Gender Digital Divide in Europe

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Abstract

This paper describes the digital divide between women and men in Europe. The paper presents the gender gaps in Europe across all areas of a woman's life: digital skills in general, in education, in employment, in career evolution, in starting a business, and more. Various European authorities address the gender digital divide and call member States for actions. Finally, the paper recommends strategies to be implemented across the life phases of a woman (young girl, student, early career, advanced career) and across action areas (Raise Awareness & Promote, Educate & Train, Mentor & Guide, Network, Fund, Legislate). The actions should not only target women but also other Stakeholders such as parents, teachers, media people, influencers, employers, public authorities, chambers, associations, and general public. Finally, the paper proposes specific measures and indicators to monitor the progress made towards gender digital equality.

Keywords: digital competence, digital skills, gender differences, gender digital divide, gender gap, gender strategies, ICT skills.

1. Introduction

In today's social distancing situation due to the pandemic, people need more than ever to possess digital skills. They have to perform many daily activities (e.g., supermarket shopping, communicating, working, learning, socializing, entertainment) using mobile phones, computers and Internet. Of course this situation also affects women who need to have digital skills. Furthermore, it is easier for women with digital skills to find jobs, protect themselves both online and offline, advance their public engagement and participation, and enhance their socio-economic status (EQUALS, 2019). If they also have access to the Internet, it is easier to initiate online businesses, and access online education, government, and financial services (ITU, 2019a).

But what do digital skills involve? Various organizations and researchers tried to define what digital skills encompass. UNESCO (2018) defines digital literacy as "the ability to access, manage, understand, integrate, communicate, evaluate and create information safely and appropriately through digital devices and networked technologies for participation in economic and social life". ITU (2018a) defines digital skills as the ability to use Information and Communication Technologies (ICTs) in everyday life in order to achieve specific objectives. ITU (2018c) also suggests five different skills for youth employment: 1) Advanced digital skills necessary to create, manage, analyze and evaluate ICT (e.g., coding, software and app development, network management, machine learning, Big Data analysis, the Internet of Things (IoT), cybersecurity, and blockchain technology); 2) Basic digital skills required for almost all jobs (e.g., web search, online communication, online shopping, banking, government, etc.); 3) Mid-level digital skills (e.g., digital multimedia design, digital marketing and social media management); 4) Soft skills necessary for effective collaboration in the digital economy (e.g., teamwork, leadership, negotiation, customer relationship management, etc.); 5) Digital entrepreneurship (e.g., online market research, web analytics, business analytics, etc.). European Union (Ferrari, 2012; Carretero, Vuorikari, & Punie, 2017) defines digital competence as the knowledge, skills, and attitudes of using digital technologies to find, manage, and evaluate information, communicate and collaborate, create, and share content, as well as solve problems.

Regarding the proficiency level of digital skills, several levels have been proposed. OECD (2016) proposes the following categories for digital skills: i) ICT basic skills for all alike to be able to use digital technologies; ii) ICT specialist skills for workers who support and develop the digital eco-system. Similarly, ITU (2018b) classifies digital skills at three levels: i) Basic digital skills for individual digital literacy; ii) Intermediate digital skills for workers in the digital economy; iii) Advanced digital skills for ICT professionals.

However, in almost all countries there is a gender divide with respect to digital skills. Women face various obstacles to develop digital skills and even follow ICT careers. The obstacles start emerging from the early years and continue during their next life phases: education, seeking employment, employment, and career advancing. Women should overcome stereotypes, cultural barriers, absence due to feminine issues (e.g., pregnancy, maternity and motherhood), male-dominated jobs, male aggressiveness, harassment, low self-esteem, and more.

Furthermore, the gender digital divide is even more extreme for older or less educated or poor women, or living in rural areas and developing countries (OECD, 2018). For example, women believe 1.6 times more than men that they lack skills to use the Internet in low- and middle-income countries (World Wide Web Foundation, 2015). There is a wide divide in Internet access and use between women and men as well as between girls and boys. In 92% of countries, there are more men than women Internet users (ITU, 2019a). Also, when there is a wide gender gap in mobile phone ownership then there is a wide gender gap in Internet use (ITU, 2019a). In low- and middle-income countries, 54% of women use mobile Internet, but women are 20% less likely than men to own a smartphone and use mobile Internet (GSMA, 2020). In 2019, 48% of women use the Internet compared to 58% of men worldwide (ITU, 2019b).

