youth SKILLS

Digital skills, risks and wellbeing among European children

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Please cite this report as:

Mascheroni, G., Cino, D., Mikuška, J., Lacko, D., & Šmahel, D. (2020). *Digital skills, risks and wellbeing among European children. Report on (f)actors that explain online acquisition, cognitive, physical, psychological and social wellbeing, and the online resilience of children and young people*. KU Leuven, Leuven: ySKILLS.

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This project has received funding from the European Union's Horizon 2020 Research & Innovation programme under Grant Agreement no. 870612. The information in this deliverable reflects only the authors' views and the European Union is not liable for any use that may be made of the information contained therein.

DISSEMINATION LEVEL

Public

Project: ySKILLS – Youth Skills
GA: 870612
Call: H2020-SC6-TRANSFORMATIONS-07-2019
Type of action: RIA

Digital skills, risks and wellbeing among European children

Report on (f)actors that explain online acquisition, cognitive, physical, psychological and social wellbeing, and the online resilience of children and young people

Work Package 2 – Deliverable 2.2

Due date: **31 October 2020**

Submission date: **30 October 2020**

Lead beneficiary: **UCSC**

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Executive summary

This report is based on further analysis of the EU Kids Online data collected across 19 European countries in 2017–19 (Smahel et al., 2020), and aims to identify the antecedents and consequences of digital skills among children. More specifically, in Section 3, "The antecedents of digital skills", we tested the relationship between individual characteristics (age and gender), social characteristics (socioeconomic status [SES] and parental mediation), country characteristics, information and communications technology (ICT) use and skills. In Section 4, "The consequences of digital skills", we examined the relations between skills, risks and opportunities. The report is aimed at outlining gaps in the evidence base and in our current knowledge of digital skills acquisition, in order to inform future research in this area.

Comparing children's digital skills across Europe

- First, our findings do not indicate clear-cut differences with respect to the North–South digital divide. Instead, country differences in children's digital skills were small. On the one hand, children from Southern European countries (France, Spain and Italy) reported the lowest scores of digital skills, while on the other hand, Serbian and Portuguese children outscored their peers in Northern European countries.
- Gender differences are only statistically significant in four countries – Belgium (Flanders), the Czech Republic, Norway and Serbia – where boys reported higher levels of digital skills than girls. While our findings are consistent with previous research showing that boys use technology more and thus have more opportunities to develop related skills, we should not underestimate that our analysis is based on self-reported skills. It may well be the case that boys tend to overestimate their abilities with digital technology and the internet, echoing a common-sense belief that boys are more naturally inclined than girls to like and be better at using technology.
- In most of the countries, except Belgium (Flanders), older children reported higher levels of skills than younger children.

Antecedents of digital skills

- The strongest and most common predictors of digital skills across the countries were self-efficacy, number of online activities children engage in, preference for online social interactions, and feeling safe on the internet.
- Restrictive parental mediation is also significant in all the countries, but it predicts digital skills negatively everywhere. In other words, when parents limit the time children spend on the internet, and the activities they do online, children score lower on digital skills. Perhaps surprisingly, instead, the positive influence of active parental mediation on children's digital skills is small.
- Children who engage in more online activities – including communication, entertainment, education, etc. – also seem to develop more skills. In fact, the number of online activities predicted digital skills positively in all the countries except for Poland.
- Self-efficacy – measured by children's confidence in their ability to solve problems in daily life – influences digital skills in all the countries to some extent, although the reasons why may vary. On the one hand, this finding suggests that when children feel self-confident, this may positively reflect on their digital abilities. On the other hand, it may simply mean that more self-confident children tend to positively rate their digital skills.

- While the relationship between digital skills and children's online activities, or the practices of parental mediation they receive, has been investigated in prior studies, we also explored whether preference for online social interaction (POSI) and feeling safe on the internet influence the acquisition of digital skills.
- POSI is a positive predictor, suggesting that children who find it easier to express themselves online may actually benefit from this usage to develop skills relevant to the digital environment they feel more at ease in.
- Feeling safe online is a positive predictor in all the countries except for France, Italy and Slovakia. It can be argued that the more children familiarise themselves with the online environment and the more they feel safe online, the better knowledge and understanding of the internet they would gain, supporting their acquisition of digital skills.
- Other variables usually considered in research on the antecedents of digital skills among children, such as age, gender, average time spent online on a weekday and SES, do not predict digital skills equally across countries, and nor are these relationships consistently statistically significant.

Consequences of digital skills

- Looking at the association between specific types of digital skills (including operational, informational, social and content creation skills) and digital engagement, online information-seeking activities are significantly associated with information navigation skills, emotional problems, active parental mediation and sensation-seeking.
- Communication and other social activities are, in turn, mostly associated with restrictive parental mediation (negatively), sensation-seeking and informational digital skills.
- Social digital skills are not statistically significant predictors of online communication activities in most of the countries.
- Higher levels of digital skills are associated with more exposure to risky and potentially harmful online content, including racist and discriminatory content, self-harm and pro-anorexia content, etc. This suggests that the more skilled children who explore the internet to a greater extent may be more likely to encounter risks. However, digital skills can also help children prevent risks from translating into harm.
- Digital skills also shape the relationship between emotional problems and exposure to potentially harmful online content: when children who suffer from emotional problems also have higher digital skills, they are more likely to be exposed to potentially harmful online content. Digital skills, in other words, increase the likelihood that children with emotional problems encounter risky content online.

1. Introduction

1.1 The ySKILLS project

The ySKILLS (Youth Skills) project is funded by the EU's Horizon 2020 programme. It involves 15 partners from 13 countries to enhance and maximise the long-term positive impact of the information and communications technology (ICT) environment on multiple aspects of wellbeing for children and young people by stimulating resilience through the enhancement of digital skills. Starting from the view that children are **active agents in their own development**, ySKILLS examines how digital skills mediate the risks and opportunities related to ICT use by 12- to 17-year-olds in Europe (see www.ySKILLS.eu).

The overarching aim of ySKILLS

To enhance and maximise the long-term positive impact of the ICT environment on multiple aspects of wellbeing for all children by stimulating resilience through the enhancement of digital skills.

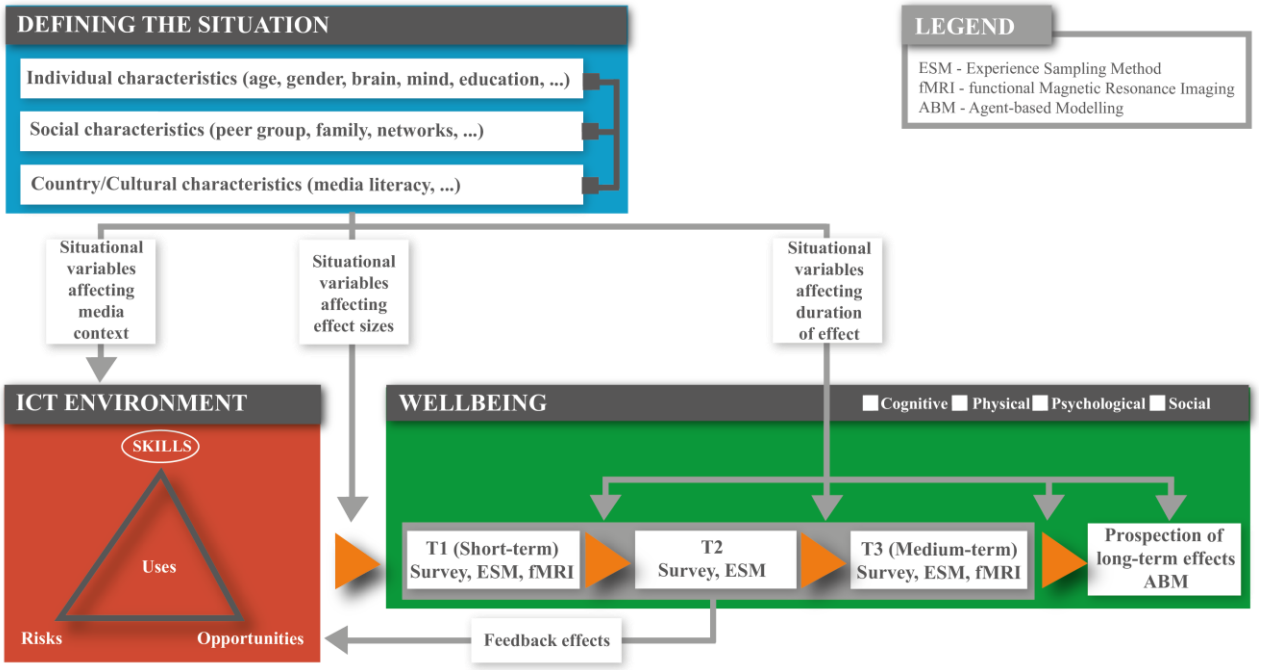
ySKILLS will **identify the actors and factors** that undermine or can promote **children's wellbeing** in a digital age. The relations between ICT use and wellbeing will be critically and empirically examined over time.

ySKILLS' research objectives

1. ***To acquire extensive knowledge and better measurement of digital skills.***
2. ***To develop and test an innovative, evidence-based explanatory and foresight model predicting the complex impacts of ICT use and digital skills on children's cognitive, physical, psychological and social wellbeing.***
3. ***To explain how at-risk children (as regards their mental health, ethnic or cultural origin, socioeconomic status and gender) can benefit from online opportunities despite their risk factors (material, social, psychological).***
4. ***To generate insightful evidence-based recommendations and strategies for key stakeholder groups in order to promote European children's digital skills and wellbeing.***

ySKILLS has proposed, and will continue to develop, its **conceptual model**:

Figure 1. ySKILLS CONCEPTUAL MODEL



In this report, we have tested some of the relationships in the conceptual model. More specifically, in Section 3, "The antecedents of digital skills", we tested the relationship between individual characteristics, social characteristics, country characteristics, ICT use and skills. In Section 4, "The consequences of digital skills", we examined the relations between skills, risks and opportunities.

1.2 This report

In order to advance ySKILLS research objective 1, our analytical effort seeks to explore in a theoretically informed fashion what variables predict the digital skills of 12- to 16-year-olds[1] (n=13,138, 50% female, mean age = 13.93, *SD* = 1.37) and the consequences of digital skills. We achieved this goal thanks to further analyses of nationally representative data from the EU Kids Online 2020 survey in 19 European countries (Smahel et al., 2020).

In this study, digital skills were conceptualised as operational, information navigation, communication, content creation and mobile skills (van Deursen et al., 2016) involved in the management of internet-connected technologies. Digital skills were measured by 10 items, two items for each of the five sub-scales: operational skills, including safety skills; information navigation skills, which enable critical engagement with online information; social skills, that is, the ability to manage online relationships with others; creative skills, namely, the capacity to produce and share content online; and mobile skills, related to the use of mobile devices. Examples of the items ranged from "I know how to change my privacy settings on SNSs", to "I find it easy to check if the information I find online is true", to "I know how to create and post online videos or music", etc.

We decided just to focus on the EU Kids Online 2020 survey because comparisons with other datasets – including the EU Kids Online 2010 survey across 25 European countries – were not possible for several reasons. Most notably, different questionnaires include different items. Therefore,

[1] While the ySKILLS project will examine the digital skills of 12- to 17-year-old children, the data we analyse in the report were collected as part of the EU Kids Online survey administered to 9- to 17-year-old children in some countries, but to 9- to 16-year-old children in others (see Smahel et al., 2020). So, in order to include all the participating countries in the analysis we considered only 9- to 16-year-olds.

comparability is low, if not impossible. For example, the EU Kids Online 2020 questionnaire was updated to better fit with technological and social changes (see Smahel et al., 2020). The skills section, in particular, was revised based on developments in the measurement of digital skills and digital inclusion (van Deursen et al., 2016).

The analysis in this report will focus on both the antecedents and consequences of digital skills, which is to say, that digital skills will be explored as an outcome, a predictor and a moderator variable.

Exploring digital skills as an outcome means treating them as a dependent variable, whose variance depends on changes on another or a set of independent variables. Let us think about the role of parental mediation, which indicates the way in which parents regulate and educate their children on media and internet use (Livingstone & Byrne, 2018). Treating digital skills as an outcome of parental mediation means exploring whether and how parental regulation has an influence on children's abilities when it comes to actively using ICT. In order to investigate this relationship, however, the role of other variables will be taken into account, to better understand not only if, but also to what extent, parental mediation can predict digital skills or not.

Digital skills, however, can work as predictors themselves. This means that our analysis will also look at them as independent variables that can lead to certain outcomes. For example, we may expect that children with higher levels of digital skills will be more able to seek good-quality information on the internet, and thus gain less biased knowledge on a given topic. Also in this case, the role of other intervening variables will be taken into account, to avoid confounding the results by the effects of other factors.

It may finally be the case, however, that digital skills themselves can work as variables that moderate the effect of other predictors. Putting this simply, a moderator conditions the relationship between a dependent (outcome) and an independent (predictor) variable, taking into account the role of another variable with respect to the strength of a relationship. For example, we may find that children who spend more time online encounter more risks but, when looking at the effect of digital skills as a moderating variable, this may be due to the fact that they are low in internet literacy and as such do not know how to use the internet effectively to avoid negative outcomes. Thus, time spent online alone would not be a sufficient predictor of encountering risks online.

Our analytical approach, then, will adopt a holistic approach to the study of digital skills among European countries keeping these three levels in mind. In what follows, we will first provide a comparison of children's digital skills across the countries. Subsequently, we will analyse the antecedents and consequences of digital skills, and explore the role of digital skills as moderators.

2. Comparing digital skills across the countries

2.1 Introduction: Learning from cross-cultural comparisons of adults' digital skills

Our cross-cultural approach to the study of children's digital skills across 19 European countries is informed by previous research suggesting that, if, on the one hand, media use seems to have spread across countries yielding similar effects with respect to changes in individual development, cultural values and learning environments (Greenfield, 2019), on the other hand, the way people use and make sense of media appears to be culture-specific (Boz et al., 2016). In fact, digital media can be understood as Vygotskyian cultural tools (Vygotsky, 1980), where people's confidence of use may vary not only according to their cognitive development, but also depending on the sociocultural milieu they are part of. Such an ambivalence is in line with cross-cultural research principles according to which comparison is possible when naturally occurring patterns of a specific phenomenon can be identified across cultures (e.g. media use, development and mastering of digital skills), but still being mindful of contextual and value-driven differences that different places come with (Ember, 2009; Sekaran, 1983).

Cross-cultural research on digital skills in Europe and around the world provides support for this notion. In this section, we briefly introduce the data from several international projects to illustrate the country differences related to the adoption and usage of ICT among adults. Subsequently, we provide new answers to the same question, providing new analysis of the data from the very recent EU Kids Online 2020 project.

The International Digital Economy and Society Index (I-DESI, European Commission, 2018), for example, measures the digital economy performances of EU-28 Member States with 17 non-European Union (EU) countries through cross-national representative quantitative surveys. The Index focuses on five core dimensions: connectivity, use of internet services, integration of digital technology, digital public service, and human capital (in terms of digital skills). Overall findings from the I-DESI show that while on a global scale Europe compares well with other major economies, main differences persist across the countries. Finland, Sweden, the Netherlands and Denmark are the most advanced European digital economies, while Bulgaria, Romania, Greece and Poland score the lowest. Cross-cultural differences are evident across all the five dimensions.

The "connectivity" dimension measures the need, allocation and use of broadband infrastructure in terms of coverage and take-up through five sub-dimensions: fixed broadband, mobile broadband, fast broadband, ultrafast broadband, and broadband price index. Although, as stressed by the report, digital connectivity is supposed to be a right in the EU, there are inequalities among the countries, with the Netherlands and Luxembourg ranking among the best performers, and Greece, Poland and Croatia among the worst.

The "use of internet services" dimension, in turn, provides information on the extent and the modalities of internet use across Europe, focusing on three main sub-dimensions: frequency and regularity of internet use, online activities (e.g. news, music, videos, games, video call, social networking sites [SNSs], online courses), and transactions (i.e., banking, shopping, selling online). While overall people in the EU seem to be involved in several online activities, the most active internet users are in Demark, the Netherlands, Sweden, Finland and Malta, while Romania, Bulgaria and Greece score lower on this measurement.

