Fostering the Digital Competencies for the 5G Era

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Abstract. *The fifth generation of telecommunication systems (5G) will represent an important pillar for the digital economy and society. 5G is going to create a network customized to various needs of people, communities, economy, and society. 5G will demand a new generation of citizens who will be attracted by various innovative services. For the time being worldwide, the countries are in a race for digital competences. All countries are committed to develop, mobilize and attract talented people. The idea of the paper is to present the impact of digitalization and to analyze the competencies needed in order to be proficient in the digital world. Based on the data from the Digital Scoreboard 2018, the paper analyses the digital competences in the EU countries. At the same time, it reveals the outcomes of the correlation between digital skills and innovation performance in the EU. The analysis highlights the necessity for effective and relevant education and training policies, programs, especially in the countries recording low values for digital skills. Taking into consideration the fact that the digital revolution will trigger the reconfiguration of the educational systems and the accomplishment of a comprehensive evaluation of future skills and labor market needs, the paper emphasizes the necessity to develop the digital competences in all the EU countries and especially in Romania by smart education. The research methodology comprises bibliographic syntheses, socio-innovative empirical researches, statistical analysis.*

Keywords: *digital competence; digital transformation; lifelong learning; innovation; smart education.*

Introduction

The literature concerning the fifth generation of telecommunication systems is scarce but it has the potential to develop fast taking into consideration the impact of the practical cases. 5G or 'network of networks' comprises various technologies and access modes. According to Deloitte (2018), 5G is "envisioned to require a new core network that can support a wide range of services".

The increasing sophistication of artificial intelligence, the fast development of the Internet of Things and robotic process automation will demand digital competences. Worldwide, the digital transformation and the labor market demands are requiring genuine changes and innovation. In this context, the investment in people and the broad access to lifelong learning opportunities are crucial. The educational transformation will require to integrate digital technology into the education systems as well as to create innovative learning ecosystems. Obviously, the role of teachers will develop and therefore it is also crucial the investment in their professional development and own digital competences.

Innovative education methodologies will endow citizens with life skills such as creative thinking, computational thinking, curiosity, and problem-solving skills. The students, professors, and universities can benefit from adaptive learning, artificial intelligence, digital assessment, predictive analytics, virtual reality, augmented reality. In view of improving the teaching and learning processes, digital technologies will also sustain new assessment methods.

Therefore, in a digital world, digital competences represent a "must".

The research accomplishes a comparative analysis concerning the digital competences in the European Union. The paper aims to analyze the digital competences in the European Union Member States and to raise awareness concerning the necessity to develop the digital competences in the knowledge society and economy as well as the necessity for effective and relevant education and training policies, programs, especially in the countries recording low values for digital skills.

The authors have chosen to achieve the research for the EU countries in view to identify the similarities and differences, as well as the strengths and weaknesses of each country in this field.

The research questions addressed by the paper are as follows:

1. What is the impact of digitalization in the European Union Member States?
2. Which are the digital competences of the EU population in terms of information and data literacy, communication and collaboration, media literacy, digital content creation, safety, problem-solving, critical thinking?
3. Which is the statistical connection between digital competences and innovation performance in the EU countries?

The research methodology is both qualitative, based on the study and analysis of the field literature (scientific articles, books, socio-innovative scientific researches) as well as of the documents and reports achieved at the European level and quantitative, substantiated on processing the statistical data.

Digital competences

In the field literature, Ferrari (2012) and Pettersson (2018) highlight the digital competences, Bawden (2001) and Eshet-Alkalai (2004) emphasize the digital literacy, Oliver and Towers (2000) and Gupta (2006) focus on computer literacy, while other specialists refer to e-skills, e-literacy, IT literacy, ICT literacy.

According to Ferrari (2012), the digital competence represents "the set of knowledge, skills, attitudes, abilities, strategies, and awareness that are required when using information and communication technologies and digital media to perform tasks; solve problems; communicate; manage information; collaborate; create and share content; and build knowledge effectively, efficiently, appropriately, critically, creatively, autonomously, flexibly, ethically, reflectively for work, leisure, participation, learning and socializing". As stated by Ilomäki et al. (2016), digital competence comprises "the skills and literacies needed for the average citizen to be able to learn and navigate in the digitalized knowledge society".