Amongst the 15-year-in OECD countries, only 1% of girls reported that they want to work in ICT-related jobs (versus 8% of boys) (OECD, 2019). Only 3% of ICT university students and of ICT graduates are women (UNESCO, 2017b).

In addition, the gender digital divide increases as technologies become more advanced, sophisticated, and expensive (United Nations University, 2019). In low- and middle- income countries, women use a smaller range of smartphone services (GSMA, 2020). Also, in many countries, women are 25 % less likely than men to use simple arithmetic formulas in a spreadsheet (UNESCO, 2017a).

Furthermore, the gender divide increases with the digital skills proficiency level. There is a higher gender gap for advanced digital skills than for basic digital skills. For example, men are around four times more likely than women to be able to code (UNESCO, 2017a). The gender gap is widest in the area of ICT specialist skills and employment. Actually, the gender gap is 82% for ICT specialists, and 65% for science, technology, engineering, mathematics (STEM) and ICT graduates (SRIP, 2020) Also, women represent the 12% of machine learning researchers (men represent the rest 88%) (Mantha & Hudson, 2018). Similarly, women account for 13.83% of Artificial Intelligence (AI) authors (NESTA, 2019). In almost all universities, big tech companies, and other research institutions, less than 25% of AI researchers are women (NESTA, 2019). Similarly, only 22% of AI professionals globally are women (UNESCO, 2020). This gender biases and stereotyping are being transported to virtual personal assistants (e.g., Siri, Alexa or Cortana) which are represented as females. Furthermore, women account for only 27% of jobs in digital platforms (SRIP, 2019). Finally, in Stack Overflow, one of the largest international online coding communities, there are around 5% feminine profiles and only one woman in the top 100 accounts (Lindsey, 2020).

2. Women and ICT in Europe

The gender digital divide also exists in European Union (EU) States. Next, the paper presents the gender digital divide across the phases of an EU woman's life.

Initially, it shows the gender gap in digital skills, then in ICT-related education. It continues exposing the gender gap in ICT-related professions, jobs, and entrepreneurships. Finally, it reveals the gender gap in ICT leadership. Various EU authorities address the gender digital divide and calls for actions.

2.1 EU Women Digital Skills

In EU, 78% of women (versus 80% of men) are Internet daily users, 31% of women (versus 36% of men) have "above basic digital skills" (more specifically, 71% for information skills, 67% for communication skills, 56% for problem-solving skills, and 39% for software skills) (Gender Equality Index, 2020) (Figures 1 and 2).