The "integration of digital technology" dimension focuses on the sub-dimensions of business digitisation (in terms of electronic information sharing, social media, big data, cloud) and e-commerce (including small and medium enterprises selling online, e-commerce turnover, and selling online cross-border). Once again, countries such as Bulgaria, Romania, Poland and Hungary fell behind in the rankings, while the Netherlands, Belgium and Denmark score the highest.

With respect to the "human capital" measurement, this focused on two mains sub-dimensions: internet user skills and advanced skills and development. The former was conceptualised as the digital

skills needed to thrive in a digital society in terms of quantity and quality of digital and internet-based activities, with indicators such as "basic" or "above basic" digital skills and "basic" software skills. Indicators of the latter, in turn, look at ICT specialist employment (and its gendered facet) as well as ICT graduates. Data show that Luxembourg, the Netherlands and Sweden have the highest level of internet user skills; Finland, Sweden and Estonia score highest on advanced skills; while Bulgaria, Romania, Italy and Greece score the lowest on both sub-dimensions of digital skills. It is worth stressing that data additionally show that lacking sufficient digital skills was the second main reason for not having internet access at home (following "lack of need or interest" and followed by "high access and equipment cost"). As the digital divide goes beyond mere access to digital technologies and the internet, including also the mastery of digital skills to use technology properly (Helsper, 2016), these data suggest that these two dimensions of digital inequalities can be related. This means that households where members lack digital skills may also be reluctant to have internet access at home, thus hindering children's acquisition of digital skills. Additionally, reasons for not having internet access at home vary notably across Member States, further pointing to different digital-related opportunities among citizens, including children. When it comes to the job market, around 10% of European workers have no digital skills, while 35% lack basic digital skills. Taken together, the I-DESI data suggest important heterogeneities in terms of domestic and work-related (skilled) use of digital technologies across Europe.

Inequalities in digital skills among Europeans are further supported by nationally representative findings from the Eurobarometer survey (2017), where 27,498 citizens aged 15 and over were interviewed. Results show that 7 in 10 European citizens self-assess themselves as sufficiently skilled in the use of digital technology, with younger users and users who access the internet more often being more inclined to feel confident about their digital skills. In spite of most respondents considering themselves skilled enough, country analysis still reveals differences with analogous patterns to those mentioned above, with the Netherlands, Sweden and Denmark self-reporting higher confidence in their digital skills, and Greece, Bulgaria and Italy at the other end of the spectrum.

Cross-national differences have also been reported in the 2018 International Telecommunication Union's (ITU) *Measuring the Information Society report* (ITU, 2018), focused on the status of ICT in 192 economies. When it comes to the EU, nationally representative household survey findings indicate that citizens from Northern Europe tend to be more digitally skilled compared to their Southern and Eastern European counterparts. ITU data show that this gap concerns skills at all levels in the broader population, ranging from basic digital skills (e.g. copy and paste functions), to standard skills (e.g. installing software or using a spreadsheet), to more sophisticated ones (e.g. computer programming).

Notwithstanding the diverse measures of digital skills, then, the studies briefly discussed above point to a North–South divide in Europe, whereby Northern European citizens are commonly shown to be more skilled and more digitally integrated than Southern and South Eastern European citizens.

2.2 Comparing children's skills across Europe

The public and policy debate around children's use of digital media has long been shaped by the persistence of two myths: the perception of children as "digital natives", who are innately techno-savvy just because they have grown up with digital technologies, and the contrasting preoccupation for children as innocent and vulnerable subjects, in need of protection from online risks (Barbovschi & Marinescu, 2013). Accordingly, between 2000 and 2010 the research agenda prioritised topics such as children's access and use of the internet, and their exposure to online risks. The tension between children as competent users or innocent victims remained implicit and unresolved until the debate moved beyond the initial focus solely on risks, and started to address the opportunities and challenges of the internet and digital technologies for children's agency, rights and wellbeing (Gasser & Cortesi, 2017; Livingstone & Third, 2017; Livingstone et al., 2018). It is within the more comprehensive

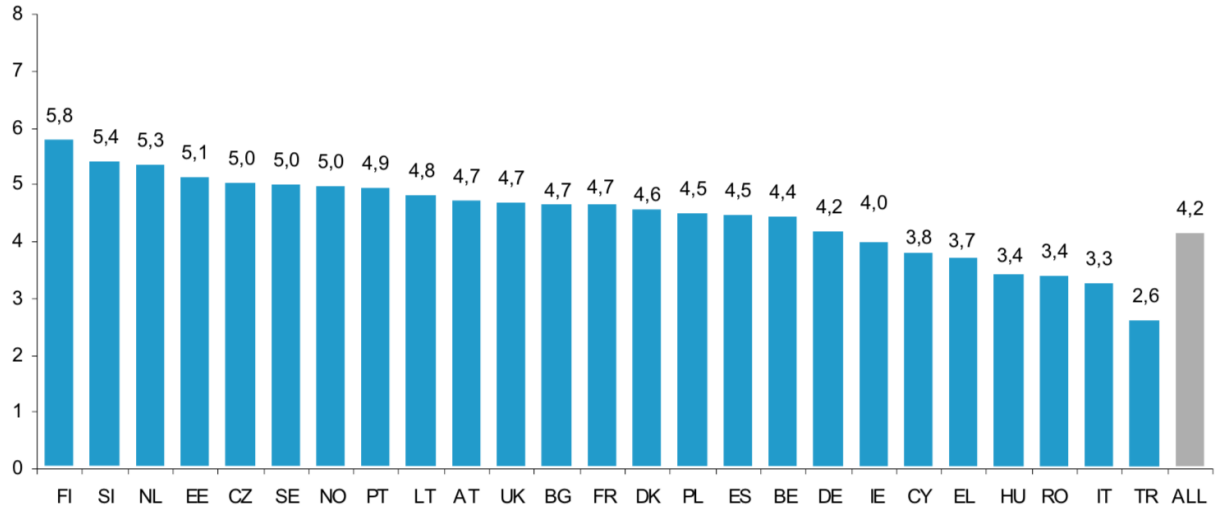
framework that situates the internet as an integral component of children's everyday life, through which children engage with the world (Livingstone et al., 2018), that understanding what skills enable children to fully harness the online opportunities and cope with risks has become crucial.

The ITU's 2018 *Measuring the Information Society report* also reports on 2016 data from the European Commission concerning the distribution of digital skills among children aged 4–14 from eight European countries (UK, Poland, Spain, Germany, Sweden, French, Italy, and the Netherlands). Using parents' estimations of their children's social, operational, information navigation, mobile and content creation digital skills, findings show a varied picture. Spanish children, for example, have high levels of social digital skills but low levels of mobile skills, while Dutch children are high on operational and mobile digital skills, but low on social digital skills. Polish children score the highest on information navigation skills, but lower on mobile and content creation; English children are the most skilled. Italian children, in turn, score lowest on operational skills, information navigation (along with Swedish children), and among the lowest as to content creation. With respect to content creation digital skills, however, parents from all the surveyed countries reported lower levels of skills for their children compared to the other digital skills investigated. Even though these findings are to be taken with a grain of salt, given that parents reported on their children, it is crucial to note that, according to the ITU, these inequalities are not generational; thus they may persist in the future, unless proper educational interventions are planned and delivered, and resources allocated.

Additional support to the unequal distribution of digital skills among European children comes from the 2018 PISA report, which evaluates 15-year-olds' academic performance. Findings suggest that European children's performance in the three broad educational domains of reading, mathematics and science are significantly different across countries. When the three subjects are considered together, in fact, the underachievement rate tends to be lower in countries such as Finland, Ireland and Denmark, and higher in countries such as Bulgaria, Malta, Cyprus and Romania. These disparities are important as they may influence children's experiences with digital-related activities, the acquisition of important skills such as discerning the trustworthiness of the countless sources of information they can find on the web, or developing coding and programming skills, as well as their ability to enter a digitalised workforce. Inequalities in education achievements may, in fact, contribute to important differences across countries in their ability to benefit from and contribute to the development of technology in society.

One of the first research projects to analyse children's digital skills with a cross-cultural and child-centred approach has been the EU Kids Online 2010 survey (Livingstone et al., 2011). The survey included three measures of digital skills: breadth and depth of online activities; self-efficacy ("How true is it for you: I know a lot about the internet?" and "How true is it for you: I know more about the internet than my parents?"); and self-reported digital skills (with a focus on safety and critical skills). Findings showed considerable variations in the self-reported skills across the countries, with most skills claimed by children in Finland, Slovenia, the Netherlands and Estonia. Conversely, fewer skills were claimed by children in Turkey, Italy, Romania and Hungary (see Figure 2).

Figure 2. **CHILDREN'S SAFETY SKILLS AND CRITICAL SKILLS IN 2010 BY COUNTRY (AGE 11+)**



Source: Livingstone et al. (2011, p. 28)

Three measures of digital literacy – self-reported skills, activities, and self-confidence – were also employed in the Net Children Go Mobile project a few years later (Mascheroni & Ólafsson, 2014), aimed at assessing how access to the internet by means of smartphones and tablets was associated with changing online opportunities and risks. Self-reported skills measured in the survey included critical, safety and content creation skills, as well as a range of operational, critical, content creation and safety skills specific to smartphones and tablets. Cross-national variations in the average number of digital skills were smaller but still significant, with 9- to 16-year-olds claiming seven skills (out of 12) on average in Portugal and Denmark while their peers in Ireland, Belgium and Italy report little more than five skills on average. Digital skills related to smartphones and tablets are higher in Italy, Portugal and the UK (where children claim on average eight skills out of 11) and lowest in Belgium, Ireland and Romania (nearly seven skills are reported by children in these countries).

2.3 Comparing children's skills across Europe through the alignment method

Based on our new analysis of the EU Kids Online 2020 data, we compared children's digital skills across the countries. However, questions of data comparability for datasets from different countries using different languages need to be addressed. In this respect, the measurement invariance framework (see the "Methodological appendix") and the alignment method analysis can help. A relatively novel approach in addressing a potential lack of measurement invariance, the alignment method (Asparouhov & Muthén, 2014) combines the elements of an exploratory factor analysis (specifically factor rotation) and measurement invariance testing to find a solution that minimises the degree of invariance among groups. Subsequently, it estimates latent means for groups, and statistically tests the differences between these means. This allows us to make the most precise estimation of difference between groups given the presence of measurement invariance.

The results of our measurement invariance tests (see the "Methodological appendix") tell us that the item loadings of the digital skills scale do not differ across countries, which allows us to compare relationships of digital skills and other variables of interest across the countries. However, invariance of item intercepts was not supported, which suggests it would not be appropriate to compare simple mean levels of digital skills. With the help of the alignment method we are, however, able to more precisely estimate the differences across the countries while minimising the bias caused by

differences in measurement, and which reflect the actual differences in digital skills. Based on the findings from our alignment method analysis, we report the T-score ranking of countries, statistically significant country differences in terms of children's digital skills, and T-score differences of gender and age groups within countries.

Estimating latent means through the alignment method yielded a mean value for each country's average digital skill level. These values were, however, not on an easily interpretable metric and so were converted into T-scores – standardised scores with a mean = 50 and *SD* = 10. This lets us describe the distribution of latent means within our sample of 17 countries – countries with a T-score of 50 were among the average and a hypothetical country with a T-score of 60 would be 1 standard deviation above the mean. Ranking of country means converted to T scores can be found in Figure 3. As we can see, most countries cluster closely together around the mean, with France and Estonia deviating no more than 4 points (0.4 *SD*) below the mean. This means that when it comes to country differences in terms of young people's digital skills, youth from Serbia, Portugal, Finland, Lithuania, Belgium and Estonia ranked among the highest skilled, while youth from France, Spain and Italy ranked the lowest.

Subsequently, latent mean differences were tested statistically, and yielded 72 significant differences between the countries. However, the magnitudes of statistically significant differences range from small (Cohen's $d = 0.13$) to medium (Cohen's $d = 0.64$), with an average effect being relatively small (mean $d = 0.31$). The list of statistically significant differences between pairs of countries, along with their effect sizes, can be found in Table 1. Our findings partially support and expand results from previous studies on the matter.

To some extent, our data suggest that the notion according to which Northern countries are more skilled than Southern countries needs to be problematised. The I-DESI data (2018) show that Northern countries tend to score higher in digital skills compared to their Southern counterparts. The same patterns have been documented by the ITU report (2018). By contrast, the EU Kids Online results show that countries such as Serbia and Portugal scored among those countries with the highest skilled youth, suggesting that Northern–Southern differences should not be taken for granted. Importantly, both the I-DESI (2018) and the ITU data (2018) looked at the general population without a specific focus on young people. As such, it can be inferred that to some extent the absence of specific measures used with children does not allow us to make straightforward comparisons between these databases. More consistent findings, in this sense, come from the Net Children Go Mobile study (Mascheroni & Ólafsson, 2014), where, in line with our results, Portuguese children claimed a high number of skills (equal to a Northern country such as Denmark). These differences suggest that when interpreting cross-cultural differences, it is important to be cautious, as no linear estimations can be made.

Nevertheless, some data do offer support for the North–South digital divide. When we look at the different distribution of digital skills among the surveyed countries, for example, we can see that Finland is among the top three countries for higher levels of digital skills, while Italy scores among the three lowest. On a general level, this is in line with the I-DESI data (2018), showing that the Finnish general population scores higher on digital skills compared to the Italian population. France, Spain and Italy have lower levels of digital skills among children, a finding mirroring the overall difference between Northern and Southern Europe in terms of digitally skilled citizens as reported by the ITU (2018). Past EU Kids Online surveys showed, to some degrees, similar patterns, with Finnish children self-reporting more digital skills than Italian children (Livingstone et al., 2011).

With respect to children's demographics, when comparing boys and girls within each country using the same alignment method approach, statistically significant differences only emerged in 4 of the 19 countries examined: Belgium (Cohen's $d = 0.19$), the Czech Republic (Cohen's $d = 0.27$), Norway (Cohen's $d = 0.26$) and Serbia (Cohen's $d = 0.25$). Boys scored higher in each instance. This finding is relevant on at least two levels. First, it is in line with previous studies showing that boys generally

use digital technology more often, and thus they are in a position to develop more skills (Durndell & Haag, 2002). Second, gender is not a consistent predictor of differences in digital skills, as it may reflect digital self-confidence and social desirability more than actual skills (Haddon et al., 2020). As such, if we look at the European landscape as a whole, the picture is overall optimistic. But while having almost three-quarters of countries not showing significant gender differences is certainly positive, gender gaps still need to be addressed as limiting children's equality in digital-related opportunities. In this sense, our findings can offer stakeholders a clear picture in terms of the gender-related digital divide in Europe among children. Importantly, studies on gender differences in digital skills are often biased, as they are based on self-report measures where boys appear to be more self-confident about their digital skills, and not necessarily more skilled than girls (Tondeur et al., 2011), which is the same for the EU Kids Online data. As such, although exact reasons why these differences occur go beyond our knowledge at this stage, knowing exactly where they occur can inform both national and international research agendas to better contextualise and possibly explain these results, as well as policy-makers, educators and parents to tailor appropriate courses of action so that a more equal distribution of different kinds of skills can be fostered among boys and girls, possibly based on measures of actual more than self-reported skills.

Finally, when comparing younger adolescents (aged 12–13) to older ones (aged 14–16), the only country with no difference between age groups was Belgium. In all other countries the difference was statistically significant and ranging from small (Cohen's d = 0.24) to a medium-to-large effect size (Cohen's d = 0.72), with an average Cohen's d = 0.47. Older adolescents expectedly reported higher levels of digital skills in all countries.

