Is Europe prepared to go digital? Making the case for developing digital capacity: an exploratory analysis of Eurostat survey data

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Abstract

Digital divides are globally recognised as a wicked problem that threatens to become the new face of inequality. They are formed by discrepancies in Internet access, digital skills, and tangible outcomes (e.g. health, economic) between populations. Previous studies indicated that Europe has an average Internet access rate of 90%, yet rarely specify for different demographics and does not report on the presence of digital skills. This exploratory analysis used the 2019 community survey on ICT usage in households and by individuals from Eurostat, which is a sample of the population aged 16-74 on Internet access and digital skills. The cross-country comparative analysis includes EEA and Switzerland. Data was collected between January and August 2019 and analysed between April and May 2021. Large differences in Internet access were observed (75-98%), especially between North-Western (94-98%) and South-Eastern Europe (75-87%). Low age, high education levels, employment, and living in an urban environment appear to positively influence the development of higher digital skills. The cross-country analysis exhibits a positive correlation between high capital stock and income/earnings and the digital skills development, while showing that the internet-access price bears marginal influence over digital literacy levels. The findings suggest Europe is current unable to host a sustainable digital society without exacerbating cross-country inequalities. Investment in building digital capacity in the general population should be the primary objective of European countries to ensure they can benefit maximally from the advancements of the Digital Era.

Manuscript Text

The digitalisation of society is a process that has not only been occurring over the past seven decades, but has been significantly accelerated by the COVID-19 pandemic. Digitalisation is one of three fundamental processes propelling change in the economic, socio-political, and cultural spheres globally, alongside globalisation and demographic change [1]. Work, social interactions, health services, and recreational activities have been all forced to (further) adopt digital technologies and platforms, as most of the world transitioned to digital environments at the beginning of the COVID-19 pandemic [2]. However, these digital and technological advances have neither equally nor equitably permeated all layers of society across the globe, further limelighting existing ‘digital divides’ [3,4]. As such, digital divides are a global wicked problem and threaten to become the new face of inequality due to their potentially detrimental effects on the Sustainable Development Agenda [5,6].

In its 2016 Skills Agenda for Europe, the European Commission first recognised the great necessity for digital skills development [7] as – at the time of writing – almost half of the European Union’s (EU) population lacked basic digital skills, while 20% had none at all. This is even more problematic considering the rapid progression into the Digital Age due to the COVID-19 pandemic—specifically the shifts in healthcare and public health [8–10] (e.g. using artificial intelligence to assist in diagnoses to the digital or the digital provision of mental healthcare with comparable quality to face-to-face care [11]). Digital skills can therefore no longer be considered luxuries; they are foundational to modern governance, societal and economic functioning, and access to parts of the healthcare and public health systems [12]—as reflected by the European Skills Agenda 2020 update [13].

While COVID-19 has showcased that – in emergencies – it is possible to live in a digital society, it exacerbated existing health and economic inequalities and widened digital divides [6]. The question thus remains whether the current European ecosystem is fit – let alone adequately prepared – to safely and sustainably host a digital society. To illustrate, the United Kingdom’s Office for National Statistics showed in 2019 that 10% of the adult population did not use the Internet and Global Kids Online reported in 2021 that 14% of children under 19 in Europe still did not have frequent internet access [14,15]. However, these statistics only reflect the first level of digital divides (binary Internet access), while the second (internet skills) and third levels (tangible and beneficial outcomes of internet use) remain largely

unexplored. Demographic characteristics, which are a known influence to the development of digital skills [3], have sparsely been accounted for in previous research.

This article therefore analyses the first two levels of digital divides among people aged 16-74 in Europe and explores the influences on the third level. Findings are interpreted through different theoretical frameworks (Greenhalgh's diffusion model to explore differences in uptake [16]; Kondratiev's wave theory to explore economic inequalities and consequences [17]; and the digital determinants of health to explain health inequalities [18,19]; see eConcepts in the Supplementary Materials). Consequently, it is possible to understand the continued existence of digital divides and their societal effects, as well as propose multi-disciplinary recommendations for global governance.

Methods

The Community Survey and Data Access

The community survey on information and communications technology usage in households and by individuals was completed across European households and individuals between January and August 2019 [20]. Data was collected via face-to-face interviews, telephone interviews, and postal surveys. However, there is some degree of heterogeneity in the methods used across European countries. The overall accuracy of the survey data is considered high, as it represents approximately 75% of the population between the ages of 16 and 74 [21]. On average, the net sample size counted between 3,000 and 6,000 units per country, amounting to a total of 147,531 households and 197,631 individuals. Data was openly accessible through Eurostat.

