEF Office of Research – Innocenti.
- Livingstone S, Mascheroni G and Staksrud E (2018) European research on children's internet use. *New Media & Society* 20(3): 1103–1122.
- Livingstone S, Ólafsson K, Helsper EJ, et al. (2017) Maximising opportunities and minimising risks for children online. *Journal of Communication* 67(1): 82–105.
- Loader BD, Vromen A and Xenos MA (2016) Performing for the young networked citizen? *Culture and Society* 38(3): 400–419.
- Mannerström R, Hietajärvi L, Muotka J, et al. (2018) Identity profiles and digital engagement among Finnish high school students. *Cyberpsychology: Journal of Psychosocial Research on Cyberspace* 12(1): 2.
- Mascheroni G, Cino D, Mikuška J, et al. (2020) *Digital Skills, Risks and Wellbeing among European Children*. ySKILLS. Available at: <https://zenodo.org/record/4267977#.YSSXu44zbIU>
- Metzger MJ, Flanagin AJ, Medders R, et al. (2013) The special case of youth and digital information credibility. In: Folk M and Apostel S (eds) *Online Credibility and Digital Ethos: Evaluating Computer-Mediated Communication*. New York: IGI Global, pp. 148–168.
- Moher D, Shamseer L, Clarke M, et al. (2015) Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Systematic Reviews* 4(1): 1–9.
- Moon SJ and Bai SY (2020) Components of digital literacy as predictors of youth civic engagement and the role of social media news attention: the case of Korea. *Journal of Children and Media* 14(4): 458–474.
- Morandini M, Thum-Thysen A and Vandeplas A (2020) *Facing the Digital Transformation*. Publications Office of the European Union. Available at: [https://ec.europa.eu/info/business-economy-euro/economy-finance-and-euro-publications\\_en](https://ec.europa.eu/info/business-economy-euro/economy-finance-and-euro-publications_en)
- Nascimbeni F and Vosloo S (2019) *Digital Literacy for Children*. UNICEF. Available at: <https://www.unicef.org/globalinsight/media/1271/file/%20UNICEF-Global-Insight-digital-literacy-scoping-paper-2020.pdf>
- Neumark Y, Lopez-Quintero C, Feldman BS, et al. (2013) Online health information seeking among Jewish and Arab adolescents in Israel: results from a national school survey. *Journal of Health Communication* 18(9): 1097–1115.
- Notten N and Nikken P (2016) Boys and girls taking risks online: a gendered perspective on social context and adolescents' risky online behavior. *New Media & Society* 18(6): 966–988.
- O'Neill B (2013) Internet policies: online child protection and empowerment in a global context. In: Lemish D (ed.) *The Routledge International Handbook of Children, Adolescents and Media*. London: Routledge, pp. 395–402.
- Organisation for Economic Co-operation and Development (OECD) (2018) *The Future of Education and Skills*. Available at: [www.oecd.org/education/2030/E2030%20Position%20Paper%20\(05.04.2018\).pdf](http://www.oecd.org/education/2030/E2030%20Position%20Paper%20(05.04.2018).pdf)
- Picatoste J, Pérez-Ortiz L, Ruesga-Benito SM, et al. (2018) Smart cities for wellbeing. *Journal of Science and Technology Policy Management* 9(2): 227–241.
- Polizzi G (2020) Digital literacy and the national curriculum for England. *Computers and Education* 152: 103859.
- Rodríguez-de-Dios I, Van Oosten JM and Igartua JJ (2018) A study of the relationship between parental mediation and adolescents' digital skills, online risks and online opportunities. *Computers in Human Behavior* 82: 186–198.
- Ryff C (1989) Happiness is everything, or is it? *Journal of Personality and Social Psychology* 57: 1069–1081.
- Santos G, Ramos E, Escola J, et al. (2019) ICT literacy and school performance. *The Turkish Online Journal of Educational Technology* 18(2): 19–39.