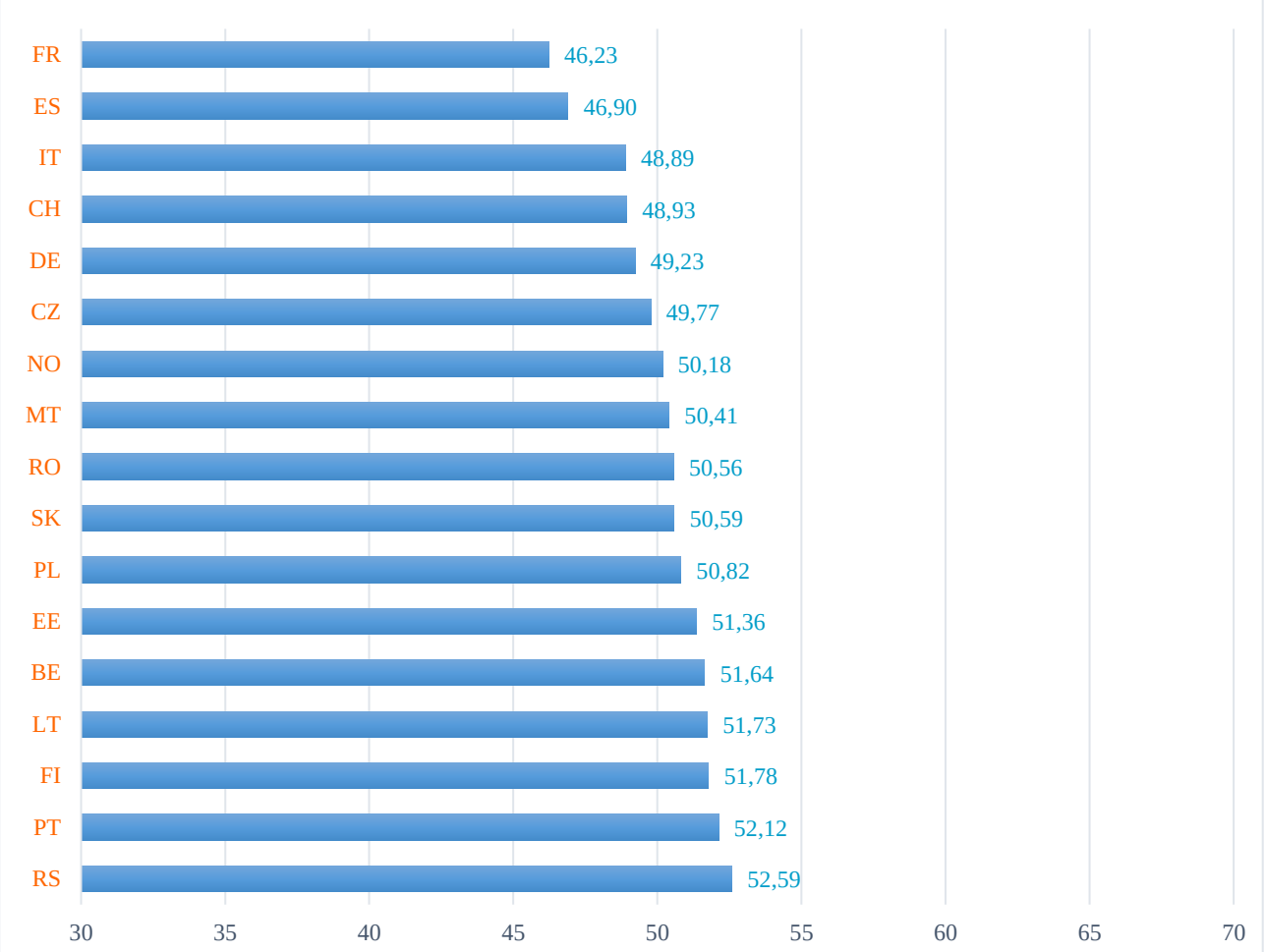
The fact that in all but one of the participating countries older adolescents are more skilled than younger adolescents confirms what was already supported by previous studies (Livingstone & Helsper, 2010), suggesting that digital skills acquisition is a cumulative – yet complex – process, where higher opportunities to more actively and extensively engage with technology that come with growing up and attaining higher education may help youth have a better grasp of internet use.

Country differences in acquisition of digital skills were small.

Variations in the adoption of digital technologies across Europe do not correspond to big differences in acquisition of skills for young people.

Overall, the observation of small or medium differences in the acquisition of digital skills among children across countries suggests that, despite persisting digital inequalities in Europe, as highlighted by the I-DESI, cross-cultural variations among young people are low, which is in line with Greenfield's (2019) suggestion that media effects can only partially be explained by cultural differences.

Figure 3. T-SCORE RANKING OF COUNTRIES



Note: For easier comparison, latent means estimated by the alignment method were converted into a standardised T-score metric (average = 50, SD = 10). This means that in our sample of 17 countries, most were clustered around the mean and none deviated from the mean by more than 0.5 standard deviation. This suggests low variability of digital skills across the tested countries.

Table 1. STATISTICALLY SIGNIFICANT COUNTRY DIFFERENCES

	T	FR	ES	IT	CH	DE	CZ	NO	MT	RO	SK	PL	EE	BE	LT	FI	PT	RS
RS	52.59	.64	.57	.37	.37	.34	.28	.24	.22	.20	.20	.18						
PT	52.12	.59	.52	.32	.32	.29	.24	.19	.17	.16	.15	.13						
FI	51.78	.55	.49	.29	.28	.25	.20	.16	.14									
LT	51.73	.55	.48	.28	.28	.25	.20	.16										
BE	51.64	.54	.47	.28	.27	.24	.19	.15										
EE	51.36	.51	.45	.25	.24	.21	.16											
PL	50.82	.46	.39	.19	.19	.16											•	•
SK	50.59	.44	.37	.17													•	•
RO	50.56	.43	.37														•	•
MT	50.41	.42	.35													•	•	•
NO	50.18	.39	.33											•	•	•	•	•
CZ	49.77	.35	.29										•	•	•	•	•	•
DE	49.23	.30	.23									•	•	•	•	•	•	•
CH	48.93	.27	.20									•	•	•	•	•	•	•
IT	48.89	.27	.20								•	•	•	•	•	•	•	•
ES	46.90			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
FR	46.23			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•

Note: Country level means estimated using alignment method and converted into T-scores;
• indicates a statistically significant difference in digital skills at a p<0.05 level. Values above the diagonal represent Cohen's ds of the differences between countries.

Figure 4. T-SCORE DIFFERENCES OF AGE GROUPS WITHIN COUNTRIES

Note: All 34 latent means estimated by the alignment method (for both older and younger adolescents in each country) were ranked and converted into a standardised T-score metric.

3. The antecedents of digital skills

3.1 Introduction

As explained in the theoretical model above (see Section 1.2), we understand digital skills as a diverse set of operational, information navigation, communicative, creative and mobile competences, which are unequally distributed and influenced by a number of individual and contextual variables. In this section, we aim to explain the uneven distribution of digital skills through a model that identifies the actors and factors, and the pathways that lead to the acquisition of digital skills. We focus on digital skills as an outcome, accounting for differences between the countries.

Several factors are related to differential gradations of digital skills in the population. Existing research on inequalities in adults' digital skills have shown that education and socioeconomic status (SES) are strong predictors of digital skills (Hargittai & Hinnant, 2008) as much as prior experience with the internet and "autonomy of use", that is, free, unrestricted access to use the internet "when and where one wants" (Hargittai & Hinnant, 2008, p.606). The relationship between age, gender and digital skills has been less consistently demonstrated, with studies showing that the influence of gender varies at different life stages (Helsper, 2012), and gender differences matter only for some types of digital skills (van Deursen et al., 2016).

The literature on inequalities in skills among children has largely drawn on research on digital divides among adults. Findings show that sociodemographics (age, gender and socioeconomic background of the child) are correlated with quality of access, amount of internet use and online expertise. Together, sociodemographic and internet-related variables shape the progression in the take-up of online opportunities from basic activities to more interactive and creative uses (Livingstone & Helsper, 2007).

Therefore, internet use (measured by both frequency of use and time spent online) is deemed to be an important variable to consider in studies of the resilient digital inequalities among children. The hypothesis underlying research in this area is that the more children use digital technologies, the more opportunities they take up and familiarise themselves with, the more skills they acquire that they would not have without direct experience of a broader range of online activities.

More specifically, children's demographics have been shown to have both a direct and indirect impact on digital skills. Research confirms differential access and use of the internet depending on demographics. With respect to *age*, prior work is consistent in showing that older children tend to have more access to the internet and computers, thus climbing further up on the "ladder of opportunities" and progressing from basic tasks to more advanced uses (Livingstone & Helsper, 2007). Consequently, older children develop more skills (Livingstone & Helsper, 2010). Age has a positive association with digital skills, and also with internet access and online activities, which, in turn, influences the acquisition of digital skills.

Similarly to what is found in relation to adults, however, research findings are ambivalent when it comes to *gender*: while some studies found that boys tend to use technology and access the web more frequently than girls (Durndell & Haag, 2002), others support the finding that girls spend more time on the internet and are more skilled when it comes to processing and evaluating online information (Aesaert et al., 2014; Hohlfeld et al., 2013). Livingstone and Helsper (2010) found a positive correlation between gender, quality of access, internet use and digital skills; however, their path analysis showed no direct effect of gender on internet use and digital skills, thus countering the common-sense belief that girls are less confident on the internet.

With respect to *children's SES*, while existing research incorporates socioeconomic and home background as significant predictors of children's use of ICT (and thus, influencing the possibility of developing skills), findings are mixed (Scherer et al., 2017). For example, Zilka (2019) found that children from higher-income families exhibited a significantly higher level of digital skills compared to their peers from more disadvantaged backgrounds. In contrast, Tondeur et al. (2011) found that

SES affects the computer use of youth only moderately, reporting small or absent relationships between SES and children's ICT use, attitudes towards computers and digital skills. Livingstone and Helsper (2007, 2010) found that children from higher-income families benefit from more autonomy of use and better quality of access; however, the effect of SES on digital skills and opportunities is only indirect, mediated by access.

With respect to *online activities*, as anticipated above, research in the field assumes a positive association between internet use, online activities and digital skills. However, the relationship between use and opportunities is mediated by digital skills (Livingstone & Helsper, 2010). Digital skills encourage the take-up of more opportunities: those who use the internet more and have more skills engage in a broader range of online activities than those who use it an equivalent amount of time, but who have lower skills.

Online activities have been mainly addressed from a usage gap perspective. The usage gap theory assumes, quite normatively, that some internet activities are more beneficial than others, both for the acquisition of digital skills and their translation into tangible resources that promote social inclusion and wellbeing (van Deursen & van Dijk, 2014). For example, a usage gap is expected between those who only use the internet for entertainment and distraction, and those who use digital technologies for work, education, banking, etc. In the digital divide debate – especially in studies theorising a third-level digital divide that consists of inequalities in the outcomes of internet use (see van Deursen & Helsper, 2015; and also Section 4) – the breadth of digital engagement (usually measured by number and variety of activities taken up) as well as the nature of online activities conducted on a regular basis are used as indicators of digital inclusion, and are seen as positively associated with skills. Studies have found that children who use the internet more often and engage in more online activities – including a range of activities not limited to those related to schoolwork – tend to score higher on internet skills than their peers who only use the internet for non-leisure-related tasks (Scherer et al., 2017). Users' digital skills are also associated with a plethora of capital-enhancing online activities that enhance the user's cultural, economic and/or social capital. Nevertheless, the strongest predictor of engagement in beneficial online activities remains education (Hargittai & Hinnant, 2008).

Another factor that children's experience of ICT depends on is *parental mediation*, the various practices through which parents aim to control and guide children's use of digital media, in order to maximise the beneficial outcomes and minimise risks. While common-sense knowledge embedded in a discourse of "good parenting" invites parents to limit their children's exposure to screens (Blum-Ross & Livingstone, 2018), empirical research supports the conclusion that enabling mediation (which encompasses parental practices that aim at enabling children's positive use of the internet, such as parents' active engagement in the child's online activities) is associated with higher opportunities for children to acquire digital skills, while restrictive mediation (namely, rules that limit time spent on the internet or restrict certain online activities) actually narrows down the breadth of online activities taken up by children and their overall level of digital skills (Livingstone et al., 2017). Whereas restrictive mediation has a direct, negative effect on digital skills acquisition, enabling mediation is positively associated with deeper engagement with the internet (more time spent online and more online activities) and, therefore, has an indirect effect on digital skills (Livingstone et al., 2017). Prior research based on the EU Kids Online 2010 survey data showed a substantial negative correlation between the range of online activities and digital skills on the one hand, and restrictive mediation on the other (Paus-Hasebrink et al., 2012). By contrast, countries where children are encouraged to experience the internet on their own, and are actively supported by their parents when they encounter risks, score higher on the overall level of digital skills possessed by children.

With digital communication being part of many children's daily lives, some of them may develop a *preference for online social interaction* (POSI), experienced when individuals find it easier to express themselves online and form intimate relationships online rather than offline (McKenna et al., 2002). Extant research, however, has mostly investigated this construct as related to and affected by

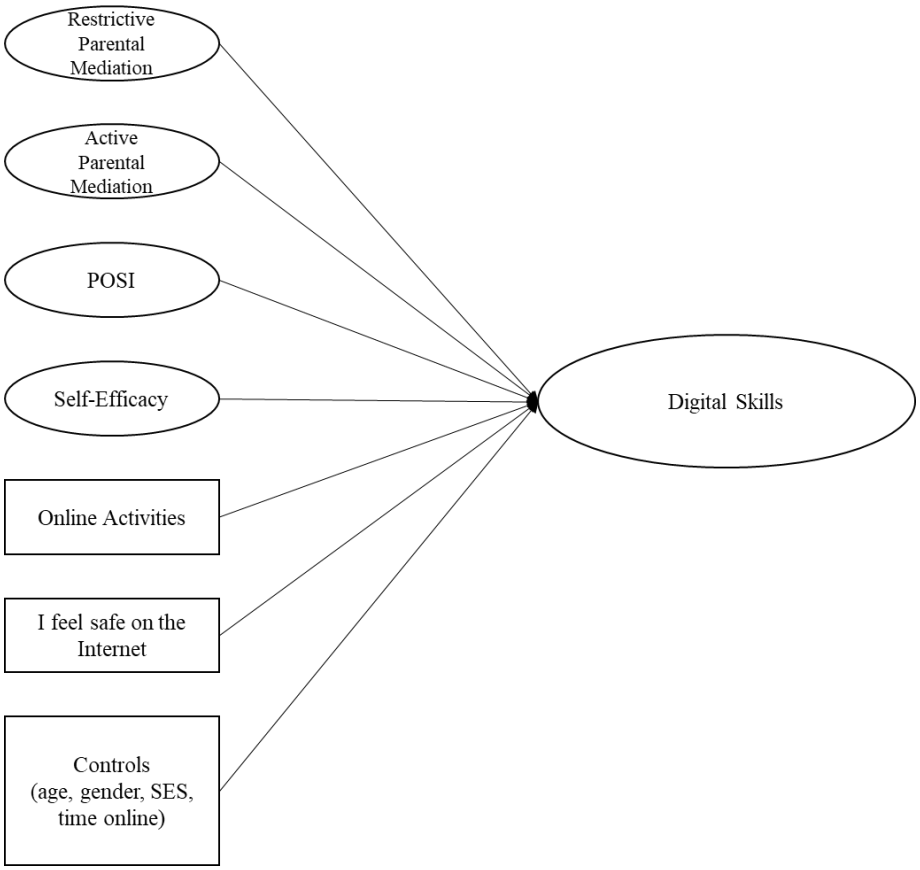
problematic traits, such as loneliness and depression, suggesting that lonely and depressed people who find hard to interact with peers offline may develop a preference for online social interaction which, in turn, results in problematic outcomes such as compulsive use of the medium (Caplan, 2003). Research has also found that higher levels of POSI were positively associated with higher preferences for online friendship for adolescents and young adults, which may potentially lead to a decline in one's offline social circle (Smahel et al., 2012). Little to no data, however, are available with respect to the role that POSI may play in children's acquisition of digital skills. A preference for online communication may, in fact, lead to using the internet and digital media more, knowing them better, and thus being more skilled. Previous research on the matter, however, may be reflective of alarmist frameworks depicting the web as a risky place for youth and overlooking collateral positive opportunities of internet use (Jewkes & Wykes, 2012), in terms of empowerment, self-expression, informal learning, content creation, and the like. As such, we seek to expand this area of inquiry, exploring whether POSI may, in turn, foster children's acquisition of digital skills.