Variable Selection

Digital skill levels are divided into "above basic", "basic", and "low." Given the aim was to analyse the level of European digital skills without accounting for internet usage in the last three months, the category "no digital skills" was omitted as it was contingent on the internet usage over the same period. Further explanation on the digital skills' classification is provided in the Supplementary Materials.

Individuals were clustered in five primary age groups (16-24, 25-34, 35-44, 45-54, 55-64, and 65-74 years). Sex was coded binarily. Educational attainment was accounted for through three-group disaggregations (low, medium, and high). Sub-stratification of education levels

was possible by means of sex and three secondary age groups (16-24, 25-54, and 55-74 years). Urban status was categorised into three levels (urban, suburban or town, and rural) according to the Eurostat Reference and Management of Nomenclatures [22]. Employment status was categorised into four categories (employed, unemployed, retired, and student). Income was classified through the distribution of national income by quartiles. All EEA Member States were included, in addition to Switzerland due to geographic, cultural, and developmental similarities with EU Member States.

Internet access was binary-coded and households were grouped into four categories (all, urban, suburban or town, and rural). The types of devices used to access the Internet were divided into three categories (mobile devices, desktop or laptop, and both). It is important to note that the variable for the type of mobile device used to access the Internet was only available in the 2018 survey, hence that data was used.

Data Analysis

Data was cleaned in R version 4.0.2, specifically using the ‘dplyr’ and ‘reshape2’ packages. Further visualisation of data was performed in Tableau version 2021.1 to create scatter plots as well as both the geographical and traditional heatmaps. Descriptive data was examined in R using the ‘summarytools’ package. To point towards potential causal mechanisms, a directed acyclic graph showing hypothetical pathways that affect the first and second level of digital divides was created before performing the analysis (Figure 1). This conceptual graph is based on existing literature outlining demographic characteristics that influence internet access or digital skills development [3,6].

Figure 1. A directed acyclic graph portraying the different causal pathways which influence internet access and digital skills development.

Results

Descriptive Statistics

Since internet access was based on households rather than individuals, the descriptive statistics are reported separately. Overall, an Internet connectivity of 89.12%(SD: 6.07%) was reported. Urban regions report 91.59%(4.43%) Internet access, suburban or towns 89.28%(6.04%), and rural areas 84.97%(10.19%). Households in the first income quartile report an across-the-board-average Internet connectivity of 72.83%(15.01%), the second quartile 86.50%(9.31%), the third quartile 95.33%(3.89%), and the fourth quartile 98.86%(1.03%).

Most individual respondents had above basic digital skills (34.65%), followed by low digital skills (27.48%), and basic digital skills (24.23%). Above basic digital skills were most common in the age group 16-24 (60.35%) and least in the age group 65-74 (7.87%).

Individuals with high levels of education report higher levels of digital skills relative to medium and low levels. The distribution of the higher levels of digital skills across all educational levels is consistently skewed in favour of males. Individuals living in urban regions report higher levels of above basic digital skills (40.81%) compared to rural regions (28.87%) and lower levels of low digital skills (24.35% versus 29.42%). Students and employed people report higher levels of above basic skills (68.16% and 40.66%) relative to unemployed and retired people (25.28% and 11.09%). People with higher incomes also tend to have higher levels of above basic digital skills (48.77%) than people with lower incomes (20.15%). All descriptive statistics are presented in Table 1.

Table 1. Descriptive Statistics.