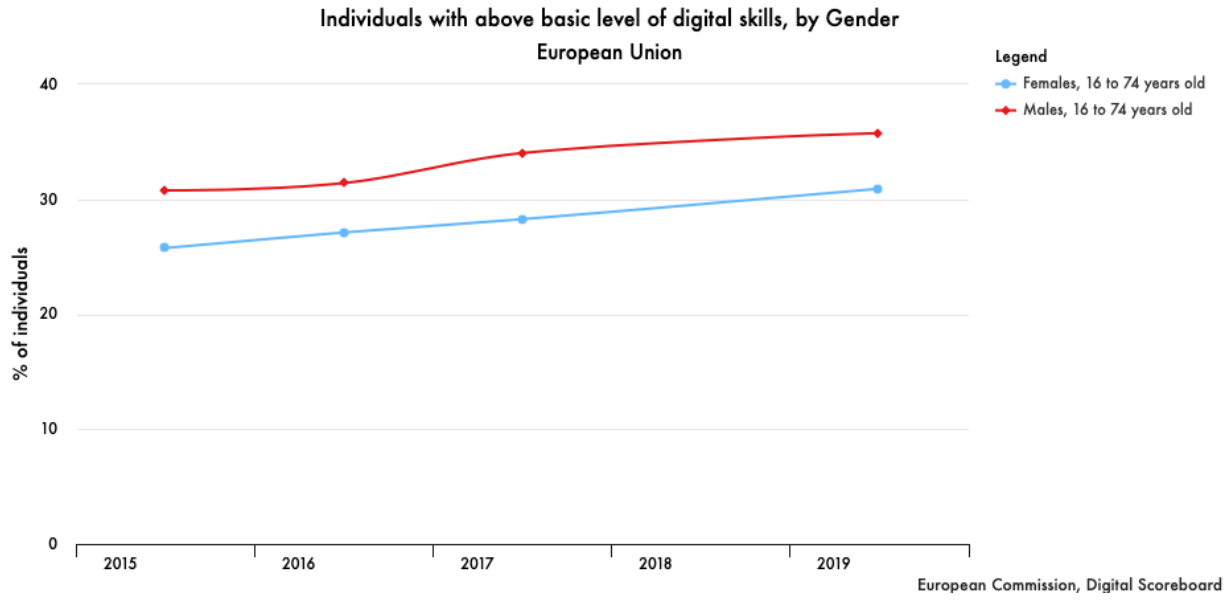

Figure 1. Females and males (16 to 74 years old) with above basic level of digital skills in EU (Gender Equality Index, 2020).

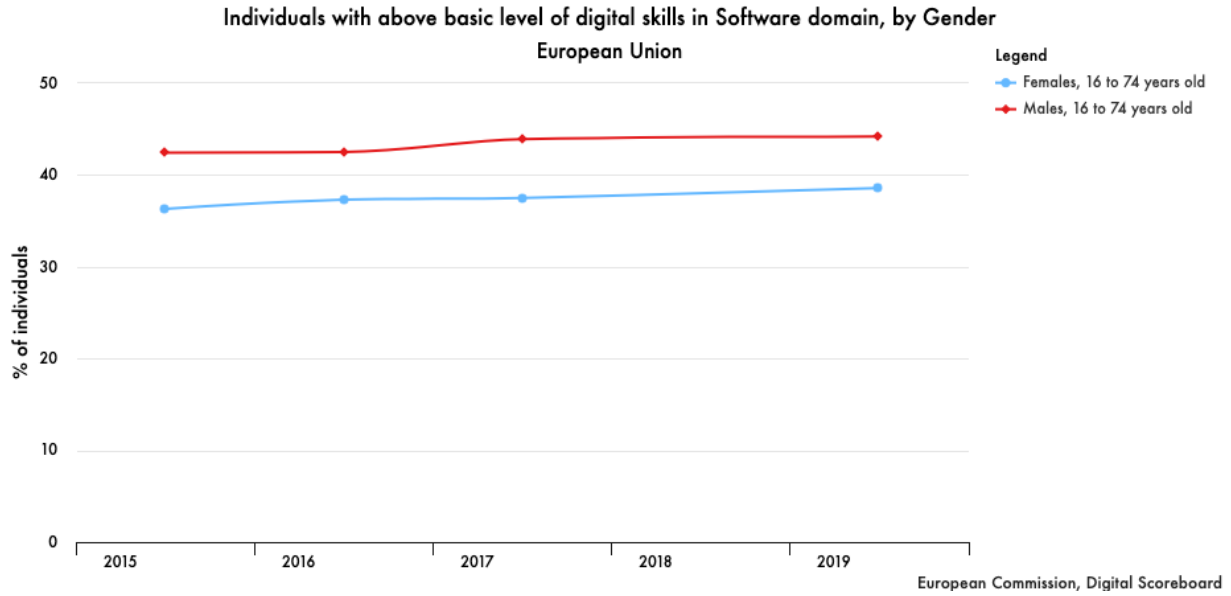

Figure 2. Females and males (16 to 74 years old) with above basic level of digital skills in Software domain in EU (Gender Equality Index, 2020).

During the last three months of participating in an EU survey (WiD, 2020), 63.1% of women used the Internet to do online banking; 13,1% of women used the Internet for participating in social or professional networks; 8.08% of women used the Internet for doing an online course (on any subject); 0.94% of women participated in on-line civic consultations or voting (e.g. urban planning, signing a petition); and 0.637% of women sent filled forms to public authorities over the internet, during the last year.

