Social and economic predictors of digital skills. Benchmarks for public policies in a time of 4.0 Revolution

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Abstract: *Since the launch of the Digital Agenda for Europe (2010), the European member countries have developed policies, strategies and programs to stimulate the digital economy in the context of advancing information and communication technology. Increasing digital skills and inclusion has become essential for governments, businesses, academia and the non-governmental sector. Apart from the technical conditions (internet access, critical infrastructures and digital devices) necessary for the development of digital skills, education and training in the field of information and communication technology must be improved by offering training and specialization courses at the same time as personal motivation and stimulating interest in the prospects of a life of quality in an increasingly digitized society. This research aims to evaluate the impact of social and economic predictors (independent variables) on the level of digital skills (dependent variable), with the potential to identify areas for improvement and strategies for growth. The research methodology includes the statistical analysis of the variables (risk of poverty and social excluzion, participation in education, PISA results at math, early leavers from education, GDP per capita, government spending on education), correlation and multiple linear regression, principal component analysis (PCA). The study will also use cartographic processing for comparative analysis at the EU-27 level. The general assumption is that government initiatives, investments in digital infrastructures and educational programs that promote digital literacy play a key role in the policy-making process in an era of digitalization in which the advance of so-called Revolution 4.0 marks the society and the economy.*

Keywords: digitalization, digital skills, digital literacy, socio-economic predictors, public policy.

1. Introduction

The world is currently experiencing the Fourth Industrial Revolution (Revolution 4.0) characterized by digitalization (WEF, 2016). We are witnessing a significant spread of information and communication technology (ICT) across all sectors. This phenomenon is evident in automation, robotization, and

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computerization, which transform analog information into digital formats. These advancements aim to enhance efficiency, drive innovation, reduce costs, and maximize outcomes.

Nowadays, education and training become irrelevant without computer devices and digital technologies, but also without people who do not have the digital skills to use them. The labour market is being reshaped by automation, robotization and informatization. Employees who focus on developing their digital skills will undoubtedly emerge as the winners of the 4.0 Revolution. In contrast, those who remain digitally illiterate may face marginalization and social exclusion. Therefore, it is essential for governments to collaborate with businesses and non-governmental organizations to identify socio-professional groups at risk of social exclusion due to their lack of digital skills.

Since the 2000s, discussions about digital competencies at the European level have emphasized the importance of digital literacy for maintaining the economic competitiveness of European Union member states. This focus aims to enhance the skilled workforce. The 2006 Recommendation of the European Parliament and the European Council on key competencies for lifelong learning was one of the first documents to highlight the development of digital competencies needed for communication, work, and leisure in our increasingly technological and computerized society (European Council, 2006).

In 2010, the European Commission initiated the Digital Agenda for Europe, which is a pivotal component of the broader Europe 2020 Strategy aimed at fostering innovative, sustainable, and inclusive growth across the continent. The Digital Agenda for Europe emphasizes the transformative role of ICT in addressing critical societal challenges, including climate change mitigation, demographic shifts associated with an ageing population, and the promotion of active ageing strategies.

The European Commission launched the first version of the European Digital Competence Framework (DigComp 1.0) in 2013. This framework is structured around five key competence categories: information and data literacy, communication and collaboration, digital content creation, security, and problem-solving (European Commission, 2013). In 2014, the European Commission began assessing the digitalization progress of EU Member States through the Digital Economy and Society Index (DESI). In 2017, the Digital Education Action Plan (2018-2020) was introduced, promoting the integration of digital competencies in education and vocational training.

In 2022, DigComp 2.2 was published, which also includes aspects related to the use of artificial intelligence in the context of cybersecurity to ensure the well-being of beneficiaries. In European documents, digital competencies are “the confident, critical and responsible use of digital technology for work, learning and participation in society” (European Commission, 2013, 2016, 2022).

The United Nations Educational, Scientific and Cultural Organization (UNESCO) defines digital competencies as "the skills needed to use digital, communication, and network technologies safely and effectively for purposes such as information sharing, communication, and problem-solving" (UNESCO, 2018). This definition highlights the importance of digital interconnectivity under secure conditions to accomplish various tasks.