		Digital Skills						Device Used to Access Internet ¹						
		Above Basic Digital Skills		Basic Digital Skills		Low Digital Skills		Mobile		Desktop or Laptop		Desktop or Laptop and Mobile		
		Mean (%)	SD (%)	Mean (%)	SD (%)	Mean (%)	SD (%)	Mean (%)	SD (%)	Mean (%)	SD (%)	Mean (%)	SD (%)	
All Individuals		34.65	12.13	24.23	4.47	27.48	7.69	80.77	10.09	75.53	12.75	61.67	12.83	
Age Group	16-24	60.35	15.36	23.03	7.70	14.84	9.30	97.03	2.89	87.93	7.67	82.70	9.44	
	25-34	50.65	14.93	25.52	6.09	21.00	11.14	95.57	4.03	85.30	9.67	77.07	10.56	
	35-44	41.61	14.05	27.52	5.27	26.48	10.79	92.20	6.09	83.20	10.06	72.70	11.03	
	45-54	30.68	13.55	26.77	5.94	32.48	10.79	83.50	10.08	78.10	12.82	62.37	14.11	
	55-64	18.81	10.50	23.68	8.49	35.32	7.65	67.13	17.42	66.77	18.59	45.13	18.18	
	65-74	7.87	5.86	17.68	11.27	31.94	7.95	45.93	22.95	49.47	23.70	28.13	19.52	
	Level of Education	High	Female	57.03	11.60	27.29	5.50	13.19	7.02	93.83	4.08	93.10	4.69	82.53
Male			53.90	11.31	29.06	5.74	14.48	7.01	94.03	4.31	92.30	5.04	81.13	7.50
16-24			60.48	12.55	25.19	5.95	11.84	7.23	93.67	3.92	93.97	4.32	84.43	6.66
25-54			74.72	15.14	18.04	9.76	6.12	7.18	98.87	2.42	94.22	6.47	90.57	8.10
55-74			63.29	11.90	25.35	6.75	10.23	6.66	97.57	1.70	95.17	3.47	87.97	5.60
			33.65	11.80	34.58	6.66	23.84	9.40	82.17	10.88	86.60	9.32	64.43	13.56
Medium		Female	29.68	12.87	26.81	6.09	32.16	10.01	82.80	10.96	76.77	12.90	61.03	13.88
		Male	27.68	11.63	27.13	6.85	33.77	9.70	82.80	11.87	75.70	13.47	58.73	14.34
		16-24	31.58	14.03	26.55	5.74	30.74	10.68	82.67	10.10	77.80	12.58	63.07	13.53
		25-54	62.03	15.02	22.74	7.36	14.32	9.67	97.90	2.16	89.43	7.00	84.47	8.83
		55-74	31.19	14.23	30.48	6.46	32.97	14.25	90.53	6.76	80.90	11.94	67.17	13.26
			12.16	8.11	22.68	11.01	39.39	7.56	62.70	20.28	64.60	20.31	39.87	19.38
Low		Female	20.39	12.96	16.61	6.48	33.42	8.76	65.70	17.49	56.80	19.90	43.63	18.37
		Male	18.16	12.49	15.58	7.50	33.71	10.39	63.00	18.83	53.27	21.00	39.87	19.01
		16-24	23.19	13.64	17.77	6.00	33.06	8.27	68.33	16.66	60.70	19.34	47.93	18.41
		25-54	51.93	18.92	26.28	12.05	19.03	10.62	95.79	4.64	84.69	10.14	78.72	12.51
		55-74	13.61	12.43	18.87	9.34	46.58	11.10	73.87	18.17	58.20	19.57	43.37	18.46
			3.81	4.49	10.48	10.64	31.87	13.45	37.83	24.55	36.50	25.49	19.43	17.63
Urban Status	Urban	40.81	12.40	24.42	3.91	24.35	7.90	84.34	7.59	79.93	10.01	68.00	11.07	
	Suburban or Town	33.03	12.41	24.45	4.97	28.94	8.42	80.72	10.15	74.76	13.46	60.38	12.98	
	Rural	28.87	12.37	23.61	6.90	29.42	8.63	75.52	13.28	70.45	16.92	55.41	15.86	
Employment Status	Employed	40.66	12.75	27.31	4.48	26.25	9.85	89.83	6.20	83.63	9.93	71.50	10.89	

	Unemployed	25.28	15.24	22.90	8.32	34.14	10.47	77.29	14.56	67.04	15.45	51.43	14.83
	Retired	11.09	9.22	19.16	9.58	35.31	6.99	56.63	19.78	55.03	20.40	33.97	16.72
	Student	68.16	14.18	20.59	8.83	9.94	7.63	97.90	2.25	92.07	5.90	87.43	7.32
Income Level	First Quartile	20.15	12.57	18.04	6.94	31.77	7.39	62.65	19.34	55.38	19.87	41.12	16.91
	Second Quartile	24.42	11.23	23.85	6.49	32.27	7.78	73.77	13.89	68.19	16.19	50.67	15.13
	Third Quartile	34.35	12.83	27.35	5.28	28.42	9.84	84.58	10.10	80.42	12.36	65.03	13.44
	Fourth Quartile	48.77	14.99	27.19	4.72	19.27	10.22	92.12	5.95	89.69	7.58	79.19	8.76