Children's *self-efficacy* (i.e., confidence in their ability to control events affecting their lives; see Bandura et al., 1999) has been found to be an important psychological variable in children's ability to balance risks and opportunities when using ICT (Livingstone et al., 2018), with internet self-efficacy being associated with age and SES (Livingstone & Helsper, 2010). As such, we expect that self-efficient children will display higher levels of digital skills compared to their less self-efficient peers.

Research on the relationship between online safety and digital skills has generally focused on whether more digitally skilled children would have a safer online experience, reporting that children with higher levels of digital skills may benefit from using the internet more safely, and that as children acquire certain skills by engaging in online activities, they may also improve their internet safety abilities (Sonck & de Haan, 2014; Sonck et al., 2012). We wonder, in turn, whether *feeling safe online* may work as a variable having the potential to affect children's acquisition of digital skills. A study by Appel (2012), for example, found that internet use was related to higher levels of comfort for children when using the computer and social media, advancing that a better knowledge of the online environment would decrease anxiety associated with its use. In this sense, it can be assumed that the more children feel safe on the internet, the more they engage in online activities, which, as a result, may foster the acquisition of skills. Following this line of inquiry, we expect that children who feel safe and comfortable online may report higher levels of digital skills.

Finally, children's *personal attitudes towards the internet* are associated with the acquisition of digital skills. Previous research suggests that the more children use social media and get to know that environment, the safer and less anxious they feel about it, which is associated with higher computer skills (Appel, 2012).

Figure 5. ANALYTICAL MODEL OF THE ANALYSIS



Note: Indicator items and error terms were omitted for clarity. The items that define the latent constructs (ellipses) can be found in the "Methodological appendix". "Online Activities" referred to the sum of online activities that adolescents engaged in at least weekly. "POSI" indicates preference for online social interaction.

3.2 Results

Following the brief literature review above, we aimed to test the relationship between online activities, POSI, children's self-efficacy, children's attitudes towards the internet (namely, feeling safe online) and different types of parental mediation. For a more detailed summary of the analysis, refer to the "Methodological appendix".

In general, the strongest predictors were restrictive parental mediation, number of online activities, self-efficacy, and feeling safe on the internet. The only non-significant predictor was SES. Overall, our findings are in line with the pool of existing literature in the topic. We now further discuss each in turn.

With respect to *parental mediation*, our findings show that restrictive strategies negatively predict skills. Controlling for all other predictors in the model, restrictive parental mediation predicted digital skills negatively (e.g. more restrictions placed by parents were associated with lower skills) and the βs ranged from –0.348 to –0.551, with an average of –0.429 (*SD* = 0.061). The negative effects of restrictive mediation on digital skills are not surprising: the literature has clearly shown that the more parents restrict their children's opportunities to engage with technology in general, and the internet in particular, the lower the possibility for them to familiarise with the digital environment, experience it, and overall learn how to use it effectively (Livingstone et al., 2017). Things get more complicated when it comes to active mediation. While the literature has shown its important role in enabling

opportunities for children to formally and informally learn how to use digital media and the internet effectively (Livingstone et al., 2010), the positive association between active parental mediation and skills in our model was generally weak. This may be due to the demographics of our sample (12- to 16-year-olds), as previous studies found that both active mediation itself and its effects tend to decrease as a child grows into adolescence (Duerager & Livingstone, 2012).

All in all, in spite of the small effect of active mediation, our findings are generally in line with the broader literature on the relationship between mediation strategies and children's development of skills.

Similarly, the breadth of *online activities* children engage in is a significant predictor of digital skills in spite of cultural differences. βs ranged from 0.144 to 0.263 with an average of 0.195 (*SD* = 0.028). *Feeling safe on the internet* was likewise a positive predictor, and the βs ranged from 0.081 to 0.148, with an average of 0.115 (*SD* = 0.019). When all other variables are held constant, adolescents who are more invested in online activities or those feeling safe on the internet tend to have better digital skills. Following Appel (2012), it can be argued that the more children familiarise themselves with the online environment and the more they feel safe online, a better knowledge and understanding of the internet would result from this, supporting their acquisition of digital skills.

The "online activities" measure adopted in this study incorporated educational and extra-educational activities, ranging from using the internet for homework to watching online videos or playing games, etc. The diversity of activities included in our measure provided support for the notion that the more varied the activities are that children take up online, the greater the skills they can learn (Livingstone & Helsper, 2007). This is in line with studies finding that children who use the internet for activities beyond the school-related ones appear to be more skilled than their peers who only use it for schoolwork, possibly developing just a limited set of skills that are difficult to transfer to other online environments and situations (Scherer et al., 2017). However, as we will see in the next section, the reverse is also true, so that higher digital skills predict engagement in a more diverse set of online activities.

Self-efficacy was found to be a positive predictor of digital skills, and the βs ranged from 0.161 to 0.300, with an average of 0.254 (*SD* = 0.045). Adolescents who perceive themselves as more capable in general also rate their digital skills higher. Consistently with our expectations, children's confidence in their ability to handle situations affecting their lives seems to positively predict a higher level of digital skills. Arguably, the more children feel in control of the events they experience – which take place not only offline but also online – the more they may feel at ease in surfing the web, seeking information online, creating and sharing content, and generally integrating the internet into their daily life to the point where they master its use. Our findings are additionally in line with previous research on the topic stressing the importance of this psychological variable for children to counterweight positive and negative experiences on the web, fostering digital skills acquisition (Livingstone et al., 2018). Moreover, since research showed that accuracy in the estimation of ICT self-efficacy is positively associated with actual digital skills, we can assume that children make relatively accurate judgements about their digital skills (Aesaert et al., 2017).

As for POSI, this variable was traditionally investigated more with respect to negative outcomes (Caplan, 2003). In our study, POSI had a relatively weak positive association with digital skills. This finding is relevant, however, as most of the literature has generally focused on the preference for online social interactions with respect to its relations with loneliness, depression, isolation from offline relationships and overall problematic internet use (Caplan, 2003; McKenna et al., 2002). Our findings, in turn, show a new facet of the coin, suggesting that youth who find it easier to express themselves online may actually benefit from this usage to develop skills relevant to the digital environment they feel more at ease in. In relation to other predictors, however, this effect is practically very weak.

The control variables had a generally weak association with digital skills. Controlling for other variables in the model, it seems that older adolescents had reported slightly lower digital skills; however, the strength of this relationship was practically negligible. Boys reported higher digital skills than girls, and time spent online was expectedly associated with higher skills. SES was the only non-significant predictor in the model.

It is furthermore important to note that the model explained the most amount of variance in Estonia (R^2 = 0.667) and in Germany (R^2 = 0.592) and the least in Slovakia (R^2 = 0.365) and Belgium (R^2 = 0.313). This suggests that, despite the high proportion of explained variance in some countries, there is still room to investigate other predictors of digital skills in future research.

The strongest predictors of digital skills across countries are: restrictive parental mediation (negative), self-efficacy, number of online activities children engage in, preference for online interactions, and feeling safe on the internet (all positive).

Table 2.	COMPARISON OF PREDICTORS OF DIGITAL SKILLS ACROSS COUNTRIES								
	Constr.	BE	CZ	EE	FI	FR	DE	IT	LT
Age	-.246	-.043	-.060	-.047	-.037	-.049	-.051	-.037	-.041
Female	-.133	-.097	-.118	-.092	-.087	-.095	-.094	-.073	-.078
Weekday online	.295	.082	.109	.076	.070	.091	.066	.064	.064
SES	.033^{ns}	.016^{ns}	.019^{ns}	.015^{ns}	.014^{ns}	.016^{ns}	.016^{ns}	.012^{ns}	.013^{ns}
Restrictive	-.318	-.384	-.438	-.551	-.424	-.365	-.480	-.463	-.491
Active	.097	.075	.089	.076	.080	.083	.059	.059	.061
POSI	.054	.053	.052	.050	.050	.057	.059	.051	.047
Self-efficacy	.308	.296	.272	.240	.300	.283	.251	.202	.166
Online activities	.053	.214	.218	.181	.220	.263	.210	.162	.170
Feel safe[a]	.101	.118	.148	.104	.099	.124	.109	.106	.095
R^2		.313	.522	.667	.413	.446	.592	.410	.427

Table 2. continued	COMPARISON OF PREDICTORS OF DIGITAL SKILLS ACROSS COUNTRIES								
	MT	NO	PL	PT	RO	RS	SK	ES	CH
Age	-.040	-.059	-.040	-.045	-.036	-.054	-.032	-.043	-.038
Female	-.086	-.114	-.077	-.088	-.062	-.103	-.062	-.098	-.101
Weekday online	.084	.082	.076	.092	.067	.096	.046	.097	.081
SES	.015^{ns}	.019^{ns}	.013^{ns}	.016^{ns}	.010^{ns}	.017^{ns}	.010^{ns}	.016^{ns}	.016^{ns}
Restrictive	-.356	-.411	-.470	-.348	-.456	-.465	-.488	-.348	-.356
Active	.087	.089	.078	.080	.064	.092	.055	.102	.088
POSI	.051	.055	.049	.057	.035	.065	.038	.068	.058
Self-efficacy	.290	.300	.242	.282	.212	.291	.161	.267	.256
Online activities	.200	.210	.161	.204	.183	.180	.144	.203	.199
Feel safe[a]	.110	.111	.112	.124	.092	.146	.081	.138	.137
R^2	.371	.453	.397	.449	.461	.554	.365	.471	.437

Note: *Constr. = Set of constrained coefficients that were estimated for all countries (unconstrained); the four most consistent and strongest predictors are bolded; [a] = "I feel safe on the internet"; ns = non-significant. All other coefficients significant at p<0.001.*

3.3 Discussion and recommendations for future research

The findings of our analysis suggest the opportunity to expand the variables tested as antecedents of digital skills beyond the "usual suspects" – namely, time spent online, online activities and parental mediation. Feeling safe online, children's level of self-confidence and, partially, preference for online social interactions, also matter.

While the negative correlation between parental restrictions of children's internet use and their acquisition of digital skills is consistent with prior research, the weak positive association between active parental mediation and digital skills may sound puzzling and even counter-intuitive. As our data do not allow us to explain such ambivalence, a possible lens to look at it comes from Paus-Hasebrink and colleagues' (2013) types of parent–child relationship and internet use. Based on EU Kids Online 2010 data from 25 European countries, the study found four family types: the digital native vs digital immigrant family, reporting low levels of parental mediation and parent–child proximity; the unskilled family, with low levels of active mediation and high levels of restrictive mediation (thus, with lower scores of children's digital skills); the "triple C" family (confident-caring-communicative), predominantly oriented towards active mediation, thus showing higher levels of children's digital skills; and the protective family, which reported high levels of active but even higher levels of restrictive mediation. Interestingly, the protective family type was particularly frequent in Italy and Germany, while in Portugal, both the digital native/immigrant and the "triple C" types were fairly common. Looking at our findings through this lens, it can be inferred (although not demonstrated) that Portuguese children's high levels of skills may be due to the presence of many "triple C" family types that are high in active mediation and thus foster children's acquisition of skills online. Future studies may build on this framework in order to find possible explanations for this difference.

The association between self-efficacy and digital skills is also noteworthy, although it should be discussed against the measure of digital skills adopted by a particular study. When digital skills are self-reported, as in the EU Kids Online survey (Smahel et al., 2020), it is likely that children who feel more self-confident are also more inclined to report higher levels of digital skills. However, as already argued above, the association between digital skills and children's self-efficacy is consistent with research suggesting the importance of psychological self-confidence and the development of digital skills and resilience (Livingstone et al., 2018).

Also notable is the influence of POSI on digital skills, although this was weak in most countries. The finding is nonetheless important as it challenges common assumptions disregarding online social interactions (Micheli, 2016; Plowman & McPake, 2013).

Overall, our model is able to predict variations in digital skills in a significant and consistent fashion across countries, capable of highlighting the role of under-investigated variables in predicting digital skills acquisition among children and consistent with the findings of prior research on children's digital skills. However, our model was limited by methodological constraints, namely, the existing measures of the EU Kids Online 2010 survey. For example, the limited influence of active mediation can be explained by the specific items asked in the survey that are more balanced towards online safety (except for the "Encourages me to explore and learn things on the internet" item). Future research in the field could enrich the measurement of parental mediation used in the survey, so as to measure the overall influence of enabling mediation (Livingstone et al., 2017) on digital skills acquisition.

Due to the design of the questionnaire, we were not able to include in the model two usually strong predictors of digital skills, namely, internet experience and autonomy of use. While still relevant for adults, internet experience, as measured by the number of years an individual has been using the internet for, may no longer be a relevant antecedent of digital skills, at least in European countries where children as young as toddlers are likely to access the internet, especially by means of touchscreens such as smartphones and tablets (Chaudron, 2015; Marsh et al., 2018). However, future

studies could investigate the influence of autonomy of use – measured by the number of devices and locations a child has at their disposal to go online – as existing studies on young people's and children's use of smartphones showed (Madden et al., 2013; Mascheroni & Ólafsson, 2014). Most notably, children from lower SES are more likely to access the internet only from a smartphone, with consequences on the kind of activities they routinely engage in and the digital skills they develop.

4. The consequences of digital skills

4.1 Introduction

The digital divide and digital inclusion debate has shifted from addressing inequalities in access to computers and the internet to investigating inequalities in the skills and competences required to effectively use digital technologies (the second-level digital divide; see Hargittai, 2002) and, more recently, to theorising inequalities in the abilities to translate internet use into beneficial outcomes in everyday life (van Deursen & Helsper, 2015). Following the more nuanced theorisation and more elaborate measurements of digital skills in the digital inclusion scholarship (van Deursen et al., 2016), research on children and the internet has expanded its scope and research questions, from asking what influences the acquisition of digital skills to investigating the outcomes of digital skills on various levels.

In this section, we will briefly review the literature that has examined digital skills as a predictor and mediator of children's offline and online opportunities and risks (see also Haddon et al., 2020). This will cover areas such as digital engagement (breadth of online activities), offline engagement (e.g. civic and political engagement, academic success), wellbeing and resilience, as well as the relationship between digital skills and exposure to risks. Indeed, the very definition of digital skills as abilities that help individuals achieve "beneficial, high-quality outcomes in everyday lives for themselves and others" (ITU, 2018, p.23) speaks for their roles in contributing to certain consequences when it comes to using digital media. Looking at consequences, however, means moving beyond the dichotomy of opportunities vs risks, given that online risks and opportunities are related and mingle in complex ways: "Taking up online opportunities is proving, for many teenagers, an experience associated with some degree of risk" (Livingstone & Helsper, 2010, p.324).

As such, we report first on the range of online and offline opportunities enhanced by digital skills, and then on potential online and offline risks.

a) Digital skills as predictors and mediators of online and offline opportunities

A factor that is known to be influenced by children's digital skills is their degree of *digital engagement*, which can be defined in terms of gradations of participation in a diverse range of online activities, including more *technical* activities such as blocking spam, *critical* activities such as checking for news and information, *social interaction*, and *creative engagement* including uploading their own photos and posts (Helsper & Eynon, 2013).

Livingstone and Helsper (2010) examined whether and how more digital skills shape children's digital engagement through a path analysis. Their findings show that digital skills have a positive direct influence on digital engagement and also mediate between access factors (such as time spent online) and opportunities. Moreover, the same study shows that age is found to have an indirect influence on opportunities as mediated by access, use and skills (Livingstone & Helsper, 2010). To put it simply, the positive effect of digital skills on opportunities is stronger for older children. Furthermore, the findings highlight the complex relationship between opportunities and risks, as the more that children use the internet, the more likely they are to encounter online risks and vice versa. Helsper and Eynon (2013) also developed a path model in order to explain digital engagement through a digital inclusion perspective. Overall, the model shows that the relationship between digital skills and digital engagement is complex rather than linear. More specifically, it shows that different types of skills (operational, critical, social and creative) explain to a greater or lesser extent engagement in different groups of online activities (e.g. social skills are more strongly correlated with social engagement, and content creation skills are more strongly associated with engagement in online creative activities). Moreover, the findings suggest that digital skills can *mediate* between structural social inclusion factors (including age, gender, economic, cultural and social capital, and personal resources) and digital engagement: for example, the relationship between gender and education and different types of digital engagement lost significance when skills were introduced. The role of digital

skills in mediating the influence of social inclusion factors was observed for every type of digital engagement (technical, critical, social and creative), but was actually stronger for communication and social activities, thus suggesting that digital skills may be more important than expected in relation to online interactions.