The Council Recommendation on Key Competences for Lifelong Learning (CEU, 2018) specifies that digital competence is "one of the top priorities for transversal/basic skills development in Europe", also representing one of the eight key competences for lifelong learning in the EU. According to the above document, digital competence comprises "the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society. It includes information and data literacy, communication and collaboration, media literacy, digital content creation (including programming), safety (including digital well-being and competences related to cybersecurity), intellectual property related questions, problem-solving and critical thinking" (CEU, 2018). At the same time, this document highlights the importance of "increasing and improving the level of digital competences at all stages of education and across all segments of the population in all the EU Member States". It emphasizes "the better use of new opportunities, including distance learning and mobile digital devices, to actively support the development of competences throughout life", indicating that the Member States "should promote a variety of learning approaches and contexts, including the adequate use of digital technologies in education, training and learning settings" (CEU, 2018).

According to the European Training Foundation (2018), the job-specific digital skills represent "a set of specific digital skills for those involved in jobs including the use and maintenance of digital tools such as 3D printers, CAD software, and robots". As stated by Baltac (2015, p.19), "most actual jobs require a specific digital competence level, ranging from digital alphabetization to digital excellence". On the other hand, the digital skills for ICT professionals encompass "a set of advanced, highly specialized, digital skills for those involved in the ICT occupations, for example, programmers and cybersecurity experts who are expected not only to use but also challenge and innovate existing information and communication technologies and

create new solutions" (ETF, 2018). The European e-Competence Framework identifies 4 dimensions and 40 different specializations in five main ICT business areas (plan, build, run, enable, manage), essential for the public and private organizations who need to make decisions about recruitment, career paths, training, curricula, assessment (EC, 2016).

It is worth to remark the holistic approach of digital competences, comprising technical skills, knowledge, and attitude in view to apply ICT as well as digital literacy, collaboration, and content creation.

Concluding, digital competence represents the ability to hold knowledge, skills, and attitudes adequate to a given context. Therefore, in view to strengthen digital competence, the following learning areas are vital: knowledge concerning technology, instrumental skills in order to use digital instruments and attitude for critical thinking, computational thinking, innovation, creativity.

Since launching the Digital Agenda 2020, the European Union has been achieving various activities and projects such as New Skills Agenda for Europe, aiming "to assist the European Union Member States in view to endow people with better skills, to make sure that no one is left behind, and that Europe nurtures the high-end skills that drive competitiveness and innovation" (EC, 2016).

The Digital Education Action Plan describes digital skills as basic skills "alongside literacy and numeracy, needed in all walks of life" (European Commission, 2018). The Digital Education Action Plan mentions three priorities: "making better use of digital technology for teaching and learning, developing digital competencies and skills, improving education through better data analysis and foresight".

The Digital Competence Framework for citizens (DIGCOMP) describes in a comprehensive way the main areas of digital competence: "information and data literacy; communication and collaboration; digital content creation; safety; problem-solving" (EC, JRC, 2017).

For the time being, according to statistics, 61 million Europeans are lacking adequate digital competences. 40% of European employers report that "it is hard to find people with the right skills in view to innovate and grow" (EC, 2019). At the European level, in all sectors of the economic and social life, there are vacant jobs due to the lack of persons holding digital competences. According to the estimations, in 2020, almost 750,000 jobs in the ICT sector will not be occupied due to the lack of persons with digital competences. Therefore, digital competencies have become a great challenge for the knowledge society and economy.

On the other hand, highly skilled young people are employed in areas that do not match their qualifications and talents. This situation is present in the context of an unemployment rate of 15% for the youth aged between 15 and 24 in the EU.