¹ Data from the 2018 survey

Internet Access across Europe

Internet access is available to the majority of the European countries' populations (75-98%). Nevertheless, there are certain geographical discrepancies between different regions. North and North-Western Europe is shown to have the highest internet access in Europe (94-98%), while Central- and South-Western (and Cyprus) show lower internet access (89-91%), and Southern and Eastern Europe (and Portugal) even more so (75-87%). Urban regions show higher levels of internet connectivity than rural regions (82-99% versus 62-99%). Notable differences are found in rural Southern and Eastern Europe (62-75%) compared to urban (82-87%). Households with income levels in the first quartile report lower internet access (33-96%) compared to other quartiles (65-100%; 83-100%; and 96-100% respectively). Figure 2 shows the overall geographic distribution of household internet access in Europe, stratified by urban status and income level. Further explanation on what devices are used to access the Internet is included in the Supplementary Materials.

Figure 2. The extent to which European countries have access to the Internet overall and the normalized prices of standalone internet (12-30MB/s, in EUR PPP) (Figure 2A) [23], stratified by urban status (Figure 2B), and by household income level (Figure 2C).

Digital Skills across Europe

The majority of highly digitally skilled people are found in the Northern and North-Western parts of Europe, indicating that over 50% of individuals possess above basic digital skills. In contrast, South-Eastern Europe shows less than 20% of individuals having above basic digital skills. This is reversed in individuals with low digital skills, who are frequently reported in South-Eastern Europe (together with Latvia), while less reported in North-Western Europe. Figure 3 shows the country-level distribution of digital skills in Europe.

Figure 3. A geographical heat map of the distribution of digital skills (Figure 3A; left shows above basic skills, centre shows basic digital skills, and right shows low digital skills), annual net earnings (Figure 3B) [24], and capital stock per capita (Figure 3C) [25].

The age group 16-24 shows the highest rates of above basic skills, while 55-74 has the highest rates of low digital skills. Conversely, both the 16-24 and 55-74 age groups report the lowest rates of low and above basic skills, respectively. A large range of above basic digital skills is observed (22-85%) in contrast with the range of older age groups of 55-64 (5-44%) and 65-74 (1-23%). The presence of above average digital skills tends to decline with age, whereas low digital skills increase with age. Above basic digital skills are mostly reported in

high education (29-84%), while least in low education (2-48%). The opposite counts for low digital skills (2-29% and 20-51% respectively). Urban areas show more above basic skills (17-63%) compared to rural areas (5-61%), while rural areas report a higher share of low digital skills (13-46%) than urban areas (11-43%). Students invariably report the highest shares of above basic digital skills (29-87%). Employed people tend to have above basic digital skills (13-66%) more frequently than unemployed people (2-61%). People with income levels in the fourth quartile report higher levels of above basic digital skills (17-74%) than people from the first three quartiles (4-44%; 4-46%; and 9-53% respectively). Further details on the stratified distribution of digital skills per country are shown in Figure 2. From Figures 2 and 3, it follows that there exists a positive cross-country correlation between the high capital stock and income/earnings and the digital skills development. Moreover, the comparative analysis shows that cost of internet access bears marginal influence over digital literacy levels. These findings are consistent with the affordability of internet access prices, i.e., with their small share within the average income/earnings. The latter is to say that the influence of the European cross-country capital/income/earnings stratification concerning the digital skills levels is complex and cannot be reduced to internet service pricing alone. The decline of above average and low digital skills is also observed in education levels, urban status, and income level and – along with the age-related decline – are shown per European country in Figure 4.

Figure 4. Scatterplot of digital skills across Europe stratified by age (Figure 4A), level of education (Figure 4B), urban status (Figure 4C), employment status (Figure 4D), and income level (Figure 4E). The top plot indicates above basic digital skills, the middle plot basic digital skills, and the bottom plot low digital skills.

Educational stratification shows large differences in above basic digital skills in age category 16-24 (43-96% in high education versus 16-86% in low education). The age groups 25-54 and 55-74 with high education exhibit higher levels of above basic skills (34-89% and 13-63% respectively) compared to medium and low education (5-55% and 0-46%; and 0-28% and 0-15% respectively). Females with higher education report lower levels of above basic digital skills (29-82%) compared to males (28-87%). For medium and low levels of education, males report above basic skills (6-56% and 3-55%) more frequently than females (6-51% and 1-47%). Low digital skills are underreported in males with medium and low education (14-57% and 18-50%) relative to females (17-53% and 18-57%), as shown in Figure 5.

Figure 5. Heat map of digital skills with level of education substratified by age (Figure 5A) and sex (Figure 5B). The left plot indicates above basic digital skills, the middle plot basic digital skills, and the right plot low digital skills.