Studies of children's digital skills have contributed to dismantle another myth associated with young people and the internet, beyond the myth of the digital natives: namely, the assumption that everyone, and especially the youngest children, are *produsers* (Bruns, 2008) who create and distribute their own content online. Research has shown, instead, that while children have fully incorporated the internet into their daily lives and engage in several online activities, not all of them are able to engage in creative ones (Livingstone & Helsper, 2007). Findings from the EU Kids Online 2010 survey support that while most children tend to have little difficulty in using the internet for more basic things such as school-related activities or watching videos, creative skills are unevenly distributed and are usually only taken up by older and more skilled children (Lobe et al., 2011). Informed by these studies, Balea (2016) found that digital skills were among the strongest predictors of children's ability to engage in creative internet use (such as creating an avatar, writing a blog or online diary, etc.), along with time spent online and self-efficacy. Mastering creative digital skills, then, can foster children's creative use of the internet, in line with research showing that creative skills are related to creative online engagement (Helsper & Eynon, 2013).

As mentioned, the digital inclusion literature has shifted its attention to the third digital divide, in order to assess whether and how online opportunities translate into tangible offline consequences that would contribute to strengthen social inclusion or, at the opposite, deepen inequalities (van Deursen & Helsper, 2015). Among the tangible offline outcomes of internet use, a topic that has received considerable public attention in recent years,[2] is *children's civic and political engagement*. Declining rates of youth participation in conventional citizenship modes (voting, party affiliation, trade unions membership) and their shift towards expressive forms of engagement and lifestyle politics (Bennett, 1998; Giddens, 1991) have been associated with the internet (Bennett, 2008; Loader et al., 2014, 2016). The question is not purely whether the internet provides opportunities for civic and political engagement beyond and independently from involvement in conventional practices of citizenship, but also whether and how digital engagement and digital skills are conducive of offline political and civic participation. Kim and Yang (2016) found a significant association between South Koreans' "internet information literacy" (i.e., critical and information navigation digital skills) and their level of interest in both political and social issues. Information navigation skills were also correlated with political efficacy and engagement in non-conventional political participation (including both offline and online activities such as signature-seeking campaigns, boycotts, rallies, posting messages to persuade others, sharing others' posts and joining online campaigns). The relationship between information navigation skills and conventional forms of political participation, instead, was rather small. Furthermore, operational digital skills and time spent on the internet were negatively associated with political efficacy. Therefore, the findings are supportive of the idea of an emergent citizenship style – "actualising citizenship" – favoured by the internet and digital literacy, as opposed to the conventional "dutiful style" (Bennett, 2008). In a further study conducted in South Korea on a national sample of 2,584 middle and high school students (Moon & Bai, 2020), digital literacy (including problem-solving, communicative and content creation skills) was found to be strongly associated with online (namely, participation in discussion and sharing of social issues on social media, signing online petitions) and offline civic engagement (volunteering, donations), although the effect of digital skills is mediated by interest for news, and more so among children who display more interest for news on social media. By contrast, in the medium attention group, digital skills predict online engagement but not offline civic engagement. Finally, among children who are least likely to engage with news on social media, the influence of digital skills is lower on both online and offline

[2] The number of empirical studies is still surprisingly low (see Haddon et al., 2020).

measures of civic participation. Examining mobile- and smartphone-based internet use, Park (2015) found that variations in teenagers' engagement in civic and political activities can be explained by differences in digital engagement and mobile skills. More specifically, content creation skills were a significant predictor of volunteering in local communities, while social entertainment-based skills had no significant relationship with indicators of civic and political engagement (volunteering, involvement in charitable organisations, political socialisation).

Children's digital skills have also been found to relate to their *academic life* in terms of general academic success and academic collaboration with peers online. In fact, a national representative study of Italian students found that pupils with higher levels of informational digital skills scored higher in reading and math tasks, supporting an association between digital skills and formal academic outcomes (Pagani et al., 2016). In terms of informal learning, studies found that mastering digital skills, such as information seeking and sharing, was a significant predictor of informal academic collaboration of high school students with their peers on Facebook, suggesting that higher-skilled youth, familiar with SNSs and able to perform school-related research online, are more likely to gather together with their peers to discuss classes or schoolwork, ask their classmates for help and get educational resources online (Khan et al., 2014). Similarly, a study by Eynon and Malmberg (2012) found that perceived digital skills predict online information seeking for homework-related activities. These findings support the notion that digitally literate children may benefit from an overall enhanced academic experience.

When considering the domestic environment, studies on *parental mediation* have generally focused on how parents educate their children to use digital technology, thus contributing to their digital skills acquisition. When considering digital skills as an outcome, as we have seen, there is a common consensus that enabling mediation strategies foster, while restrictive ones hinder, the range of online activities children engage in (e.g. Livingstone et al., 2017). A study from Rodríguez-de-Dios, van Oosten and Igartua (2018) specifically looked at this relationship, finding that digital skills mediate the relationship between restrictive mediation and online risks and opportunities. Restrictive mediation limits the acquisition of digital skills, which, in turn, reduces both online risks and opportunities. However, another important but less explored strand of research concerns the way children and parents reciprocally educate themselves to digital media use and acquire new digital skills. Clark's co-learning framework (2011), in this sense, conceptualises children as active agents who, in a two-way asymmetrical relationship with their caregivers, not only learn from, but also educate their own parents when the former are more skilled than the latter. More digitally skilled children are more likely to engage in intergenerational assistance and help their parents to do something they may find difficult on the internet (Katz et al., 2018), supporting the notion that digital skills can work as predictors of intergenerational assistance, expanding the parental mediation framework, and can be influential in supporting a Vygotskyian "zone of proximal development" where children themselves act as the "more knowledgeable other" (Vygotsky, 1980).

b) Digital skills as predictors and moderators of online risks

The relationship between digital skills acquisition, internet use, digital engagement and exposure to risks prompted research into the less desirable consequences and side effects of digital literacy.

For example, if digital skills increase with online experience and time spent on the internet, then digital skills may also be associated with *excessive internet use*. The fear that higher frequency of ICT use may lead children to develop addictive behaviours when using the internet is a recurring concern among caregivers and public opinion in general, with studies reporting on that dating back to over 20 years ago (Young, 1999; Young & Rogers, 1998). Scientific findings present a complex picture in this regard. On the one hand, research conducted with adolescents show that youth with higher levels of internet literacy in terms of self-regulation abilities (i.e., being able to control and self-regulate their internet use) were less likely to develop internet addiction symptoms compared to

their peers who scored lower in this measure (Wegmann et al., 2015). On the other hand, adolescents with higher internet skills have been found to more easily develop problematic internet use (Yu et al., 2019), which is in line with the fact that digital skills and time online are related, thus higher-skilled children may also tend to spend more time on the internet. An example of the complex relationship between excessive internet use, psychological vulnerability and digital skills is offered by Helsper and Smahel (2020). They found that children who self-reported higher internet skills spend more time online and use the internet for a broad range of activities, and had more chances of experiencing negative outcomes, although this was more the case for emotionally vulnerable youth. Findings from this study, in fact, supported the notion that children with higher skills and less psychological problems were least at risk of excessive internet use, while those with high levels of skills and psychological problems were more at risk, but when controlling for intervening variables, children with higher skills experienced less negative effects. As such, if, on the one hand, digital skills can facilitate children's excessive internet use, on the other, they can also provide a buffer against negative outcomes.

Equally worrying is the question of whether time spent online relates to more digital skills, but also to higher chances for children to be victims of, or to engage in, *risky and aggressive behaviour* (Livingstone & Helsper, 2010). Drawing on the EU Kids Online 2010 survey data, Sonck and de Haan (2013) showed that children with a higher level of self-reported digital skills were more likely to encounter some online risks – namely, seeing sexual images on the internet and meeting online contacts in person. Focusing on cyberbullying, adolescents with lower digital skills are more likely to both cyberbully their peers and also to be cyber victims (Çakir et al., 2016). This may be due to the fact that children are less aware of the potential consequences of sharing offensive content online, and less able to defend themselves against online attacks. In this sense, research supports that digital skills both prevent children from engaging in cyberbullying behaviour – as they are more aware of their actions – and also protect them from the risk of becoming a victim when able to control the breadth and depth of information they share online about themselves (Müller et al., 2014). These findings are further supported by Gini and colleagues (2019), who found that ethical media use is negatively associated with cyberbullying others and being a victim of cyberbullying. Taken together, these studies suggest that digital skills can play both a protective and preventive role in children's experience of online aggressive behaviour.

The *correlation between digital skills, opportunities and risks* of the internet for children has been particularly puzzling for researchers, policy-makers and educators, as research findings have shown that the more children use the internet, the more skills they develop, but equally the more likely they are to encounter online risks. Sonck and de Haan (2013), for example, found a statistically significant correlation at the European level between self-reported digital skills and online risk encountered. The relationship was positive for all the European countries and highest in Austria and Norway. However, one of the most important conclusions of the EU Kids Online project has been that, although exposure to online risks is positively associated with opportunities, it does not necessarily translate into actual harmful experiences (Livingstone et al., 2018). Rather, children who report lower levels of digital skills are less likely to encounter risks on the internet but more likely to experience harm when they see inappropriate content or have risky contacts (Sonck & de Haan, 2013). However, Sonck and de Haan (2013) also found that self-reported skills, sociodemographic variables and internet experience could not fully explain variation in the incidence of harm across the EU Kids Online 2010 survey countries, suggesting that psychological factors or the context in which children use the internet (e.g. school context, peer influence) are more influential in shaping the relationship between risks and harm.

Further analysis on the EU Kids Online data showed that digital skills are associated with the way children deal and *cope with online problematic situations*. Less digital skills are correlated with more passive responses to dealing with online risks. By contrast, more skilled children are more likely to adopt pro-active responses, such as blocking unwanted contacts and deleting aggressive and harmful

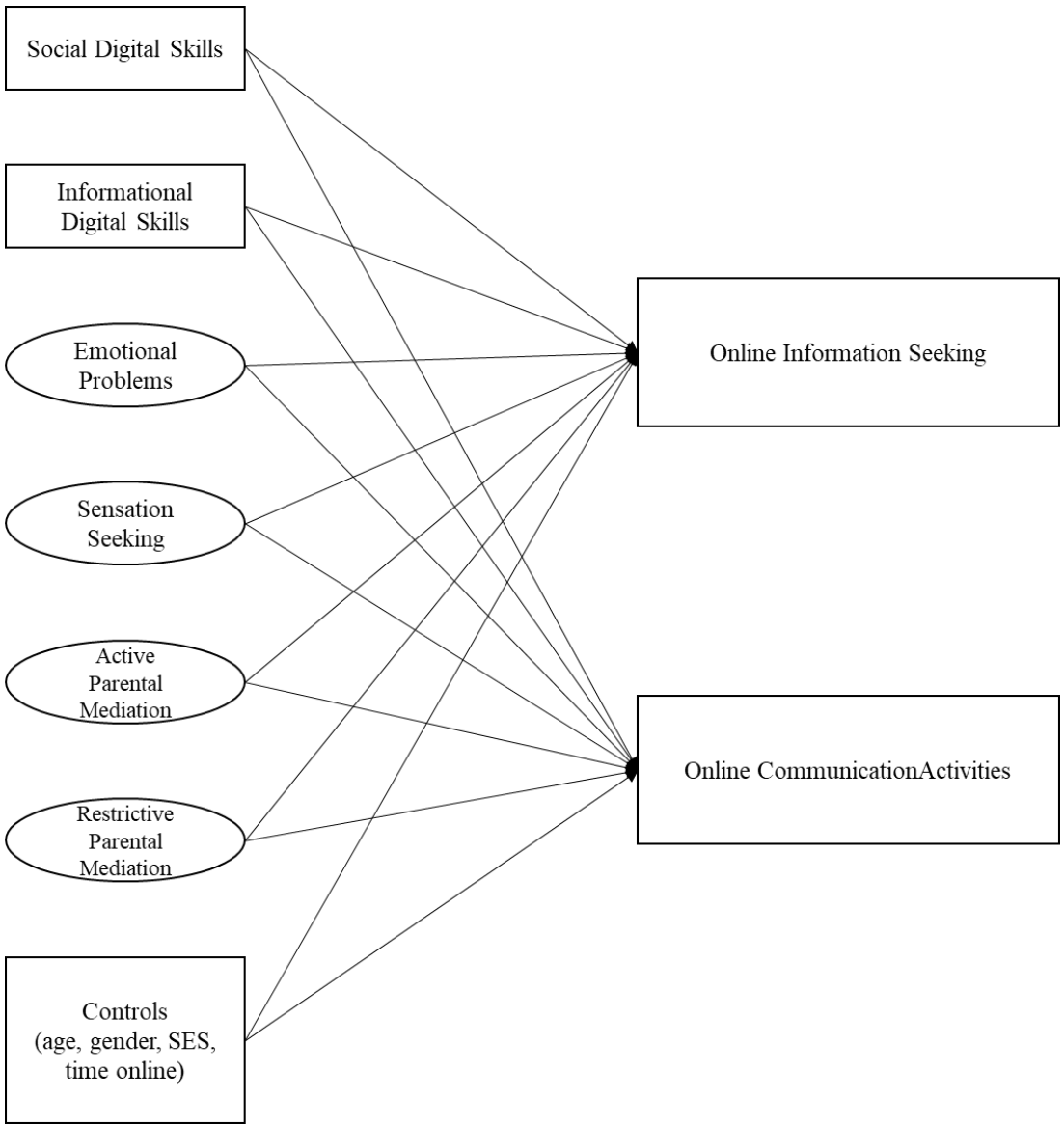
messages (Vandoninck et al., 2013). The coping strategies enacted to counter online risks mediate between social inclusion factors and the overall vulnerability of children. More specifically, Vandoninck et al. conclude that, "although girls and younger children experience more harm, they are more likely to talk to somebody about the problem. Lower-class children are not necessarily more vulnerable online, as they are more likely to respond proactively when confronted with disturbing sexual image" (2013, p. 72). Social and proactive responses, it is suggested, are more effective ways of dealing with online problematic situations and reducing harm. However, later analysis by the same authors distinguishes between behavioural avoidance (stopping use of the internet for a while) and indifference (hoping that the problem would go away), and demonstrate that the former does not denote a passive attitude. Rather, "deliberately deciding to (temporarily) avoid specific online content, platforms or services should be considered as an active coping strategy" through which more vulnerable children actively and effectively deal with cyberbullying and content risks (Vandoninck & d'Haenens, 2015, pp.232–3).

4.2 **Digital skills as predictors of digital engagement**

In order to test digital skills as predictors of digital engagement, we analysed the relationship between two clusters of online activities (information-seeking activities and communication activities) and the corresponding set of skills (namely, information navigation and social skills). This indicates that the concepts of active parental mediation, emotional problems and the way adolescents communicate online likely differ across countries, and that there are differences in their measurement.

However, estimating digital activities sub-scales as latent variables reduced the analytical model fit considerably. Hence, both these sub-scales were included as observed variables computed as the mean of relevant items. The final analytical model is illustrated in Figure 6. We also tested digital skills as moderators of the relationship between sensation-seeking, emotional problems and online activities; however, none of these were statistically significant and considerably reduced model fit. Therefore, they were omitted from the final iteration of the model. Again, more detailed description of the analysis can be found in the "Methodological appendix".