As presented by the International Telecommunication Union (2018), the challenges for the digital competences refer to scaling and sustainability, affordability of training, skilled teachers and trainers, relevant curriculum, innovation and adaptation, gender divides and inequalities in skills development. In this context, the most successful approaches could be to integrate the soft and entrepreneurial skills development into digital skills, educational and training programs, to incorporate the basic digital skills, computational thinking into schools and universities, to develop job training programs, to create dynamic learning processes and partnerships, to upskill the teachers and trainers and obviously to adapt the programs to the changing needs.

Impact of digitalization

Information and communication technologies (ICT) improve life opportunities, by enlarging possibilities for mobility, enhancing social capital, providing a wide range of information to citizens, fostering civic participation and engagement, as well as providing facilities for labor market integration and increasing the income. Worldwide, the impact of digitalization focuses on ICT accessibility and personalization which contributes to inclusive learning paths and a learning continuum between formal, non-formal and informal learning.

Digital citizens are creating and organizing knowledge in various forms of digital content according to their principles and values. Greater emphasis on knowledge creation has the potential to generate relevant innovations in education and technology.

Social innovation triggers social value both for final users and the whole community. Nowadays learning has become more blended and thus the learners are capable to manage the digital environment in a safe and efficient way. For example, the improvement of the educational services by introducing methods of e-learning and blended learning has a positive impact both on students and the academic community. The Faculty of Public Administration of the National University of Political Studies and Public Administration has developed the POSDRU project entitled "Curricular development and increase of the relevance of study programs in public administration by innovative methods of blended learning and correlation with the labor market", very successful for both students and academic staff. Adaptive learning and artificial intelligence are going to have a powerful impact on students and universities.

Learning should be reflective, adaptive, customized and based on projects, games, phenomena, and involve quizzes, smart applications, videos, virtual reality. The educational methodologies could be more innovative in view to trigger life abilities such as creative thinking, computational thinking, curiosity, problem-solving. For the time being, the countries are in a race for digital competences. All countries are committed to develop, mobilize and attract talents. So, worldwide, we witness a fierce competition to attract brains.

In "A Digital Europe needs Digital Skills: best practices from around the EU", the European Commission fosters the spread of best practices, presenting the projects that could be a source of inspiration (EC, 2018). Among the projects demonstrating amazing creativity, we remark 'Biblionet' project from Romania that has turned all public libraries into digital hubs for local communities. The project endowed the libraries with technology and trained librarians in view to provide ICT-based services, contributing to Romania's digital development. The 'Make IT Work' program in the Netherlands is also relevant focusing on training non-IT university graduates for new careers in IT while the employers participating in the fast-track training partnerships have gained access to high-quality specialists.

An empirical analysis of digital competences in the EU Member States

Based on the data from the Digital Agenda Scoreboard 2018, the empirical analysis of the digital competences of the EU population reveals the need for investment in upgrading the skills, so vital in the knowledge society and economy.

The Digital Skills Indicator (all individuals) refers to "the persons that have been using the internet during the last 3 months, being attributed a score on four digital competence domains: information, communication, content-creation and problem-solving, depending on the activities they have been able to do. The scores are above basic, basic and low, while the individuals not using the internet are classified without digital skills (Digital Agenda Scoreboard 2018)".

Analysis of the *above basic overall digital skills in the EU*

The above basic overall digital skills enable the use of information technology in meaningful and beneficial ways, including the ability to critically evaluate the technology or create content.

Table 1. *Percentage of individuals who have the above basic overall digital skills*

Country	2017	Country	2017
Luxembourg	55	Slovenia	30
Netherlands	48	France	29
Denmark	47	Ireland	28
Sweden	46	Latvia	27
United Kingdom	46	Hungary	26
Finland	45	Czech Republic	24
Malta	39	Greece	22

Germany	37	Croatia	21
Austria	36	Poland	21
Estonia	35	Italy	19
Slovakia	33	Cyprus	19
Spain	32	Bulgaria	11
Lithuania	32	Romania	10
Belgium	31	European Union	31
Portugal	31		

(European Commission, Digital Agenda Scoreboard 2018)

We remark that the top countries are Luxembourg (55%), the Netherlands (48%), Denmark (47%), Sweden and UK (46%), Finland (45%), while at the other extreme we find countries such as Bulgaria (11%), Cyprus and Italy (19%). We note that Romania is among the weak performers in this category (Figure 1). Why? A main reason refers to the whole education and training system. It is necessary to foster a smart education and training system, based on critical thinking, computational thinking and problem-solving, inspiring to be creative and innovative, on a reflective attitude.