Discussion

The main purpose of this article is to examine the first two levels of European digital divides: internet access and digital skills. Overall, large differences are observed between North-

Western Europe and the other regions, with internet access and digital skills being vastly higher in the former. When stratifying by age, level of education, sex, urban status, employment status, and income level, inter-country differences also become evident. People who are younger, higher educated, male, live in urban regions, are either a student or employed, or are employed consistently have higher internet access and digital skills compared to other demographic groups. While previously reported statistics for the European region have shown high internet access [14,15,26], these numbers can be misleading considering the intra- and extra-group demographic distributions of European countries. Findings in terms of overall Internet access are comparable to previous research (88% versus 89.12% [26]), yet geographical discrepancies are glaring (75-98% access rate). Notably - even though Internet pricing is lower and they have a higher proportion of economically active people (see eFigure 1) - the development of digital skills continues to lag behind in South-Eastern Europe.

Greenhalgh's diffusion model offers three vital elements which contribute to the large differences in the uptake of digital technology. Digital technologies cannot be used without some degree of prerequisite knowledge, thereby creating a barrier to access and, by extension, a flaw in the adoption. Additionally, the required knowledge and skills are arguably unique, meaning there are few-to-no pathways for knowledge from another field to be transferred in the piloting of digital technologies. With the 2019 Digital Competence Framework now calling for more advanced digital competences, this becomes especially alarming considering only 34.65% of respondents in 2019 had above basic skills under the 2016 classification and these skills are predominantly found in specific population groups (young people, people with high income, employed people and students, and people living in urban areas). When examining countries and systems and their uptake of digital technologies, it remains a question whether they: (1) experience a need and desire to innovate; (2) possess the available resources and the necessary leadership to instigate and sustain change; and (3) have a politico-cultural climate and population structure that facilitates the uptake of digital technologies. This same rationale applies when examining the uptake of digital technologies across demographic groups. For instance, younger people, students, and urban people are more likely to have an innate motivation to innovate and develop, which may contribute to easier assimilation of digital technologies and, in turn, result in greater digital skills development. People with higher incomes are also more likely to enrich their lives through

innovations (further enabled by the presence of expendable resources [27]), which may explain that demographic's higher digital skills levels.

When it comes to the third level of digital divide, failing or delaying the assimilation of new technological innovations (e.g. digital technologies) can impede a region or country's economic and public health sectors. Following Kondratiev's wave theory, novel technologies are associated with positive economic impulses [17,28]. Mazzucato explains that this impulse results from private sector investments in novel technologies, which become profit-bearing opportunities once the high financial risks associated with earlier stages of development are averted [29]. Once avoided, the private sector is then incentivised to invest. Consequently, as state-of-the-art technologies are implemented and further developed, the skill-biased technological changes cause intra-firm and cross-country competitiveness to soar, and the multiplier spiral sets the economy on an expansionary trajectory.

Finding and sustaining employment can also become more difficult with increasing digitalisation if the digital skills of the current and prospective workforce are not adequately developed [30]. Simultaneously, as healthcare and public health continue to digitalise, access to health services may become jeopardised without sufficiently digital skills [6,18]. Health may further deteriorate due to poor digital skills if social support and employment become more contingent on the possession and mastery of digital skills, further exacerbating inequalities. It is therefore not only crucial from an economic perspective to invest in developing the general population's digital literacy and capacity, but also a public health perspective.

It becomes self-evident that the existing cross-country digital divides will further intensify the economic ones. Given the strong correlation between capital stock, income, and earnings with digital skills development, less developed European countries find themselves in an unfavourable position relative to the developed. These countries will have difficulties catching up, whereas the skill-biased technological change will deteriorate their cross-country competitiveness. The result will present an enormous challenge to maintaining the European commitment to socio-economic and geographical cohesion, upward cross-country convergence, reduction of inequalities, and balanced economic growth. Should such a scenario prevail, a permanent and calamitous perpetuation of the ongoing economic schism

will ensue, an antithesis to the European founding values and a force that will perpetuate the existing disintegration bias.