Figure 6. ANALYTICAL MODEL OF DIGITAL SKILLS AS PREDICTORS AND MODERATORS OF DIGITAL ENGAGEMENT



Note: Indicator items and error terms omitted for clarity. The items that were defined by the latent constructs (ellipses) can be found in the "Methodological appendix".

The results (see Tables 3 and 4) suggest that *online information-seeking activities* are significantly associated with age (average β = 0.223), active parental mediation (average β = 0.185), informational digital skills (average β = 0.177), emotional problems (average β = 0.176) and sensation-seeking (average β = 0.066), whereas *online communication activities* are associated mostly with restrictive parental mediation (average β = –0.264), time spent online (average β = 0.212), sensation-seeking (average β = 0.179), active parental mediation (average β = 0.111) and informational digital skills (average β = 0.093). Despite our expectations, social digital skills were not statistically significant predictors of online communication activities in the vast majority of the countries.

Previous studies have already reported a correspondence between some types of digital skills and digital engagement (Helsper & Eynon, 2013), showing mixed findings, which, to some extent, align with ours. The association between informational skills and online information-seeking activities is not surprising as, one can argue, children who have better information navigation skills would feel more comfortable when engaging in information-seeking behaviour. Similarly, the association of informational digital skills with active parental mediation is a little surprising, as children who are actively encouraged by their parents to use the internet may better incorporate it into their information-seeking routines. The association of information navigation skills with emotional problems, in turn, warrants future research. We may speculate, at this stage, that children who suffer from emotional problems may be inclined to look online for information as to how to cope with such difficulties.

Information navigation skills and social skills predict online information seeking, while social digital skills are not predictors of online communication in most of the countries. Distinctive sets of skills are correlated with different kinds of digital engagement.

With respect to *online communication activities*, the negative association with restrictive mediation can be explained by the fact that more restrictive parents are likely to impose limits on what children can do online (e.g. using SNSs, using a web or phone camera for video chat), thus reducing the opportunities for children to engage in these activities. The association with sensation-seeking, in turn, may be explained by the fact that youth who are inclined to seek new and exciting experiences, even risky ones, may be more likely to engage in a set of digital activities including expanding their social contacts, visiting SNSs and communicating with friends online, as these may be potential sources of gratification. The lack of association between communication activities and social digital skills, in turn, requires attention for future research. In their study, Helsper and Eynon (2013) found that not all types of digital engagement relate to the corresponding skills, problematising the idea according to which doing something online will foster the acquisition of related skills. Our findings support this idea, emphasising the need for future research to better understand why digital engagement predicts certain skills and not others.

Table 3.	PREDICTORS OF ONLINE INFORMATION-SEKKING ACTIVITIES								
	Constr.	BE	CZ	EE	FI	FR	DE	IT	LT
Digital skills: Informational	.151	.182	.181	.183	.199	.138	.198	.198	.145
Digital skills: Social	-.044	-.037	-.035	-.039	-.045	-.041	-.058	-.053	-.038
Emotional problems	.143	.173	.180	.179	.200	.137	.225	.177	.165
Sensation-seeking	.053	.064	.067	.067	.074	.051	.084	.066	.061
Active parental mediation	.150	.181	.188	.188	.209	.144	.236	.185	.173
Restrictive parental mediation	-.002^{ns}	-.002^{ns}	-.002^{ns}	-.002^{ns}	-.002^{ns}	-.002^{ns}	-.003^{ns}	-.002^{ns}	-.002^{ns}
Age	1.357	.192	.239	.241	.220	.180	.288	.232	.224
Gender (female)	.018*	.011*	.011*	.011*	.013*	.009*	.014*	.011*	.010*
SES	.129	.052	.054	.054	.060	.041	.068	.053	.049
Weekday online	.201	.046	.055	.047	.049	.041	.048	.049	.041
R^2		.141	.199	.157	.203	.101	.188	.159	.136

Note: Constr. = Constrained set of unstandardised coefficients. Country-specific coefficients are all standardised.

Unless noted otherwise, coefficients are significant at p<0.001; ns = non significant; * p<0.05.

Table 3. – continued	PREDICTORS OF ONLINE INFORMATION-SEKKING ACTIVITIES								
	MT	NO	PL	PT	RO	RS	SK	ES	CH
Digital skills: Informational	.153	.183	.192	.165	.159	.175	.168	.199	.195
Digital skills: Social	-.036	-.038	-.046	-.036	-.041	-.034	-.044	-.043	-.043
Emotional problems	.152	.201	.177	.163	.139	.195	.162	.173	.198
Sensation-seeking	.057	.075	.066	.061	.052	.073	.060	.064	.073
Active parental mediation	.159	.210	.186	.171	.145	.205	.170	.181	.207
Restrictive parental mediation	-.002^{ns}	-.002^{ns}	-.002^{ns}	-.002^{ns}	-.002^{ns}	-.002^{ns}	-.002^{ns}	-.002^{ns}	-.002^{ns}
Age	.180	.278	.235	.193	.214	.260	.217	.188	.203
Gender (female)	.009*	.013*	.011*	.010*	.009*	.012*	.010*	.011*	.013*
SES	.046	.060	.053	.049	.041	.059	.049	.052	.059
Weekday online	.046	.045	.053	.051	.047	.056	.038	.054	.052
R^2	.130	.195	.194	.149	.159	.205	.165	.160	.210

Table 4.	PREDICTORS OF ONLINE COMMUNICATION ACTIVITIES								
	Constr.	BE	CZ	EE	FI	FR	DE	IT	LT
Digital skills: Informational	.086	.096	.092	.095	.101	.078	.085	.104	.084
Digital skills: Social	.023	.018	.016	.018	.021	.021	.023	.025	.020
Emotional problems	.063	.071	.071	.072	.079	.060	.075	.072	.074
Sensation-seeking	.158	.178	.177	.180	.197	.150	.188	.180	.185
Active parental mediation	.097	.110	.109	.111	.122	.093	.116	.111	.114
Restrictive parental mediation	-.232	-.262	-.261	-.265	-.290	-.221	-.277	-.265	-.272
Age	.340	.045	.054	.055	.049	.045	.055	.054	.057
Gender (female)	.108	.061	.060	.062	.068	.051	.065	.062	.063
SES	.181	.068	.068	.069	.075	.057	.072	.068	.070
Weekday online	.956	.205	.235	.205	.211	.193	.174	.214	.198
R^2		.206	.315	.315	.263	.219	.277	.342	.247

Table 4. – continued	PREDICTORS OF ONLINE COMMUNICATION ACTIVITIES								
	MT	NO	PL	PT	RO	RS	SK	ES	CH
Digital skills: Informational	.083	.105	.098	.093	.090	.092	.102	.100	.083
Digital skills: Social	.018	.020	.022	.019	.022	.017	.024	.020	.017
Emotional problems	.064	.089	.070	.071	.061	.080	.076	.067	.065
Sensation-seeking	.160	.222	.176	.178	.153	.200	.190	.167	.163
Active parental mediation	.099	.137	.109	.110	.094	.123	.117	.103	.101
Restrictive parental mediation	-.236	-.327	-.259	-.262	-.225	-.294	-.280	-.247	-.240
Age	.043	.070	.053	.048	.054	.061	.058	.042	.038
Gender (female)	.054	.076	.060	.060	.052	.068	.065	.057	.057
SES	.061	.084	.067	.068	.058	.076	.072	.064	.062
Weekday online	.208	.215	.228	.239	.226	.249	.193	.225	.186
R^2	.213	.323	.285	.312	.231	.399	.329	.291	.244

4.3 Digital skills as predictors and moderators of online risks

To estimate a standardised effect and model contribution of interaction effects, constructs included in tested interactions were entered into the model as observed variables (digital skills and emotional problems). A similar comparative process, as described in the "Methodological appendix" for previous structural models, was used to test the cross-cultural invariance of the relationships among variables. For a summary of standardised estimates for each country, see Table 5. The models explained on average 40% of the variance of exposure to potentially harmful content online, ranging from 28.4% in Poland to 54.6% in Finland (*SD* = 7.2%).

As seen in Figure 7, the model included exposure to potentially harmful content[3] online (racist and violent content, self-harm, pro-ana content, etc.) as the outcome tests digital skills, restrictive parental mediation, active parental mediation, sensation-seeking, emotional problems and demographic variables (age, gender, SES and time spent online during a weekday) as predictors. A moderation effect of digital skills on the relationship between emotional problems and exposure to potentially harmful content was also tested. As for previous analyses, model fit indices support the notion that the tested relationships are for the most part similar across the 17 tested countries.

Higher *active parental mediation* was found to be associated with lower exposure to potentially harmful content online. Considering that our previous analysis on antecedents of digital skills showed little influence of active mediation, its role in preventing exposure to online risks is noticeable. It may be the case that parents engaged in active mediation strategies help their children evaluate media content, providing them with appropriate frameworks to identify and avoid risks online. Active parental mediation may thus serve as a buffer against being exposed to potentially harmful content.

The other predictors, including digital skills, predicted exposure to potentially harmful content positively. The strongest effect was found for *sensation-seeking* (average $\beta = 0.407$, *SD* = 0.048) and emotional problems (average $\beta = 0.241$, *SD* = 0.027). Not surprisingly, adolescents who tend to seek out new experiences and stimuli eventually end up finding the negative ones as well, in line with previous studies (Livingstone & Gorzig, 2014). However, the relationship of emotional problems and exposure with potentially harmful content is a curious one – do adolescents with more emotional problems tend to seek out more harmful content online, or does this content have an impact on their emotional state (or likely both at the same time)?

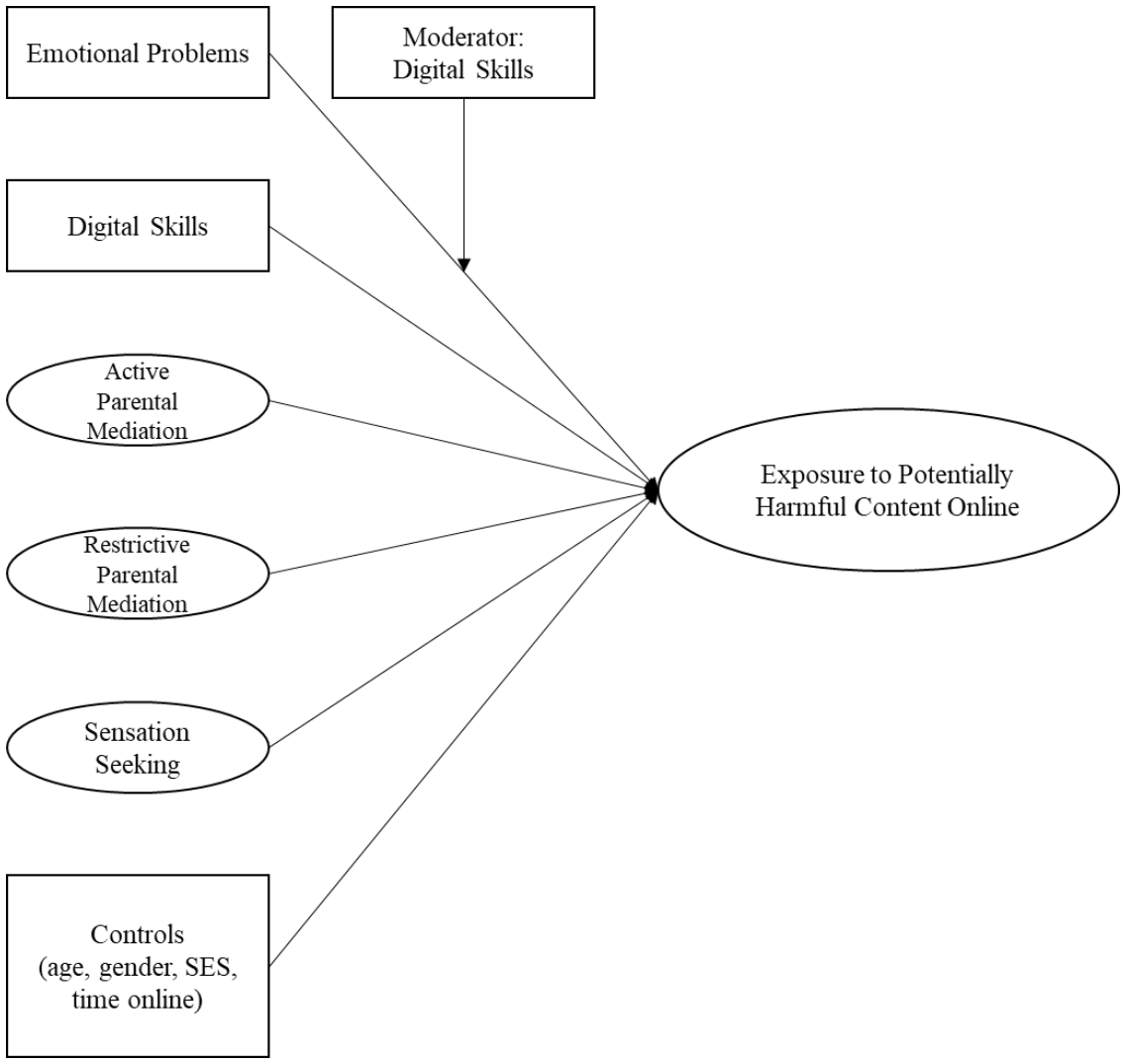
Digital skills, in their direct effect, are associated with higher *exposure to potentially harmful content*, but to a relatively weaker extent than sensation-seeking or emotional problems (average $\beta = 0.145$, *SD* = 0.020). Digital skills, however, do moderate the relationship of *emotional problems* and exposure – adolescents with higher digital skills and higher emotional problems tend to see the potentially harmful content more than those with lower digital skills and the same level of emotional problems (see Figure 8). These findings align with those from Helsper and Smahel (2020), who, likewise, found that emotionally vulnerable 11- to 16-year-olds, who scored higher on digital skills, were more likely to experience problematic situations of internet use. That digital skills predict exposure to potentially harmful content, however, may sound counterintuitive, although it can be contended that more competent children use the internet more and more extensively, and that such extensive use could lead them to encounter not only "positive" but also risky content, as suggested by previous studies (Sonck & de Haan, 2013). Theoretically speaking, we can better understand this puzzling relationship if we think about the fact that by exploring and experiencing an environment – whether it is online or offline – children will have the opportunity to better familiarise themselves

[3] In previous EU Kids Online work (Livingstone et al., 2011), potentially harmful online content was called "negative user-generated content" (NUGC). However, we later renamed risky content of this kind as "potentially harmful content" (Smahel et al., 2020), first, because it is not limited to user-generated content, and second, because of the disturbing nature it can have, although this does not mean to conflate risk with harm. Rather, and as explained in Section 4.1, our framework distinguishes between exposure to risks and harm, since not all exposure to risk necessarily translates into harmful and bothering experiences for children.

with that environment, acquiring skills to better navigate it, and as such, explore more aspects of it. Potentially harmful content is an intrinsic, yet not exclusive, aspect of the digital environment. It is not out of the realm of possibility, then, that children who are better equipped to navigate such a landscape may have higher chances of encountering problematic content compared to those whose exploratory skills are, for whatever reasons, lower or hindered by some constraints.

For a summary of standardised estimates for each country, see Table 5. The models explained on average 40% of the variance of exposure to potentially harmful content online, ranging from 28.4% in Poland to 54.6% in Finland (*SD* = 7.2%).