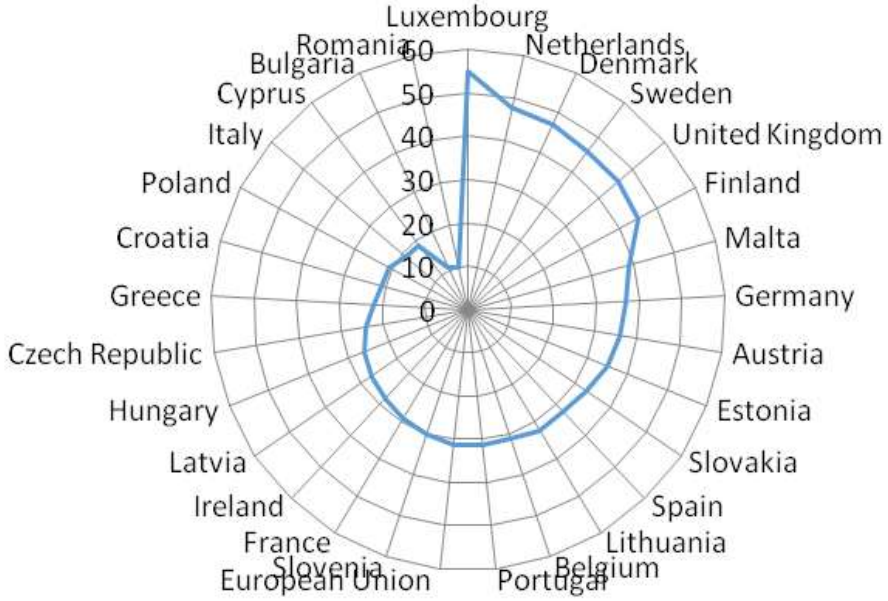

Figure 1. *Percentage of individuals who have the above basic overall digital skills (Source: the authors)*

Analysis of basic overall digital skills in the EU

The basic skills are enabling the interaction for accessing the e-government services, for commercial purposes or for financial services. The basic skills mean that individuals have skills in all four digital competence domains included in the index: information, communication, content-creation and problem-solving, but no more than three above basic.

Table 2. *Percentage of individuals who have basic overall digital skills*

Country	2017	Country	2017
Czech Republic	36	Slovenia	24
Netherlands	32	Hungary	24
Cyprus	32	Greece	24
Sweden	31	Lithuania	23
Germany	31	Spain	23
Austria	31	Italy	23
Luxembourg	30	Latvia	21
Finland	30	Portugal	20
Belgium	30	Ireland	20

France	28	Croatia	20
Slovakia	26	Romania	19
United Kingdom	25	Malta	18
Estonia	25	Bulgaria	18
Poland	25	European Union	26
Denmark	24		

(European Commission, Digital Agenda Scoreboard, 2018)

It is worth to note that the top performers are Czech Republic (36%), the Netherlands and Cyprus (32%), Sweden, Germany and Austria (31%), while Bulgaria and Malta (18%), Croatia, Ireland and Portugal (20%) are the weakest performers (Figure 2), the EU average being of 26%. Romania has a score of 19%, thus being necessary to improve this area in view to be more competitive in the digital environment.