It suffices to note that the empirical arguments outlined in this study are constrained by the sampling size and data collection appropriateness. Eurostat's survey metadata indicates differences among national statistical institutes regarding sampling design [21]. Some countries use samples based on individuals as primary sampling units, while others represent primary sampling units as households in the public register. It is also unclear if all countries used the same data collection modalities or if the same type of organisations were responsible for data collection. Gender is also not included separately in this survey, so all gender-related items were inferred using sub-categorisations of education level. This study's findings are only relevant for the age range 16-74 and cannot be blindly translated to younger or older age groups. Due to a cross-sectional design, this study could only highlight associations and correlations. Moreover, the way in which digital skills are outlined in the framework may not be fully representative of the required competencies for Europeans to fully benefit from digital transformations in a post-pandemic world. Regardless, in line with previous research, it can be reasonably assumed that these methodological limitations should not undermine the study findings.

Recommendations for Policy and Governance

The initial economic endowments are a prerequisite for establishing the infrastructure, acquiring the necessary equipment, and developing digital skills. From the aforementioned, it can be inferred that costly infrastructural ICT investments must be considered public goods to be carried out through public investment or public-private partnerships and under the supervision of central authorities. Alternatively, should the provision of necessary public goods be left to profit-centred, free-market stakeholders, they will remain under-provided and inequitably distributed across Europe. Similarly, in the case of other public goods (e.g., roads, railways, healthcare facilities), this scenario will generate market failure if not adequately addressed. In line with Mazzucato's recommendations, governments must shift away from the neoliberal ideology that they are only tasked to fix and repair and instead, towards a mindset of innovation, catalysing the economy to be more purpose-driven and goal-oriented to achieve sustainable development [29]. This entails the development of digital capacity in-government and across the general population. Following that reasoning, traditional definitions of digital literacy and approaches to building digital capacity must be expanded

and updated to adapt to the pace of development brought about by the COVID-19 pandemic. Furthermore, it is crucial for curricula and teaching practice to be updated to better reflect and incorporate this new definition/conceptual framework of digital literacy. However, in doing so, it is paramount that digitalisation – particularly in education practice – is used as a means to an end, not a solution in and of its own [10].

Acknowledgement of these conclusions under the framework of European (in particular EU) institutional design brings about an additional dimension of complexity. Given the vast differences in available resources and absence of the supranational political climate delivering inclusive strategies, digital divides threaten to become principal contemporary forces leading the cross-country divergence. Coupled with the core-periphery divide, digital divides impede the European objectives of promoting all citizens' well-being, combatting social exclusion and inequality, reducing developmental disparities and the backwardness of the least-favoured regions, and ensuring harmonized socio-economic growth. Hence, to prevent a growing gap and halt continuous suffering of less-developed areas, the provision of necessary public goods cannot be left in the private nor country-level sphere alone and must be addressed at a supranational level. European policymakers must prioritize equitable and sustainable development and make better use of existing facilities financed through direct transactions and delivered through a combination of private and public arrangements. Aligned with this agenda, a step in the right direction would be to approve the NextGenerationEU instrument. This recovery and transformative agreement aims to target digital transition (Digital Europe Program) and education and training to support digital skills development at the European level. However, while it bolsters the paramount concept of cross-country solidarity, it leaves the sovereignty and local state capacity to play an integral role. To that end, it remains to be seen as to whether or not this large stimulus package will be sufficient, in size and structure, to tackle digital and economic divides and deliver sustainable results.

The transition into the Digital Age provides novel opportunities to minimise existing inequalities and pursue the Agenda for Sustainable Development. However, to effectively pursue this goal, we must first ensure that inequalities are not exacerbated whilst transitioning. Europe's digital climate at the start of the pandemic left much to be desired. Although the pandemic forced society to digitalise, it remains to be seen how much sticks

around. One conclusion, however, is certain: Europe is still unfit to sustainably host a digital society and doing so would exacerbate in- and cross-country inequalities.

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No conflicts of interests are reported. All authors had access to all the data in the study and accept responsibility to submit for publication.

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Data Sharing

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Supplementary Materials

Van Kessel, R., Wong, BLH., Rubinić, I., Czabanowska, K. Is Europe prepared to go digital? Making the case for developing digital capacity: an exploratory analysis of Eurostat survey data.

eConcepts. Background information on the analytical frameworks.

eMethods. Supplementary information on methodology.

eTable 1. Indicators that make up the digital skills measurements of Eurostat.

eFigure 1. Demographic structure of Europe: economically inactive-to-active ratio.

eResults. Devices used to access the internet.

eFigure 2. Distribution of devices used to access the internet.

eReferences. Supplementary reference list.

eConcepts. Background information on the analytical frameworks.