The Organization for Economic Co-operation and Development (OECD) defines digital competencies as a combination of technical knowledge, critical thinking, and cognitive skills necessary for effective work and learning in a digital environment (OECD, 2019).

2. Literature review

This study section will present a series of approaches to digitalization and the formation of digital skills in a society of knowledge and innovation. We start from the idea that what seemed like science fiction yesterday is science fact today (Leonhard, 2017). The world is transforming at an astonishing speed under the impact of digital technologies. All technological processes are accelerated to the maximum level. Governments and companies allocate enormous resources for digitalization, especially for the development of artificial intelligence.

Robotization, automation, and artificial intelligence are freeing humans from routine, time-consuming, and energy-draining tasks and processes. As a result, people can now focus on more interesting, complex, and innovative endeavors. Almost all of the devices we use – ranging from household appliances and transportation to communication tools and medical or sports equipment – are interconnected through sensors, networks, digital platforms, and algorithms that provide optimal solutions. To avoid being left behind in the 4.0 Revolution era, it is imperative to develop a digital literacy.

The concept of digital literacy was introduced by researcher Yoram Eshet-Alkalai in 2004. It encompasses the knowledge and skills needed to effectively use computers, software, and the Internet, but it goes beyond just technical skills. Eshet-Alkalai emphasizes the importance of cognitive, psycho-emotional, and social skills required for navigating the virtual environment. Digital literacy includes several components, such as photo-visual literacy, information literacy, and socio-emotional literacy (Eshet-Alkalai, 2004).

Recently, there has been increasing discussion about "digital natives", referring to young individuals who are familiar with digital devices from an early age. Ellen Johanna Helsper and Rebecca Eynon highlight a divide between generations based on their level of digital skills. However, being part of a certain generation is just one factor that influences how someone interacts with the Internet and digital technology. Other important factors include the frequency of use ITC, personal experience, gender, and level of education. (Helsper & Eynon, 2010).

The concept of digital competence is dynamic and multidimensional, and it is examined in various ways within specialized literature, including public policy, education, vocational training, and certification. The European Commission also uses synonymous terms such as digital literacy, digital competence, and ICT skills. In support of this assertion, Anusca Ferrari, Yves Punie, and Christine Redecker present three key arguments. The first highlights the benefits of digital skills in the field of education. Students are motivated to use digital technologies in the learning process, which leads to improved performance. The second argument stresses the ubiquity of digital technologies in contemporary society. The third argument emphasizes that, in a knowledge-based society, functioning without digital skills is increasingly difficult (Ferrari, Punie & Redecker, 2012).

Kashan Pirzada and Fouzia Khan argue that in developing economies, digital skills – including computer literacy, communication abilities, internet proficiency, and advanced digital competencies – are likely to provide job seekers with a significant advantage in obtaining employment and retaining well-paying positions (Pirzada & Khan, 2013).

Digital skills refer to the competencies, knowledge, and attitudes needed to effectively integrate digital technologies (both hardware and software) into various areas of human activity, such as education, vocational training, work, leisure, and participation in socio-cultural activities. These skills involve the use of computer equipment and programs and extend beyond them to include abilities related to communication through digital tools, critical thinking, teamwork both in physical and online environments, as well as the creation and dissemination of digital content (Vuorikari et al., 2022).

Possessing digital skills is also crucial for older people to communicate online with their family and friends, in relation to telemedicine service providers, or with public authorities that have developed digital platforms for the services they offer. Training older people in digital skills must be oriented towards their desires, needs and problems, specific to this age group. Digital pedagogy, the level of training of trainers in digital skills, and the formative content are important in obtaining a level of basic digital skills and above in a comfortable environment for older people (Schirmer et al., 2022).