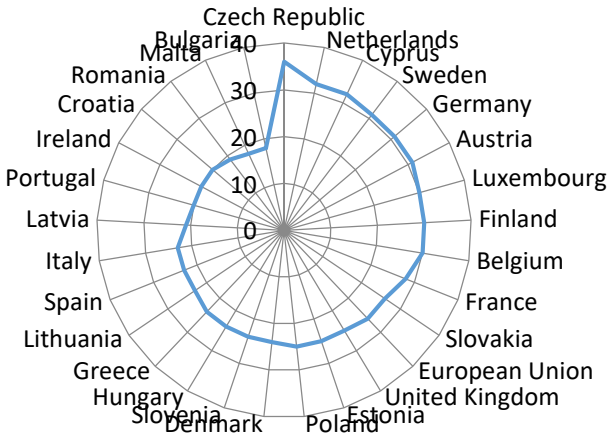

Figure 2. *Percentage of individuals who have basic overall digital skills*
(Source: the authors)

Analysis of low digital skills in the EU

Low digital skills refer to individuals who have at least one of the four digital competence domains included in the index: information, communication, content-creation and problem-solving.

Table 3. *Percentage of individuals who have low overall digital skills*

Country	2017	Country	2017
Romania	35	Slovenia	24
Bulgaria	34	Greece	23
Ireland	33	United Kingdom	23
Latvia	33	Germany	22
Italy	30	Lithuania	22
Cyprus	29	Malta	22
France	29	Portugal	22
Poland	29	Slovakia	22
Spain	28	Austria	20
Estonia	27	Finland	18

Hungary	27	Sweden	18
Belgium	26	Netherlands	15
Denmark	26	Luxembourg	12
Croatia	25	European Union	25
Czech Republic	24		

(European Commission, Digital Agenda Scoreboard 2018)

According to Figure 3, the countries are ranked in a wide range from 35% (Romania) to 12% (Luxembourg), the EU average being 25%. Although it has the highest percentage of individuals who have low overall digital skills, Romania has the potential to improve this area by powerful educational instruments and systems.

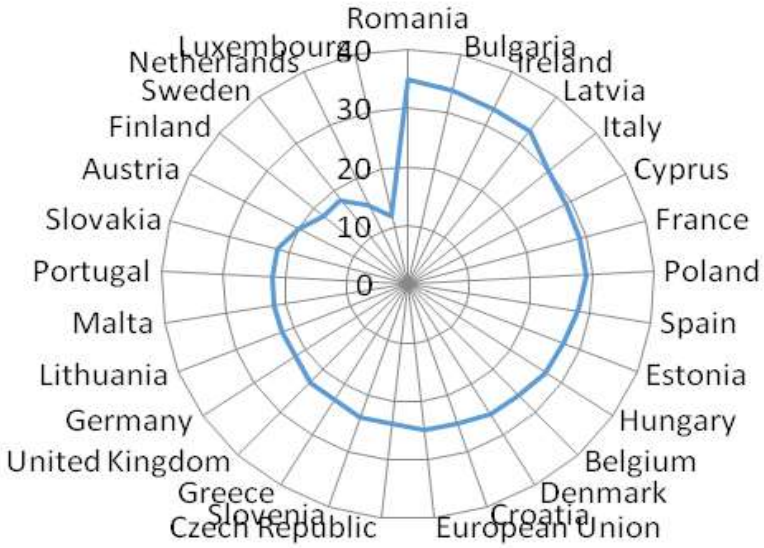

Figure 3. *Percentage of individuals who have low overall digital skills*
(Source: the authors)

Analysis of the EU population who have no overall digital skills

Individuals who have not used the internet during the last 3 months are defined as having no digital skills.

Table 4. *Percentage of individuals who have no overall digital skills*

Country	2017	Country	2017
Bulgaria	37	Spain	17
Romania	36	Czech Republic	16
Croatia	34	France	14
Greece	31	Austria	13
Italy	28	Estonia	13
Portugal	27	Belgium	13
Poland	25	Germany	10
Lithuania	23	Finland	7
Hungary	23	United Kingdom	6
Slovenia	22	Netherlands	5
Malta	21	Sweden	5
Cyprus	20	Luxembourg	3
Slovakia	19	Denmark	3
Ireland	19	European Union	17
Latvia	19		

(Source: European Commission, Digital Agenda Scoreboard 2018)

The results of Figure 4 show that there is a wide range between the best and lowest performing countries, from 3% to 37%. Unfortunately, Romania is scoring 36%, above twice than the EU average (17%), while the top performers are Denmark and Luxembourg (3%), Sweden and the Netherlands (5%), UK (6%) and Finland (7%).