2.2 EU Women in ICT Education

In most cases, girls do equally or even outperform boys in Science, Technology, Engineering, and Mathematic (STEM) classes in primary and secondary education, but their interest in STEM subjects starts decreasing by the age of 15. During the EU Code Week 2019, women represented the 47% of participants (DESI, 2020).

Note that EU Code Week provides teachers with free educational resources to promote coding to students. However, the gender gap widens in secondary and tertiary education.

Around 2.7% of Europeans studied in university ICT-related subjects (European Commission, 2018). However, in Europe, there are around four times more men than women with ICT-related studies (European Commission, 2018). A similar statistic shows that females are only 29.2% of ICT students (compared to females at 36.2% of STEM students) (EQUALS, 2019). Also, 68% of women undergraduates have taken coding or computing classes, compared to 83% of men undergraduates (European Commission, 2018).

In EU, in 2016, there were 1,113 (21%) women doctoral graduates in broad ICT-related fields (versus 4,127 men) (She figures, 2018). Finally, only 18% of women (versus 22% of men) have received at least one training activity to enhance their skills related to the use of computers, applications, or software (Gender Equality Index, 2020).

2.3 EU Women in ICT professions

Although there is a high demand for ICT professionals, there are few women in the ICT sector. In EU, out of 1,000 women tertiary education graduates only 24 women have a degree in ICT-related fields, of which only 6 women went on to work in ICT jobs (European Commission (2018). On the other hand, out of 1,000 male graduates, 92 are graduates in ICT-related fields, and 49 went on to work in ICT jobs.

Although being a university degree increases employability, this increase for ICT-graduates is small (between 2% and 3%) for men. Even worse, for women ICT-graduates, the probability of being employed decreases between 1% and 2%, in comparison to women graduates of other type of university studies (European Commission, 2018).

Women correspond to 52% of the European population but only around 17% of women work in ICT-related jobs (SRIP, 2020). Also, although women account 57% of all university graduates, they are only 24.9% of all graduates in ICT-related fields, and very few enter the ICT sector (European Commission, 2018). Actually, women correspond to the 13% of the graduates in ICT-related fields who are working in ICT jobs (European Commission, 2018).

In EU, women represent only the 17% among 8 million people working in ICT (EIGE, 2018). According to the Gender Equality Index (2020), there are only 20.1% women ICT graduates (versus 79.9% men) and only 17.7% women ICT specialists (versus 82.3% men). Furthermore, 37% of employed women perform ICT activities at work (versus 42% of men). More specifically, 8% of women used other computerized equipment (versus 13% of men), 32% of women exchanged emails (versus 36% of men), 24% of women created or edited electronic documents (versus 28% of men), 9% of women used social media (versus 11% of men), 10% used applications to receive tasks or instructions (versus 14% of men), 19% used occupational specific software (versus 24% of men), and 3% developed or maintained IT systems or software (versus 7% of men). Moreover, 16.5% of women work part-time in ICT (versus 5.4% of men). Finally, women are payed 11% less than men in ICT jobs.

In EU, there are about three times more men than women working in the ICT sector. Only 21.5% of all workers in ICT jobs are women (European Commission, 2018). There are four times more men than women ICT specialists. Only 1.38% of women employees are ICT specialists (i.e., ICT service managers, ICT professionals, ICT technicians, ICT installers and servicers) (versus 5.66% of men employees) (Digital Europe, 2019).

Finally, women ICT workers tend to leave their jobs at a greater rate than men (European Commission, 2018). This resignation is more intense for women between 30 and 44 years old (during these ages, most Europeans take care of their babies and small children). Around 9.7% of women (versus 1.2% of men) with tertiary ICT education left their profession in 2015 (European Commission, 2018).

2.4 EU Women ICT entrepreneurs

In EU, only 14.8% of start-up founders are women (European Commission, 2018). In 2015, women accounted to 23.4% of entrepreneurs in the ICT sector (European Commission, 2018). Although start-ups that are founded by women perform 63% better than startups founded by men, the average investments in women entrepreneurs have decreased since 2014. Women entrepreneurs in the ICT sector are overall satisfied with their work, have a greater sense of achievement, and experience relatively low levels of stress. However, they are less paid than men (European Commission, 2018).