In a study on digital inequality, Christopher Reddick and his colleagues investigate three important dimensions of digital literacy: access to the internet, use of ICT technology, and their outcomes. The researchers conducted a city-wide survey, using both paper and electronic questionnaires, to examine all three dimensions of digital inequality. The empirical findings show that the persistence of digital divides is mainly influenced by factors such as demographics, socioeconomic status, geographic location, and language skills (Reddick et al., 2023).

Focusing on differences in digital skills and their impact on existing inequalities, Fabian Kosse, Tim Leffler and Arna Woemmel propose a twodimensional approach, taking into account both technical skills (the absolute dimension) in the use of ICT and the skills related to confidence in their use. In this sense, there is a complementarity between cognitive and non-cognitive skills in accessing jobs requiring digital skills. Public policies that aim exclusively to improve digital competence may be insufficient if they neglect the role of confidence in acquiring and effectively using skills. Social disparities in digital skills can amplify existing social and economic inequalities (Kosse, Leffler & Woemmel, 2024).

In this study, we will use the definition of the concept of "digital skills" as formulated by ***DigComp 2.2 The Digital Competence Framework for Citizens***: “Digital competence involves 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 wellbeing and cybersecurity skills), intellectual property issues, problem-solving and critical thinking” (European Council Recommendation, 2018; European Commission, 2022, 2023, 2024).

3. Research methodology, indicators, data sources

From the literature mentioned in the previous section, it follows that the concepts of "digitalization", "digital literacy", and "digital skills" are correlative and describe the dynamics of a world marked by the 4.0 Revolution. The scientific and technical imagination of people in previous decades is surpassed by the amplitude of digital technologies of the present and the future. Although digital skills are essential for socio-professional integration, people do not have the basic level everywhere in the world to face the challenges related to education and work.

There are disparities in the level of digital skills between countries and regions of the world, also reflected in official statistics and public policy documents. The level of digital skills is explained by social and economic predictors (determinants): age, gender, residential environment, level of education, income, place or field of work, government investments in digitalization, the contribution of the ICT sector to the economy.

The present study analyses the relationships between digital skills and social, education, and economic factors in the European Union Member States. In order to explore this complex topic, we applied a methodology based on a combination of statistical techniques to provide a comprehensive understanding of the data. This study aims to answer the following research questions:

- What is the relationship between the standard of living and the level of digital skills?
- How do the performances obtained by students in the PISA - mathematics tests impact the level of digital skills?

- To what extent do the participation rate in education, respectively the early school leaving rate, influence the level of digital skills?
- What is the impact of economic prosperity (GDP per capita) on digital skills?
- To what extent does the share of public spending on education influence the performance in terms of digital skills.

The analyses were carried out using the XLSTAT software, which allowed the detailed assessment of relevant data sets and the generation of relevant graphical visualizations to clarify the observed trends.

Two distinct data sets were used; the first set focused on the digital skills of the population:

- Individuals with basic or above basic digital skills;
- Individuals with advanced digital skills;
- Individuals with basic digital skills, not all above basic;
- Individuals with low digital skills;
- Individuals with limited digital skills;
- Individuals with minimal digital skills;
- Individuals without digital skills.

The data from the first set were only analysed descriptively, using boxplots to examine the distributions of variables across the different Member States of the European Union. This set provided a general perspective on the diversity of the data without involving advanced statistical analyses. In contrast, the second set constituted the primary basis of the study, being used in all statistical analyses within this effort. This data set was essential for analysing the relationships between digital skills and economic and social factors. The set includes economic and educational indicators relevant to the European context alongside a central indicator on digital skills: "the percentage of individuals with basic or advanced digital skills".

The second set of data includes the following indicators:

- AROPE (At Risk of Poverty or Social Exclusion) 2018-2022 measures the percentage of the population at risk of poverty or social exclusion, a determinant of social and economic performance.
- Low achieving 15-year-olds in math (PISA) 2018-2022 represents the percentage of 15-year-olds with low performance in mathematics, an indicator of educational quality and the level of mathematical skills.
- Early leavers from education 2018-2022 indicate the percentage of

young people who abandon education before completing upper secondary education, a signal of school dropout and integration into the labour market.