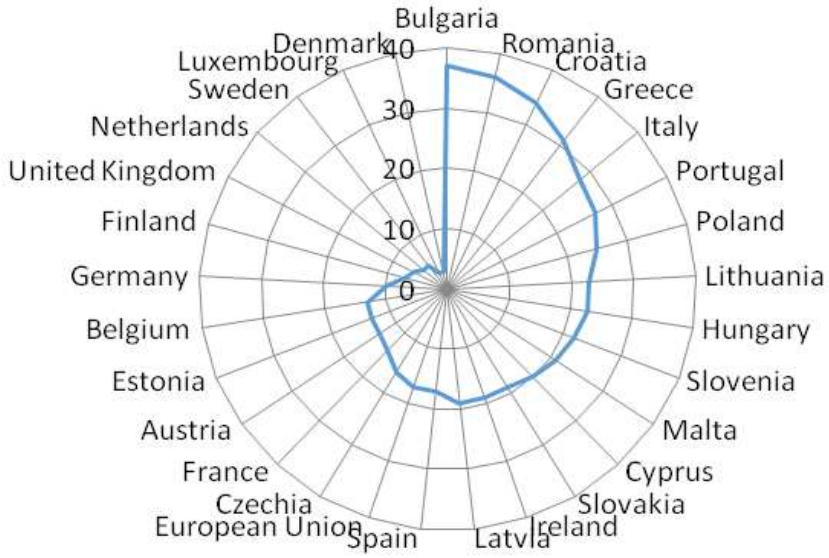

Figure 4. *Percentage of individuals who have no overall digital skills*
(Source: the authors)

Relationship between digital competence and innovation performance for the EU Member States

The current paper explores the statistical connection between digital competence and innovation performance in the EU Member States. It presents in a descriptive way the relationship between the associated two indicators. Thus, the paper reveals the analysis of correlation and regression concerning the digital competence indicator from Pillar 2 of the Global Competitiveness Index and the innovation performance indicator of the European Innovation Scoreboard.

Analysis of digital competences in the EU

Worldwide, innovation fosters economic growth, leads to job creation and improves competitiveness.
The Global Competitiveness Index comprises four dimensions: enabling environment, human capital, markets, innovation ecosystem, and twelve pillars. The sixth pillar on skills comprises the digital competences (DC).

Table 5. *Digital competences in the EU*

Country	DC	Country	DC	Country	DC
Austria	4.8	Germany	5.2	Poland	4.2
Belgium	4.8	Greece	3.5	Portugal	4.6
Bulgaria	4.2	Hungary	5.2	Romania	4.4
Croatia	3.6	Ireland	4.3	Slovak	4.7
Cyprus	4.9	Italy	4.7	Slovenia	4.8
Czech	5	Latvia	4.8	Spain	4.2
Denmark	5.3	Lithuania	5.2	Sweden	5.8
Estonia	5.4	Luxembourg	4.8	United	4.9
Finland	5.8	Malta	4.8	EU average	4.8
France	4.3	Netherlands	5.7		

(Schwab, 2018; World Economic Forum, 2018)

The data in Table 5 demonstrate that the Nordic countries with innovative educational systems, embracing new digital methods are most successful: Finland and Sweden (5.8%), the Netherlands (5.7%), Denmark (5.3). Also, Estonia is a top performer (5.4%).

Analysis of innovation performance in the EU

The European Innovation Scoreboard "provides a comparative assessment of research and innovation performance, the strengths and weaknesses of national research and innovation systems" (European Commission, European Innovation Scoreboard 2017, p.8).

Based on the statistical data of the Innovation Union Scoreboard 2018, Table 6 reveals the scores for innovation performance (IP) in the EU Member States in 2017.