Figure 7. **ANALYTICAL MODEL OF DIGITAL SKILLS AS PREDICTORS AND MODERATORS OF EXPOSURE TO HARMFUL CONTENT ONLINE**



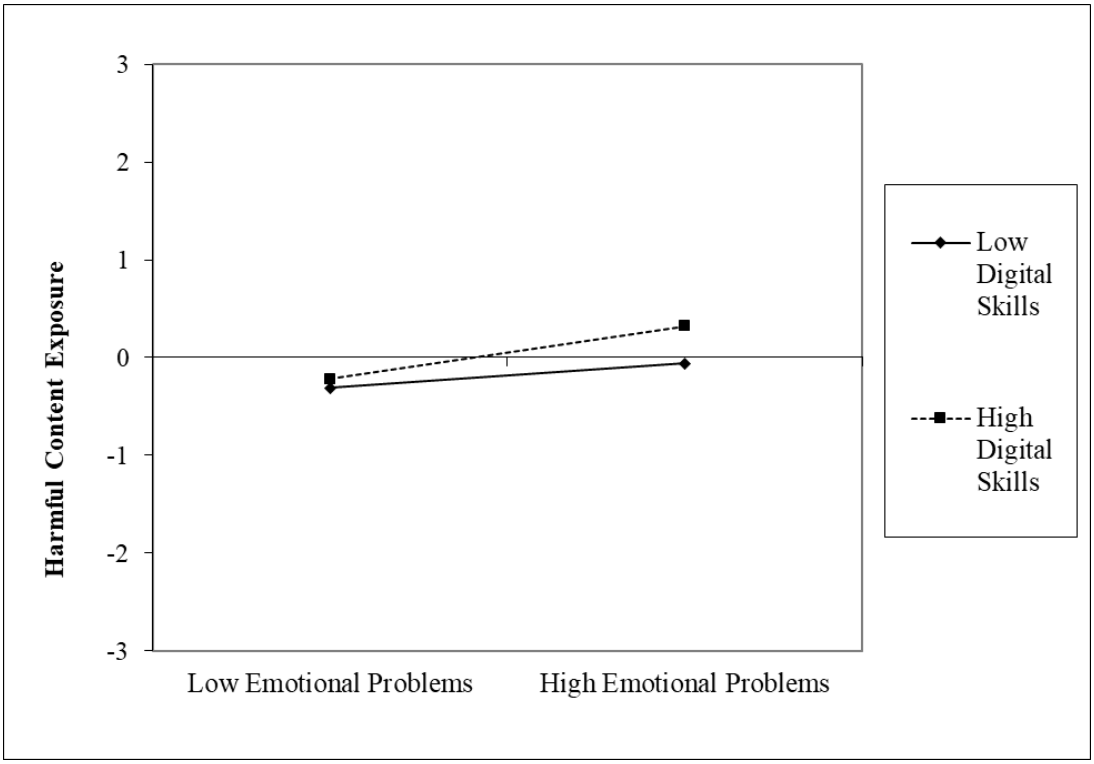
Note: Indicator items and error terms omitted for clarity. The items that were defined in the latent constructs (ellipses) can be found in the "Methodological appendix".

Table 5.	PREDICTORS OF EXPOSURE TO POTENTIALLY HARMFUL CONTENT ONLINE								
	Constr.	BE	CZ	EE	FI	FR	DE	IT	LT
Active parental mediation	-.064***	-.044***	-.044***	-.044***	-.049***	-.038***	-.044***	-.040***	-.053***
Restrictive parental mediation	.091***	.101***	.103***	.103***	.129***	.067***	.118***	.082***	.120***
Sensation-seeking	.399***	.441***	.390***	.378***	.456***	.424***	.491***	.402***	.433***
Digital skills	.149***	.138***	.143***	.150***	.151***	.126***	.191***	.165***	.177***
Emotional problems	.267***	.284***	.252***	.220***	.286***	.213***	.253***	.203***	.295***
Emo x DS	.124***	.098***	.089***	.081***	.105***	.085***	.091***	.086***	.113***
Age	*X*	.201***	.213***	.175**	.156***	.028	.566***	.206***	.217**
Female	*X*	.134**	.183***	.204***	.220***	.048	.282***	.106*	.070
Weekday online	*X*	.010	.190***	.190***	.051	.110*	-.221*	-.019	.003
SES	*X*	-.129**	-.036	.016	-.048	-.011	-.020	.079	-.102
R^2		.348	.508	.375	.546	.359	.401	.378	.311

Note: Constr. = Constrained set of unstandardised coefficients. X = Control variables were not constrained to equality. Country-specific coefficients are all standardised. *** *p<0.001,* ** *p<0.01,* * *p<0.05.*

Table 5. Continued	PREDICTORS OF EXPOSURE TO POTENTIALLY HARMFUL CONTENT ONLINE								
	MT	NO	PL	PT	RO	RS	SK	ES	CH
Active parental mediation	-.045***	-.044***	-.047***	-.042***	-.048***	-.048***	-.050***	-.051***	-.045***
Restrictive parental mediation	.077***	.070***	.090***	.057***	.172***	.090***	.105***	.058***	.058***
Sensation-seeking	.352***	.346***	.358***	.411***	.389***	.428***	.488***	.406***	.321***
Digital skills	.120***	.127***	.137***	.126***	.136***	.123***	.170***	.140***	.138***
Emotional problems	.244***	.246***	.230***	.224	.241***	.252***	.218***	.220***	.217***
Emo x DS	.089***	.077***	.089***	.075***	.100***	.079***	.081***	.088***	.079***
Age	.241***	.338***	.156**	.221***	.230***	.256***	.125*	.279***	.220***
Female	-.020	.231***	.122*	.210***	-.085	.161***	.153**	.203***	.154**
Weekday online	.076	.154**	-.024	.045	.041	.084	-.078	.073**	.084
SES	-.023	.037	-.134**	-.005	-.091	-.101*	.077	-.069**	-.053
R^2	.378	.439	.284	.362	.458	.454	.362	.490	.338

Figure 8. MODERATING EFFECT OF DIGITAL SKILLS ON THE RELATION BETWEEN EMOTIONAL PROBLEMS AND EXPOSURE TO POTENTIALLY HARMFUL CONTENT ONLINE



Digital skills moderate the relationship between emotional problems and exposure to online risks: when children who suffer from emotional problems are also skilled, they are more likely to be exposed to harmful online content. Navigation skills and social skills predict online information seeking, while social digital skills are not statistically significant predictors of online communication in most of the countries. Distinctive sets of skills are correlated with different kinds of digital engagement.

4.4 Discussion and recommendations for future research

Two important findings of our analysis stand out as novel and deserving to be further explored: first, the lack of correlations between children's engagement in online communication activities and their level of social digital skills; and second, the finding that digital skills actually increase the likelihood that children with emotional problems are exposed to problematic online content. Both these aspects have not been addressed by prior research on this topic, but have important policy implications. The lack of relationship between social digital skills and online communication activities may, for example, indicate that, no matter how much they use the internet to communicate with friends and other people online, children have now learned how to protect themselves from risky online contacts (knowing when it is better to avoid disclosing personal information or removing certain contacts from their online networks). The second finding, instead, identifies a further area of vulnerability: whereas we already knew that offline vulnerabilities and online vulnerabilities go hand in hand, the role of

digital skills suggests that policy initiatives should not just be directed towards improving digital skills, but should also support children's general wellbeing and resilience.

Our analysis of the consequences of digital skills based on the EU Kids Online data collected between 2017 and 2019 (Smahel et al., 2020) also shows patterns that are consistent with prior research. More specifically, digital skills are found to be positively associated with online opportunities. As in the literature on digital inclusion, we have shown that different types of skills are conducive to different types of digital engagement (Helsper & Eynon, 2013), thus suggesting that media education programmes should emphasise different skills depending on the outcomes that children are expected to reach. Furthermore, the relation between children's emotional problems and informational digital activities deserves further attention: do the results suggest that children who experience emotional problems are more likely to look for health information online, and, if so, what are the consequences for their wellbeing? The relationship between digital skills and wellbeing remains largely under-investigated.

Future research should seek to investigate the relationship between digital skills, risk, harm and coping resilience, in order to assess whether children scoring higher on digital skills explore more online opportunities and are therefore exposed to a wider range of risks, but do not suffer from harmful emotional consequences. While our analyses could not address the relationship of digital skills and specific risky experiences and their consequences, parents, educators, care providers and policy-makers would benefit from having answers to these questions in future research.

Prior research based on the EU Kids Online 2010 data highlighted a positive correlation between online opportunities and online risks. Given that digital skills are one of the strongest predictors of online opportunities, one might conclude that they are associated with higher exposure to online problematic content, contact and conduct. However, the relationship between skills and risks is not straightforward. First, exposure to risks does not necessarily translate into actual harmful experiences (Livingstone et al., 2018). And second, we can hypothesise that digital skills, while being related to exposure to online risks, can actually moderate the effects of online risks, by reducing the harmful consequences for children's wellbeing and, at the same time, reinforcing children's resilience and ability to deal with online problematic situations. Existing research suggests a positive role of digital skills in protecting children from harm, rather than from encountering risks: children who report lower levels of digital skills are less likely to see inappropriate content or run into risky contacts on the internet, but are more likely to experience harm when they encounter online risks (Sonck & de Haan, 2013). Sonck and de Haan (2013) also found that self-reported skills, sociodemographic variables and internet experience could not fully explain differences in the incidence of harm across the EU Kids Online 2010 survey countries, suggesting that psychological factors or the context in which children use the internet (domestic or school context, peer influence, etc.) are more influential in shaping the relationship between online risks and harm. In other words, children who are more vulnerable online usually also experience a range of pre-existing offline vulnerabilities (including emotional problems, lack of support from family and friends, socioeconomic disadvantages, etc.). Since children who are vulnerable offline are more likely to be harmed by internet use, they represent an important target to keep in mind for policies and interventions.

Further analysis on the EU Kids Online data showed that digital skills are associated with the way children deal and cope with online problematic situations. Children with lower digital skills are more likely to adopt passive responses when dealing with online risks. By contrast, higher skills positively correlate with pro-active responses, such as blocking unwanted contacts and deleting aggressive and harmful messages (Vandoninck et al., 2013). The coping strategies enacted to counter online risks mediate between social inclusion factors and the overall vulnerability of children. In this respect, Vandoninck et al. conclude that, "although girls and younger children experience more harm, they are more likely to talk to somebody about the problem. Lower-class children are not necessarily more vulnerable online, as they are more likely to respond proactively when confronted with disturbing

sexual images" (2013, p. 72). Social and proactive responses, it is suggested, are more effective ways of dealing with online problematic situations and reducing harm. However, later analysis by the same authors distinguishes between behavioural avoidance (stopping use of the internet for a while) or indifference (hoping that the problem would go away), and demonstrates that the former does not denote a passive attitude.

Therefore, digital skills are both related to exposure to online problematic situations and to the development of resilience and more effective coping strategies to deal with such experiences.

More research, however, is needed to better understand the relationship between digital skills and children's wellbeing: for example, to determine whether distinctive types of digital skills are equally crucial to minimise the likelihood of experiencing harm and moderate the effect of offline vulnerabilities; or, instead, whether distinct sets of digital skills lead to different paths to online resilience and wellbeing. It is even more important to conduct longitudinal research in order to address not only the short-term but also the medium- and long-term influence of digital skills on children's wellbeing, and to be able to simultaneously examine the feedback effects from wellbeing on ICT use-related variables.

5. Conclusions

The analyses presented in this report aim to provide a contribution to research on children's digital skills in several ways. First, we presented new and innovative results about the role of digital skills as moderators, which fills an important research gap – in fact, as shown in the evidence review conducted by Haddon et al. (2020) (ySKILLS Deliverable 2.1), existing research on the consequences of digital skills mostly analyses skills as a predictor and/or a mediator rather than a moderator, of beneficial or detrimental outcomes. Moreover, the analyses led to highlighting a number of research gaps that future investigations should address. And finally, they corroborated the findings of prior research on the antecedents and consequences of digital skills among children.

In what follows, we briefly list the most important findings and recommendations for future research that we want to emphasise:

Digital skills

- The conceptualisation and measurement of digital skills condition the analysis and its results. Our understanding of what fosters digital skills, and which outcomes digital skills contribute to, would improve if we examined the differential antecedents and consequences of distinct kinds of skills (operational, information navigation, social, creative). Future surveys could refine the measurement of digital skills in order to allow the examination of the differential effect of distinct types of skills.
- Cross-cultural analysis benefits from invariance tests, which ensure that the observed variations do not depend on issues of translation and culturally specific interpretations.
- The little variations in children's digital skills across the countries suggest that several factors may be at stake beyond the known differences in ICT use and development between Northern and Southern European countries.

Antecedents

- The strongest and most common predictors of digital skills across the countries were restrictive parental mediation (negative), self-efficacy, number of online activities children engage in, POSI and feeling safe on the internet (all positive). Conversely, age, gender, average time spent online on a weekday and SES do not predict digital skills consistently across the countries.
- Consistent with the evidence review published in Haddon et al. (2020), our findings show that gender differences need to be understood in terms of boys' and girls' self-efficacy and confidence in ICT use, to avoid it translating into a self-fulfilling prophecy.
- In line with prior research, our analysis shows that digital skills increase with age in the majority of the countries. This may indicate that digital skills acquisition is a cumulative process, but once again, the role of social desirability bias should be taken into account when interpreting these results.
- Moreover, we found no evidence of association between SES and digital skills acquisition across all of the countries. However, we have not measured "autonomy of use" (i.e., the possibility of accessing the internet anywhere, anytime), which is likely to be correlated with SES. Therefore, the influence of SES on digital skills may be indirect, mediated by the number and quality of internet-connected devices, the type of connectivity and the locations where the child accesses the internet.
- Restrictive parental mediation is negatively correlated with children's digital skills. This means that when parents restrict their children's opportunities to participate and explore online, this may reduce their chances to learn and develop more skills. However, it can also

be the case that children who engage in a lower range of online activities are generally less skilled, but are also less likely to be restricted in terms of the amount and type of screen time.

- In our investigation, we found weak associations between enabling mediation and digital skills. While the role of restrictive mediation is clearer now, future research should further investigate the role of enabling mediation on digital skills acquisition.

Consequences

- Consistent with prior research, digital skills are positively associated with online opportunities, although different types of skills are conducive to different types of digital engagement. More specifically, information navigation skills and social skills predict online information seeking, while social digital skills are not statistically significant predictors of online communication in most of the countries – possibly because digital competences related to safe and appropriate online communication have long been incorporated in media education programmes taught in schools. That distinctive sets of skills are correlated with different kinds of digital engagement suggests that media education programmes should emphasise different skills depending on the outcomes that children are expected to reach.
- Higher levels of digital skills are associated with exposure to potentially harmful online content. This suggests that more skilled children who explore the internet to a greater extent may be more likely to encounter risks. However, prior research suggests that digital skills can also help children prevent risks from translating into harm. Therefore, future research should be designed so as to allow a robust analysis of the relation between digital skills, risks, harm and resilience.
- Our research has shown that digital skills also moderate the relationship of emotional problems and exposure to online risks, by increasing their chances to be exposed to potentially harmful content. More precisely, when children who suffer from emotional problems are also skilled, they are more likely to look for information online and to encounter problematic situations on the internet.

General recommendations

Taken together, these data support the urge for pan-European research that will inform culturally sensitive interventions aimed at facing these disparities across countries. Evidence-based interventions may have an important impact on European children's abilities to agentively access, use and make the most of the opportunities coming from equal ICT access and use to develop appropriate digital skills. Ensuring children's ability to do so would not only contribute to foster children's digital (and social) inclusion; it would also contribute to a broader social and political agenda aimed at recognising and guaranteeing children's rights to participation in the ever-evolving digital world they are part of (Livingstone & O'Neill, 2014).

Furthermore, our analysis has foregrounded the need for research on children's wellbeing: more specifically, we need to better understand whether and how digital skills can prevent exposure to online risks from turning into harmful experiences for children and, in so doing, foster their resilience. Special attention should be paid to children suffering from emotional problems, who are seemingly more likely to be exposed to online risks when they are also digitally skilled. Understanding which kind of digital skills can strengthen vulnerable children's resilience and help them cope with higher exposure to online risks should be a priority on the research and policy agendas.

6. Acknowledgements

The authors thank the reviewers (Willem Joris, Leen d'Haenens, Sonia Livingstone, and Katariina Salmela-Aro) for their critical reading and useful suggestions which helped improve and clarify this report.

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8. Methodological appendix

8.1 Measurement invariance

Measurement invariance is a statistical property used when measuring a construct comparing different groups of research participants with different individual and cultural backgrounds, to make sure that the measurement is understood the same way by the whole sample in spite of their heterogeneous background (Milfont & Fischer, 2010). In layman's terms, if we are comparing groups of people from different countries with respect to their opinions on experiences with a specific topic of inquiry (i.e., digital skills), it will be important to make sure that participants have a common understanding of what this topic is, so that their perspectives can be more accurately compared. As such, we need the measurement to be invariant, that is, to make sure that the items measure the same thing across all countries. When a measurement tool is not invariant, there may be differences in the way people understand the construct being studied, making comparison among groups biased and inaccurate.