- Scherer R, Rohatgi A and Hatlevik OE (2017) Students' profiles of ICT use: identification, determinants, and relations to achievement in a computer and information literacy test. *Computers in Human Behavior* 70: 486–499.
- Schorr A (2019) Pipped at the post: knowledge gaps and expected low parental IT competence ratings affect young women's awakening interest in professional careers in information science. *Frontiers in Psychology* 10: 968.
- Shin W, Huh J and Faber RJ (2012) Developmental antecedents to children's responses to online advertising. *International Journal of Advertising* 31(4): 719–740.
- Sonck N and de Haan J (2013) How the internet skills of European 11- to 16-year-olds mediate between online risk and harm. *Journal of Children and Media* 7(1): 79–95.
- Staude-Müller F, Hansen B and Voss M (2012) How stressful is online victimisation? Effects of victim's personality and properties of the incident. *European Journal of Developmental Psychology* 9(2): 260–274.
- Sutherland S (2004) An introduction to systematic reviews. *Journal of Evidence Based Dental Practice* 4(1): 47–51.
- Teimouri M, Benrazavi SR, Griffiths MD, et al. (2018) A model of online protection to reduce children's online risk exposure: empirical evidence from Asia. *Sexuality and Culture* 22(4): 1205–1229.
- Tirado-Morueta R, Mendoza-Zambrano DM, et al. (2017). Empirical study of a sequence of access to Internet use in Ecuador. *Telematics and Informatics* 34(4): 171–183.
- Third A, Collin P, Walsh L, et al. (2019) *Control Shift: Young People in Digital Society*. London: Palgrave Macmillan.
- Vaikutytė-Paškauskė J, Vaičiukynaitė J and Pocius D (2018) *Digital Skills in the 21st Century*. European Parliament. Available at: [www.europarl.europa.eu/RegData/etudes/STUD/2018/617486/IPOL\\_STU\(2018\)617486\\_EN.pdf](http://www.europarl.europa.eu/RegData/etudes/STUD/2018/617486/IPOL_STU(2018)617486_EN.pdf)
- Van Deursen AJAM and Helsper EJ (2018) Collateral benefits of internet use. *New Media & Society* 20(7): 2333–2351.
- Van Deursen AJAM, Helsper EJ, Eynon R, et al. (2017) The compoundness and sequentiality of digital inequality. *International Journal of Communication* 11: 452–473.
- Van Deursen AJAM and Van Dijk JAGM (2014) The digital divide shifts to differences in usage. *New Media & Society* 16(3): 507–526.
- Van Dijk JAGM and Van Deursen AJAM (2014) *Digital Skills: Unlocking the Information Society*. London: Palgrave Macmillan.
- Van Laar E, Van Deursen AJAM, Van Dijk JAGM, et al. (2017) The relation between 21st-century skills and digital skills. *Computers in Human Behavior* 72: 577–588.
- Vandoninck S, d'Haenens L and Donoso V (2010) Digital literacy of Flemish youth: how do they handle online content risks? *Communications* 35(4): 397–416.
- Vandoninck S, d'Haenens L and Roe K (2013) Online risks: coping strategies of less resilient children and teenagers across Europe. *Journal of Children and Media* 7(1): 60–78.
- Vuorikari R, Punie Y, Carretero Gomez S, et al. (2016) *Digcomp 2.0: The Digital Competence Framework for Citizens* (EUR 27948 EN). Luxembourg: Publication Office of the European Union.
- Wegmann E, Stodt B and Brand M (2015) Addictive use of social networking sites can be explained by the interaction of internet use expectancies, internet literacy, and psychopathological symptoms. *Journal of Behavioral Addictions* 4(3): 155–162.
- Weston TJ, Dubow WM and Kaminsky A (2019) Predicting women's persistence in computer science- and technology-related majors from high school to college. *ACM Transactions on Computing Education* 20(1): 1.

- Yu L, Recker M, Chen S, et al. (2018) The moderating effect of geographic area on the relationship between age, gender, and information and communication technology literacy and problematic internet use. *Cyberpsychology, Behavior, and Social Networking* 21(6): 367–373.
- Ziya E, Dogan N and Kelecioğlu H (2010) What is the predict level of which computer using skills measured in PISA for achievement in mathematics. *Turkish Online Journal of Educational Technology-TOJET* 9(4): 185–191.

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