Table 6. *Innovation performance in the EU Member States in 2017*

Country	IP	Country	IP	Country	IP
Austria	0.579	Germany	0.603	Poland	0.27
Belgium	0.593	Greece	0.328	Portugal	0.406
Bulgaria	0.229	Hungary	0.332	Romania	0.157
Croatia	0.258	Ireland	0.585	Slovak Republic	0.323
Cyprus	0.386	Italy	0.371	Slovenia	0.465
Czech Republic	0.415	Latvia	0.285	Spain	0.4
Denmark	0.668	Lithuania	0.359	Sweden	0.71
Estonia	0.397	Luxembourg	0.611	United Kingdom	0.613
Finland	0.649	Malta	0.403	EU average	0.45
France	0.551	Netherlands	0.648		

(European Commission, 2018; Innovation Union Scoreboard 2018)

The Nordic countries are leaders in this ranking as Sweden (0.71), Denmark (0.668), Finland (0.649), Netherlands (0.648) are recording the best performance. These countries represent incontestable leaders for innovation performance, taking into consideration the dimensions concerning human resources, efficient research systems, funding the activities of research, development, and innovation. At the other extreme, we find Romania (0.157), Bulgaria (0.229), Croatia (0.258) and Poland (0.27), at around half of the EU average (0.45).

Analysis of correlation and regression between digital competences and innovation performance

Table 7 presents the analysis of correlation, revealing a global image at the European Union level, a static one for 2017.

Table 7. *Analysis of correlation*

		IP	DC
IP	Pearson Correlation	1	.728**
	Sig. (2-tailed)		.000
	N	28	28
DC	Pearson Correlation	.728**	1
	Sig. (2-tailed)	.000	
	N	28	28

**. Correlation is significant at the 0.01 level (2-tailed).
(Source: the authors)

Taking into consideration the structure of the statistical database as well as how the indicators are measured, the correlations are powerful for a 0.01 level of significance.
It is worth to note the powerful correlation between digital competence and innovation performance (0.728). The conclusion of the analysis of correlation is also confirmed by an analysis of regression.

Table 8. *Analysis of regression*
(Source: the authors)

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	DC[a]	.	Enter
[a] All requested variables entered.			
[b] Dependent Variable: IP			

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.728[a]	.530	.512	.10765
[a]. Predictors: (Constant), DC				

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.340	1	.340	29.314	.000[a]
	Residual	.301	26	.012		
	Total	.641	27			
[a] Predictors: (Constant), DC						
[b] Dependent Variable: IP						

Coefficients [a]

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.465	.167		-2.784	.010
	DC	.192	.035	.728	5.517	.000
[a] Dependent Variable: IP						

Table 8 presents the analysis of regression for digital competence and innovation performance indicators in the EU Member States in 2017.

The role of regression is to reveal the causality between the two variables. Obviously, the value of regression is important as it shows how one variable influences the other. Within the analysis of regression, the dependency between digital competence (DC) and innovation performance (IP) is moderate taking into consideration the coefficient from the equation of regression (0.192). If the value of the independent variable (DC) increases, the mean of the dependent variable (IP) also tends to increase.

The conclusion of this statistical analysis reveals the fact that there is a powerful relationship between digital competence and innovation performance. This conclusion is valid for an overview of the two processes at the EU level while analyzing them at each EU State Member level, sensitive differences could show up. It is important to highlight that the digital competences influence powerfully the innovation performance and the impact is significant.

Conclusions

Access to the advantages of the digital world can be ensured only by adequate digital competences and lifelong learning. The empirical analysis reveals the fact that concerning the digital competences, there are high differences between the EU countries, reflected also by their digital competitiveness. At the same time,

the outcomes of the statistical analysis reflect a powerful correlation between digital competence and innovation performance.

In this context, the above analyses highlight the necessity for increasing and improving the digital competence level through effective and relevant education and training policies, programs, strategies especially in the countries recording low values for digital competences. The education should be based on projects and discovery processes, should be cross-disciplinary and applied, facilitated by teachers connected to reality and future of technology, prepared pedagogically to facilitate experiences of autonomous learning.

Taking into consideration the fast development of artificial intelligence, machine learning, virtual reality, big data, cloud computing, the Internet of Things, various mobile applications, digital competences should be a priority. In a globalized world, the new generation of students, future jobs, the labor market needs, the new information technologies require powerful digital competences.

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