2.5 EU Women ICT leaders

In EU, in 2015, only 21.4% of the workers in the ICT sector have women bosses (versus 48.4% of workers in other non-ICT service sectors) (European Commission, 2018). Although there is an increase in women board members in ICT companies, these boards are dominated by men. Specially, all-men board constitute the 17.2% of the IT companies (European Commission, 2018). In addition, there is not even one IT corporation in STOXX 600 having a women CEO. On the other hand, there is at least one woman on boards of Telecommunication Services companies, and in total there are 27% women on boards of such companies. Furthermore, there are women CEO in 9.5% of Telecommunications Services companies (European Commission, 2018).

2.5 EU initiatives to support EU women in ICT

Various EU authorities address the gender digital divide and calls for actions. General Secretariat of the Council (2018) urged the EU States and the Commission to prevent gender stereotypes, combat gender divide, women participation in the ICT sector and develop digital skills for both women and men. Also, EU Presidency (2018) called on the EU States to: i) Support young people in enhancing their digital competences (knowledge, skills, and confidence) in using digital technologies and social media; ii) Foster and promote gender equality and digital competences in formal, informal and nonformal education and vocational training. The Digital Agenda for Europe (2020) aims at exploiting digital technologies to stimulate the EU's economy and help its citizens and businesses to utilize digital technologies. One of its main pillars is dedicated to enhance digital literacy, skills and inclusion. One particular action aims to 'increase [the] participation of women in the ICT workforce'. The European Skills Agenda (2020) is a five-year plan to help individuals and businesses develop more and better skills and utilize these skills. Particularly, it aims at ensuring social fairness with respect to access to education, training and lifelong learning for everyone. The European Pillar of Social Rights (2020) aims (among others) at fostering gender equity in employment access, conditions, career progression and payment.

The Digital Skills and Jobs Coalition (2020) creates an alliance of EU States, companies, social partners, non-profit organizations and education providers to take actions fighting the shortage of digital skills in Europe. One of its action is the European Digital Skills Awards which recognizes initiatives that have enhanced the digital skills of Europeans at school, at work, for ICT specialists, and in society in general. Furthermore, European tech firms signed a Declaration (2018) expressing their intention to achieve gender balance and providing equal opportunities in their companies. More specifically they became committed to: i) promote an open and female-friendly company culture; ii) implement recruitment and human resources business policies fully considering the importance of women value; iii) open senior management and high rank positions to women; iv) identify potential female leaders and train them to develop their strengths and assign to them high-level positions in the company.

The Social Investment Package (2020) urges EU States to ensure that women have adequate ICT access and ICT-enabled flexible working conditions to help their employment (Davaki, 2018). The EU e-skills for the 21st Century strategy aims at increasing the participation of women in ICT and STEM fields. The EU Agenda for new skills and jobs recommends to EU States to invest in digital skills. Finally, the European Code of Best Practices for Women and ICT aims to narrow the ICT skills divide in Europe and also to keep on and advance ICT women.

3. Framework of strategies for empowering women in Digital Society

In this section, we recommend a framework for organizing strategies to fight the gender digital divide. The strategies could be implemented during the whole life of a women: i) during primary and secondary education (young girls); ii) during tertiary education (undergraduate and postgraduate studies); iii) during the first years after graduation, looking for a job and a career; iv) during the professional life and career evolution (Table 1).

The strategies could be also implemented along the following action areas: 1) *Raise Awareness* (also, Promote, Sensitize, Inspire, Role Models, Best Cases, Awards, Events, Digital Women Days, Hackathons, etc.); 2) *Educate & Train* (also, Redesign Education, Online Teach, Develop Open Educational Resources, Traineeships / Apprenticeships/ Practice Opportunities); 3) *Mentor* (also, Coach, Council, Guide, Support, Encourage, Foster Confidence/ Self-Esteem/ Self-Efficacy, etc.); 4) *Networking* (also, Communities, Hubs, Alliances, Associations, etc.); 5) *Funding* (also, Fellowships, Grants, Prizes, Startup Investments); 6) *Legislation* (Table 1).