Let us think about our study: a questionnaire on children's internet use was administered to a sample of children from European countries that are different in terms of cultural backgrounds, language and incorporation of digital technology in daily life. The international research team worked on an English version of the questionnaire, which had to be translated in in the languages of the respective countries. Translation alone could be an important source of bias, as English terms can be translated differently in Italian, Spanish, German, etc. Also, even when the translation process is accurate, the chances are that this may not be very culturally sensitive, as words are dependent on specific cultural contexts. To minimise this risk, most of the EU Kids Online national teams adopted the TRAPD approach to localisation of survey measures (translation, review, adjudication, pre-testing and documentation) (Harkness et al., 2003). The TRAPD approach is based on two fundamental principles. First, questionnaires should be adapted between languages rather than merely translated. Second, the adaptation should be done by a team (two translators, a reviewer and adjudicator) rather than handing tasks over to individuals. In several countries, the research team also conducted cognitive testing with a sub-sample of the population (Collins, 2003) to assure the comprehensibility of the questionnaire and its translations, in order to adjust any specific item as needed.

While TRAPD localisation and cognitive testing procedures are important in helping cross-cultural research in general, and quantitative surveys in particular, all of the above contribute to the many challenges that researchers face when engaging in cross-cultural inquiries. Therefore, before comparing different groups with respect to their opinions about, or interpretations and understanding of, certain constructs, it is also important to assess the degree of measurement invariance of an instrument, or to what extent that instrument could be understood fairly similarly by different people. Testing for measurement invariance helps the researcher do that. Technically speaking, the three most commonly discussed levels of invariance are configural (set of items belonging to the instrument is equal across groups – countries, in our case), metric (items load the same way on the latent construct) and scalar (item intercepts are the same). One relatively novel approach in addressing a potential lack of measurement invariance is the alignment method (Asparouhov & Muthén, 2014), which combines the elements of an exploratory factor analysis (specifically factor rotation) and measurement invariance testing to find a solution that minimises the degree of invariance among groups, estimates latent means for groups, and statistically tests the differences between these means. This allows us to make the most precise estimation of difference between groups given the presence of measurement invariance.

Ensuring invariance in measurement is, therefore, a crucial step in cross-cultural analysis. In fact, by reducing the differences due to different translations and understandings of the survey items, we increase the likelihood that the measured differences in digital skills are explained by actual different levels of digital skills across countries.

First, the measurement invariance tests of the EU Kids Online 2020 digital skills scale indicated invariance at the metric level, that is, items load the same way on the latent construct (according to Cheung and Rensvold's [2002] suggestions of ΔCFI and ΔRMSEA cut-off <0.010 and <0.015 respectively): configural χ^2 (595) = 6,147.787, p<0.001, CFI = 0.942, RMSEA = 0.110; metric χ^2 (739) = 5,906.715, p<0.001, CFI = 0.946, RMSEA = 0.095, $\Delta\chi^2$ (144) = 544.490, p<0.001, ΔCFI = 0.004, ΔRMSEA = 0.015; but not at the scalar level, meaning that item intercepts vary: scalar χ^2 (1,203) = 11,446.629, p<0.001, CFI = 0.894, RMSEA = 0.105, $\Delta\chi^2$ (464) = 6,310.985, p<0.001, ΔCFI = 0.052, ΔRMSEA = 0.010.

8.2 Measures

Based on the literature review presented in Livingstone et al. (2020) and discussed throughout the report, the variables included in the analysis were as follows (unless otherwise noted):

Digital skills were measured by 10 items from Helsper et al. (2016). We asked children the following question: *Please indicate how true the following things are of you when thinking about how you use technologies such as mobile phones and the internet. If you don't understand what the question is referring to, choose the option "I don't know". If you have never done this, then think of how much this would apply to you if you had to do this now. On a scale from 1 to 5, where 1 is "Not at all true of me" and 5 is "Very true of me", how true are these of you?* Two items measured each of the five sub-scales: operational, informational, social, creative and mobile.
More specifically, operational skills included the following items: "I know how to save a photo that I find online" and "I know how to change my privacy settings". Information navigation skills were operationalised as: "I find it easy to check if the information I find online is true" and "I find it easy to choose the best keywords for online searches". Social skills were measured through the items "I know which information I should and shouldn't share online" and "I know how to remove people from my contact lists". Content creation skills items were: "I know how to create and post online videos or music" and "I know how to edit or make basic changes to online content that others have created". Finally, we selected here only two of the mobile skills children were asked about in the EU Kids Online 2020 survey: "I know how to keep track of the costs of mobile app use" and "I know how to make an in-app purchase". Response options ranged from (1) Not true of me to (5) Very true of me. Cronbach's alpha was 0.891. In Section 4, the informational and communicational sub-scales were used separately. Their Cronbach's alpha was 0.674 and 0.671 respectively.

Demographics (age and gender of the child, perceived SES). Participants were asked the month and year of their birth and "What would you say is your sex/gender?" SES was measured by a graphic measure of a ladder with 11 steps ranging from 0 = Worst off to 10 = Best off, with the instructions asking "Here is a picture of a ladder. Think of this ladder as representing where people stand in your country. Please tick the box where you think you and your family are."

Internet use. Measured with one item: "About how long do you spend on the internet during a regular weekday (schoolday)", with response options ranging from (1) Little or no time to (9) About 7 hours or more.

Restrictive parental mediation. Adapted from EU Kids Online (2010), the instructions asked "Does your parent/carer allow you to do the following things on the internet, and if so, do you need their permission to do them?" and followed up with three items: "Use a web or phone camera (e.g. for Skype or video chat); Download music or films; Use a social networking site (e.g. Facebook, Snapchat, Instagram, Twitter)." The response scale ranged from (1) I am allowed to do this anytime to (3) I am not allowed to do this. Cronbach's alpha was 0.767.

Active parental mediation. Adapted from EU Kids Online (2010). The instructions asked "When you use the internet, how often does your parent/carer do any of these things?" and followed up with four items: "Encourages me to explore and learn things on the internet", "Suggests ways to use the internet

safely", "Talks to me about what I do on the internet" and "Helps me when something bothers me on the internet [when you use the internet]." The response scale ranged from (1) Never to (5) Very often. Cronbach's alpha was 0.806.

Preference for online social interaction (POSI). Measured by three items (Smahel et al., 2012): "I find it easier to be myself online than when I am with people face-to-face", "I talk about different things online than I do when speaking to people face-to-face" and "I talk about personal things online which I do not talk about with people face-to-face", with a four-point response scale ranging from (1) Never to (4) Always. Cronbach's alpha was 0.703.

Self-efficacy. Measured by four items from Schwarzer and Jerusalem (1995): "It's easy for me to stick to my aims and achieve my goals", "I am confident that I can deal with unexpected problems", "I can generally work out how to handle new situations" and "If I am in trouble I can usually think of something to do". The response scale ranged from (1) Not true to (4) Very true, and Cronbach's alpha was 0.829.

Online activities. An index of 15 items was used to measure the breadth of the adolescents' online activities. The items were adapted from EU Kids online (2010) and Helsper et al. (2015). The items asked about frequency of engagement in various online activities ranging from using the internet for schoolwork, looking up news online, communicating with family or friends, playing online games, watching online clips, to participating in online groups with shared interests, looking up health-related information, or getting involved in online campaigns, protests or petitions. For current analysis, the items were dichotomised into (0) Never or hardly never and (1) At least every week or more frequently, and summed together into an index measure indicating a number of online activities adolescents engage in weekly or more often. Cronbach's alpha was 0.698. For the analysis in Section 4, clusters of related items were used to create measures of information-seeking online activities and social communicative online activities:

Online information-seeking activities were measured by four items, including: "I looked for information about work or study opportunities", "I looked for news online", "I used the internet for schoolwork" and "I looked for health information for myself or someone I know". The response options ranged from (1) Never to (6) Almost all the time. The scale score was created as a mean of the four items. Their Cronbach's alpha was 0.597.

Online communication activities were measured by four items – namely, "I used the internet to talk to people from other countries", "I created my own video or music and uploaded it to share", "I visited a social networking site" and "I communicated with family or friends". The response options ranged from (1) Never to (6) Almost all the time. The scale score was created as a mean of the four items. Their Cronbach's alpha was 0.542.

Personal attitude towards the internet was measured by the item "I feel safe on the internet", with a response scale ranging from (1) Never to (4) Always.

Sensation-seeking was measured by two items adapted from Slater (2003): "I do dangerous things for fun" and "I do exciting things, even if they are dangerous". Response options ranged from (1) Not true to (4) Very true, and Cronbach's alpha was 0.844.

Emotional problems were measured by four items adapted from Goodman et al.'s Strengths and Difficulties Questionnaire (1998). The four items were: "I worry a lot", "I am nervous in certain new situations, I easily lose confidence", "I am often unhappy, sad or tearful" and "I have many fears and I am easily scared". The response options ranged from (1) Not true for me to (4) Very true for me. Their Cronbach's alpha was 0.791.

Exposure to potentially harmful content was measured by six items from the 2010 EU Kids Online data collection asking whether the participants have seen online content or online discussions where people talk about or show "Ways of physically harming or hurting themselves", "Ways of committing

suicide", "Ways to be very thin" (such as being anorexic or bulimic, or "thinspiration"), "Hate messages that attack certain groups or individuals (e.g. people of different colour, religion, nationality, or sexuality)", "Their experiences of taking drugs" and "Gory or violent images, for example, of people hurting other people or animals". The initial response scale of (1) Never to (5) Daily or almost daily was recoded to a four-point scale collapsing the response options (4) At least every week and (5) Daily or almost daily together into one due to sparsity of participants selecting option 5. The recoded items reached Cronbach's alpha of 0.875.

8.3 Plan of analysis: Section 3

Multi-group structural equation models were fitted to test the relationships of the aforementioned predictor variables and digital skills. A mix of latent and observed variables was used in the models. As a first step, measurement invariance of all constructs with more than one item was tested.[4] We first estimated the structural equation model fit of a measurement model in which all loadings of all latent factor indicators as well as item intercepts were estimated freely for each country. Subsequently, to test metric invariance required for comparison of variable relationships, we estimated a model in which item loadings were constrained to equality among the countries. Based on suggestions from Cheung and Rensvold (2002), if the CFI and RMSEA indices of these models differed by more than 0.010 or 0.015 respectively, a lack of measurement invariance is assumed. In such case, as a follow-up to identify non-invariant constructs, individual constructs were freed from the constraints based on modification indices until partial invariance was achieved. Latent variable indicators were specified as ordinal and WLSMV estimator was used for all tested models.

Subsequently, in the main analytical model an analogous comparative approach was utilised to test whether the relationships of focus differed between countries. Two models were fitted: a first model in which all the path coefficients were estimated freely for all countries (unconstrained model), followed by a second model, in which path coefficients of focal variables were constrained to equality across countries (constrained model). A cut-off CFI difference of more than 0.010 is used to conclude whether the relationships in the model meaningfully differ across countries. Standardised coefficients (β) from these analyses, along with the proportion of variance of digital skills explained by the predictors (R^2), can be found in Table 2 of this report.

Measurement invariance tests indicated lack of metric invariance: configural χ^2 (4,114) = 13,646.379, p<0.001, CFI = 0.956. RMSEA = 0.054; metric χ^2 (5,282) = 23,296.315, CFI = 0.916, RMSEA = 0.066, $\Delta\chi^2$ (1168) = 10,833.258, p<0.001, ΔCFI = 0.040, ΔRMSEA = 0.012. However, partial metric invariance was achieved after releasing active parental mediation and self-efficacy from the constraints: partial metric χ^2 (4,370) = 15,825.465, p<0.001, CFI = 0.947, RMSEA = 0.058, $\Delta\chi^2$ (256) = 2,179.086, p<0.001, ΔCFI = 0.009, ΔRMSEA = 0.004. This indicates that the concepts of active parental mediation and self-efficacy likely differ across countries and that there are differences in their measurement.

The analytical model fit the data well: χ^2 (7,220) = 28,533.970, p<0.001, CFI = 0.906, RMSEA = 0.061, and constraining the path coefficients to equality improved the model fit slightly: χ^2 (7,380) = 27,554.902, CFI = 0.911, RMSEA = 0.059, $\Delta\chi^2$ (160) = 979.068, p<0.001, ΔCFI = 0.005, ΔRMSEA = 0.002. This indicates that the relationships between variables are similar across countries. For a description of the results, please refer to the main report.

8.4 Plan of analysis: Sections 4.2 and 4.3

[4] Note: expectation maximisation (cf. Musil et al., 2002) was used to impute plausible values for Item QA21i that was completely missing in France and items QA21i and QD2f that were completely missing in Romania.

Plans of analyses in the current sections were analogous to the one described in Section 7.3. First, measurement invariance was verified for latent variables in each model. Subsequently, multi-group structural equation models were fitted to test the relationships of digital skills and risks and opportunities online. Path coefficient constraints were introduced and model fit change was inspected to test whether the relationships differ among countries.

Measurement invariance tests for the model in Section 4.2 indicated lack of metric invariance: configural χ^2 (4,097) = 12,756.370, p<0.001, CFI = 0.947, RMSEA = 0.052; metric χ^2 (4,497) = 16,345.092, CFI = 0.927, RMSEA = 0.058, $\Delta\chi^2$ (400) = 3,588.722, p<0.001, ΔCFI = 0.020, ΔRMSEA = 0.006. However, partial metric invariance was achieved after releasing active parental mediation, emotional problems and communication activities from the constraints: partial metric χ^2 (4,305) = 13,939.793, p<0.001, CFI = 0.941, RMSEA = 0.053, $\Delta\chi^2$ (208) = 1,183.423, p<0.001, ΔCFI = 0.006, ΔRMSEA = 0.001.

After the modifications, the analytical model in Section 4.2 fit the data well χ^2 (2,701) = 11,316.016, p<0.001, CFI = 0.936, RMSEA = 0.063. Additionally, constraining the regression paths to equality across countries did not exceed Cheung and Rensvold's (2002) cut-off point of ΔCFI < 0.100, ΔRMSEA < 0.015: χ^2 (3,021) = 11,617.239, p<0.001, CFI = 0.936, RMSEA = 0.060; $\Delta\chi^2$ (320) = 301, p=0.907, ΔCFI = 0.000, ΔRMSEA = 0.003. This indicates that the tested relationships are for the most part similar across the 17 countries.

Measurement invariance tests for the model in Section 4.3 yet again indicated lack of metric invariance: configural χ^2 (6,137) = 17,363.529, p<0.001, CFI = 0.957, RMSEA = 0.048; metric χ^2 (7,513) = 27,190.960, CFI = 0.925, RMSEA = 0.058, $\Delta\chi^2$ (1,376) = 11,724.375, p<0.001, ΔCFI = 0.032, ΔRMSEA = 0.010. However, partial metric invariance was achieved after releasing active parental mediation, emotional problems and exposure to harmful content online from the constraints: partial metric χ^2 (6,377) = 19,861.157, p<0.001, CFI = 0.948, RMSEA = 0.052, $\Delta\chi^2$ (1,136) = 2,497.628, p<0.001, ΔCFI = 0.009, ΔRMSEA = 0.004. This indicates that the concepts of active parental mediation, emotional problems and exposure to harmful content online likely differ across countries, and that there are differences in their measurement.

The unconstrained analytical model fit the data well: χ^2 = 11,389, df = 3,328, p<0.001, CFI = 0.956, RMSEA = 0.055, and constraining the focal paths to equality across countries actually improved the fit slightly: χ^2 = 11,102, df = 3,424, p<0.001, CFI = 0.958, RMSEA = 0.053; $\Delta\chi^2$ = 287, df = 96, p<0.001, ΔCFI = 0.002, ΔRMSEA = 0.002. Again, this suggests that the paths did not significantly differ across countries.