Greenhalgh's diffusion model

Greenhalgh and colleagues performed an elaborate systematic literature review to identify the factors that influence the spread and sustainance of innovations in health service delivery and organisations. In doing so, they identified nine relevant dimensions: (1) the innovation itself; (2) the adopter; (3) assimilation; (4) communication and influence; (5) system antecedents; (6) system readiness; (7) outer context; (8) implementation process; and (9) linkage. A visual representation of the model is shown below. Each of these dimensions shows various characteristics that can benefit the uptake of an innovation in a new environment. For instance, an innovation is more likely to be taken up in a new system if it has a clear and unquestionable advantage in (cost-)effectiveness, is compatible with the needs and values of the adopter, is simple to use, offers room to experiment, has observable benefits, can be adapted and refined to suit an adopter's needs, fits in existing infrastructures of the adopter (e.g. is compatible with the hardware that is used by the adopter in case of a software innovation), poses low risks, can make use of existing knowledge to ease the learning curve, and is supported by technical support.

Source: Greenhalgh T, Robert G, Macfarlane F, Bate P, Kyriakidou O. Diffusion of innovations in service organizations: systematic review and recommendations. Milbank Q. Milbank Memorial Fund; 2004;82:581–629. Available from:

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Digital determinants of health

In 1991, Dahlgren and Whitehead conceptualised the now widely used social determinants of health model that divided factors that affected health into five domains (constitutional factors; individual lifestyle factors; social and community networks; living and working conditions; and the general socio-economic, cultural, and environmental conditions) [1]. This model was established at a point where the digital era was still in its infancy. Over time, a need to innovate this model has been expressed and such innovation has been attempted [1]. Rice and Sara innovated the original model by adding a sixth domain on top of the socio-economic, cultural, and environmental conditions: *the virtual world: information and communication technologies* [1]. They briefly explore the impacts of this new domain on physical, mental, and social health. A comprehensive overview of the digital determinants of health was shown later in 2019 by Risling [2], who identified twelve factors that strongly correlate with health in a digital age: (1) income; (2) physical environment; (3) employment; (4) social support and coping skills; (5) gender; (6) health service access; (7) biology/genetics (e.g. age); (8) healthy behaviours; (9) culture; (10) race; (11) childhood; and (12) education/level of literacy.

eMethods. Supplementary information on methodology.

Composition of digital skill levels in the community survey on ICT usage

The community survey on ICT usage in households and by individuals data provides a set of variables that, when combined, measure an individual's level of digital skills. They are based on the 2016 Digital Competence Framework of the European Commission in which key skills relating to digital technologies are set out [3]. Proficiency in digital skills is divided into four levels: above basic digital skills, basic digital skills, low digital skills, and no digital skills.

The level of digital skills is determined by the reported outcomes in four domains: information skills, communication skills, problem-solving skills, and software skills (for content manipulation). Further breakdown of the domains into their respective subcategories is provided in eTable 1 below.

Individuals with above basic digital skills score “above basic” in all four domains; individuals with basic digital skills score at least one “basic” but no “no skills” in all four domains; individuals with “low” digital skills (i.e. missing some type of basic skills) score one to three “no skills” in the four domains; and individuals with “no digital skills” score “no skills” in all four domains. In other words, they report to have no activities performed in all four domains, despite indicating that they used the internet at least once during last three months.

Demographic Structure in Europe

According to Regulation 1260/2013 on European demographic characteristics, EU Member States send data regarding their population to Eurostat annually. This data includes details on sex, broad age group and NUTS 3, five-year age group and citizenship/country of birth/NUTS 2 & NUTS 3 (under regional data), single age and educational attainment/marital status / broad group of citizenship/broad group of country of birth / NUTS 2 (under regional data), citizenship and broad group of country of birth/country of birth and broad group of citizenship, and population structure statistics: median age of population, proportion of population by various age groups, old age dependency ratio [4].

To further contextualise the data in the main article on economic measures (income, pricing of internet), the demographic structure of economically inactive versus economically active people is extracted from this dataset. A full depiction is shown in eFigure 1.

eTable 1. Indicators that make up the digital skills measurements of Eurostat.