Some example strategies include the following: promote successful women in ICT as role models to young girls; raise awareness to female students regarding opportunities in the ICT sector; educate female students on advanced digital technologies (e.g., blockchain, augmented reality coding, data analytics); redesign the educational content to highlight female success stories in ICT; encourage young girls to be involved in coding events; mentor early career women to found a startup in blockchain technology; establish networks of female ICT students, companies' recruiters, and ICT experts; connect female owned ICT startups and investors; establish innovation hubs for ICT women; nominate

fellowships to female students succeeding in ICT contests; fund women e-entrepreneurs; issue laws to protect ICT women in men- dominated companies; issue laws to protect the health of ICT women during pregnancy.

In addition to women, there are other Stakeholders involved and affect women digital skills. These Stakeholders include the following: parents, teachers, media people, influencers, employers, public authorities, chambers, associations, general public, etc. Corresponding strategies could be also implemented having as target group each one of the Stakeholder groups. For example, raising awareness and sensitizing campaigns regarding digital skills for women could be implemented targeting a specific Stakeholder group; training a specific Stakeholder group on the emergency of digital skills and the women' appropriateness to fill in ICT jobs.

Finally, monitoring strategies could monitor the progress made in various areas such as specific digital skills (e.g., Internet skills, social media, mobile, e-shopping, e-banking, coding), participation in higher education ICT studies (bachelor, master, doctorate, post-doctorate), in ICT research, in near ICT jobs, in core ICT jobs; e-entrepreneurship and startups; ICT leadership; and salaries.

In addition to already monitoring measures and indicators, the ICT women participation in the following domains could be also monitored: Awards & Prizes, ICT Awards & Prizes, Grants & Funds, ICT Grants & Funds, ICT Researchers in all fields, ICT Researchers in the ICT field, Authorship in all scientific fields, Authorship in ICT, ICT Professorships (at all levels) at University Departments of all fields, Professorships (at all levels) in ICT University Departments, Chairs in ICT University Departments, Directors in ICT Departments of Companies, Directors in ICT Companies, Board Members in all companies, Board Members in ICT companies, High Rank Positions in Public & Private Organizations, Salaries in all Companies, Salaries in ICT companies, etc.

Strategies for empowering Women in ICT	Young Girls	Female Students	Early Career Women	Professional Women
1. ***Raise Awareness*** (also, Promote, Sensitize, Inspire, Role Models, Best Cases, Awards, Events, Digital Women Days, Hackathons, etc.)	√	√	√	√
2. ***Educate & Train*** (also, Redesign Education, Online Teach, Develop Open Educational Resources, Traineeships/Apprenticeships/ Practice Opportunities, etc.)	√	√	√	√
3. ***Mentor*** (also, Coach, Council, Guide, Support, Encourage, Foster Confidence/ Self-Esteem/ Self-Efficacy, etc.)	√	√	√	√
4. ***Networking*** (also, Communities, Hubs, Alliances, Associations, etc.)	√	√	√	√
5. ***Funding*** (also, Fellowships, Prizes, Grants, Startup Investments, etc.)	√	√	√	√
6. ***Legislation***	√	√	√	√

Table 1. Framework of strategies for empowering women in ICT.

4. Conclusions and future research

Empowering women with digital skills enable them to participate in active citizenship, democracy, education, culture, economy and business in the digital society. This paper describes the gender digital divide and initiatives to tackle it in Europe. Although there is a high demand for ICT professionals and there are various actions to promote and support the inclusion of women in ICT education and jobs, women still face obstacles to exploit all these opportunities. As a result, women are underrepresented in almost all areas of ICT education, employment, entrepreneurship, and leadership.

Then the paper proposes a framework for implementing gender sensitive strategies across twenty-four (24) areas (six action areas times four lifetime phases). However, the actions should not only target women but also other Stakeholders such as parents, teachers, media people, influencers, employers, public authorities, chambers, associations, general public, etc. In addition, a monitoring strategy should monitor specific progress made towards gender equality using specific measures.

Future research may consider to compare the gender gap among the specific digital skills proficiency levels and ICT areas (e.g., basic, intermediate, and advanced digital skills; computer systems, database management, computer networks, data mining, artificial intelligence, multimedia, etc.) and identify those areas that need urgent intervention. Also, future research may compare the effect of the recommended strategies and actions on the gender digital divide using some of the recommended measures and indicators.

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