Indicator	Competence	Sub-categories
Information skills	“To identify, locate, retrieve, store, organise and analyse digital information, judging its relevance and purpose”	<ul style="list-style-type: none"> - Copied or moved files or folders; - Saved files on Internet storage space; - Obtained information from public authorities/services' websites; - Finding information about goods or services; - Seeking health-related information.
Communication skills	“To communicate in digital environments, share resources through online tools, link with others and collaborate through digital tools, interact with and participate in communities and networks, cross-cultural awareness”	<ul style="list-style-type: none"> - Sending/receiving emails; - Participating in social networks; - Telephoning/video calls over the internet; - Uploading self-created content to any website to be shared.
Problem solving skills	“To identify digital needs and resources, make informed decisions as to which are the most appropriate digital tools according to the purpose or need, solve conceptual problems through digital means, creatively use technologies, solve technical problems, update one's own and others' competences”	<p><i>A – Problem solving</i></p> <ul style="list-style-type: none"> - Transferring files between computers or other devices; - Installing software and applications (apps); - Changing settings of any software, including operational system or security programs. <p><i>B – Familiarity with online services</i></p> <ul style="list-style-type: none"> - Online purchases (in the last 12 months); - Selling online; - Used online learning resources; - Internet banking.
Software skills	“To create and edit new content (from word processing to images and video); integrate and re-elaborate previous knowledge and content; produce creative expressions, media outputs and programming; deal with and apply intellectual property rights and licences”	<p><i>Part A</i></p> <ul style="list-style-type: none"> - Used word processing software; - Used spreadsheet software; - Used software to edit photos, video or audio files. <p><i>Part B</i></p> <ul style="list-style-type: none"> - Created presentation or document integrating text, pictures, tables or charts; - Used advanced functions of spreadsheet to organise and analyse data (sorting, filtering, using formulas, creating charts); - Have written a code in a programming language.

eFigure 1. Demographic structure of Europe: economically inactive-to-active ratio.

eFigure 1. A country-level heatmap showing the demographic structure of economically inactive people (ages 0-24 and over 65) versus economically active people (ages 25-65).

eResults. Devices used to access the internet.

Descriptive Statistics of Device Usage

Most respondents indicated they used mobile devices to access the internet (80.77%[10.09%]), followed by desktop or laptop (75.53%[12.75%]) and both (61.67%[12.83%]). Similar to the statistics on digital skills, age group 16-24 uses mobile devices more than twice as often to access the internet than 65-74% (97.03%[2.89%] versus 45.93%[22.95%]), desktops or laptops nearly twice as often (87.93%[7.67%] versus 49.47%[23.70%]), and a combination of both nearly three times as often (82.70%[9.44%] versus 28.13%[19.52%]). Mobile device usage to access the internet is more common among females than males in high and medium education (94.03%[3.92%] and 82.80%[11.87%] versus 93.67%[3.92%] and 82.67%[10.10%]), whereas this is reversed in low education level (63.00%[18.83%] for females versus 68.33%[16.66%] for males). Males use desktops or laptops or a combination with mobile devices more often than females. Rural areas score between 8.82 and 12.59 percentage points lower in using devices to access the internet than urban areas. All descriptive statistics are also presented in Table 1 of the main manuscript.

Distribution of Devices across Europe

Mobile devices commonly used to access the internet in the age group 16-24 (90-100%), followed by desk- or laptop (66-97%), and a combination of both (53-92%). The age group 25-34 shows similar numbers (86-100%; 60-98%; and 53-92%). Numbers slightly decline in the age group 35-44 (77-99%; 57-96%; and 48-89%), after which they decline more steeply in age 45-54 (63-98%; 51-96%; and 38-86%), age 55-64 (40-97%; 34-97%; and 21-83%), and age 65-74 (13-84%; 16-94%; and 7-66%). Individuals with high education more commonly use mobile devices (85-99%), desk- and laptops (82-99%), and a combination of both (70-93%) to access the internet compared to the medium (61-96%; 52-97%; and 38-85%) and low education strata (33-95%; 24-90%; and 17-79%). Urban regions use mobile devices (71-97%), desk- and laptops (56-96%), and a combination of both (46-89%) to connect to the internet more than rural areas (48-97%; 38-97%; and 28-87%). Students and employed people use mobile devices (92-100% and 68-99%) notably more than unemployed and retired people (42-100% and 23-93%). This trend is also observed in desk- and laptops (74-100% and 61-96% versus 32-94% and 23-93% respectively) and in using a combination of both (67-99% and 50-89% versus 21-86% and 14-66% respectively). eFigure 2 portrays a general and stratified overview of the devices used to access the internet.

eFigure 2. Distribution of devices used to access the internet.

eFigure 2. Scatterplots to indicate what devices are used to access the internet, divided by age category (eFigure 2A), education level (eFigure 2B), urban status (eFigure 2C), employment status (eFigure 2D), and income level (eFigure 2E). The upper plot depicts the use of mobile

devices only, the middle plot desk- or laptops, and the lower a combination of mobile and desk- or laptop.

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