- Participation rate in education 2022 measures the involvement of young people in educational processes, reflecting access to education and influencing the development of digital skills.
- Real GDP per capita 2018-2022 reflects a state's economic prosperity, directly impacting the resources allocated to education and the development of digital skills.
- Education GDP % 2018-2022. The percentage of GDP allocated to education indicates the priority given to the education sector and the support for developing digital skills.

Regarding the statistical techniques applied, we used four main methods, each chosen to address different aspects of the analysis: boxplot analysis, Pearson correlation, multivariate linear regression, and principal components analysis.

The first graphical tool used in this study was the boxplot, which allowed for exploring the distributions of the two data sets. In the case of digital skills, boxplots were applied to analyze variables reflecting the proportions of individuals in different categories of digital skills, from basic to complete lack of them. This graphical approach helped to identify significant discrepancies between the Member States of the European Union, highlighting not only the median values and quartiles but also outliers that indicate areas of interest for further analysis.

Similarly, boxplots were used for educational and economic indicators to compare their distributions across EU member states. Thus, interstate variations in key indicators such as AROPE or GDP per capita were explored, providing a clear perspective on the structural differences between the countries analyzed.

Pearson correlation was used to investigate linear relationships between variables of interest. This method allowed us to identify how much digital skills correlate with various educational and economic indicators, such as PISA performance or GDP per capita. The results provided a detailed understanding of how economic and educational factors influence the digital skills of the European population, thus constituting a starting point for further analyses. Pearson correlation also represented an alternative view to the results obtained within the framework of multivariate linear regression.

We applied multivariate linear regression to better understand the relationships between digital skills and social and economic factors. This model's dependent variable was the proportion of individuals with basic or more advanced digital skills. In contrast, the independent variables included indicators such as early school leaving rates, PISA performance, and GDP per capita. This analysis aimed to identify those determinants that influence the development of digital skills in the European Union member countries.

Principal component analysis (PCA) was used to facilitate the interpretation of the data, a technique that reduces the data's dimensionality without losing its essence. This method allowed the identification of the most relevant components that describe the data's variability and highlighted the correlations between digital skills and economic and educational indicators. PCA was essential to deepen the understanding of the data's structure and eliminate redundancies, thus facilitating interpreting the complex relationships between the variables.

4. Results and discussions

Between 2017 and 2022, the Digital Economy and Society Index (DESI) highlighted significant progress in the digitalization of European Union member states, reflecting their efforts to develop their digital infrastructure, the population's digital skills, and the adoption of emerging technologies in various economic sectors.

Nordic countries such as Denmark, Finland and Sweden have consistently held the top positions thanks to a combination of key factors: advanced digital skills among the population, state-of-the-art connectivity infrastructure and broad integration of digital technologies in the public and private sectors. For example, in Finland, the DESI score increased from 47.8 in 2017 to 69.6 in 2022, indicating a steady and accelerated evolution of digitalization (Figure 1). Similarly, Denmark and Sweden have maintained a steady growth rate thanks to strategic investments in infrastructure and national policies that encourage digital innovation.

The Netherlands, Ireland, and Luxembourg also ranked among the top countries, demonstrating remarkable adaptability to global technological change. The Netherlands benefited from a robust digital infrastructure and early adoption of advanced technologies in the business environment, while Ireland was boosted by the presence of multinational technology hubs and a highly digitally savvy workforce. Luxembourg stood out with its advanced connectivity infrastructure and business environment, which is friendly to digital innovations.

Romania, Greece, Bulgaria, and Poland have consistently been at the bottom of the DESI rankings. These countries have recorded lower scores due to underdeveloped digital infrastructure, lower levels of digital skills among the population and slower adoption of digital technologies in the public sector. For example, in Romania, the DESI score increased from 19.4 in 2017 to only 30.58 in 2022, remaining at the bottom of the ranking. Greece and Bulgaria have had similar developments, recording modest increases but insufficient to reduce the digital gap compared to the EU average.

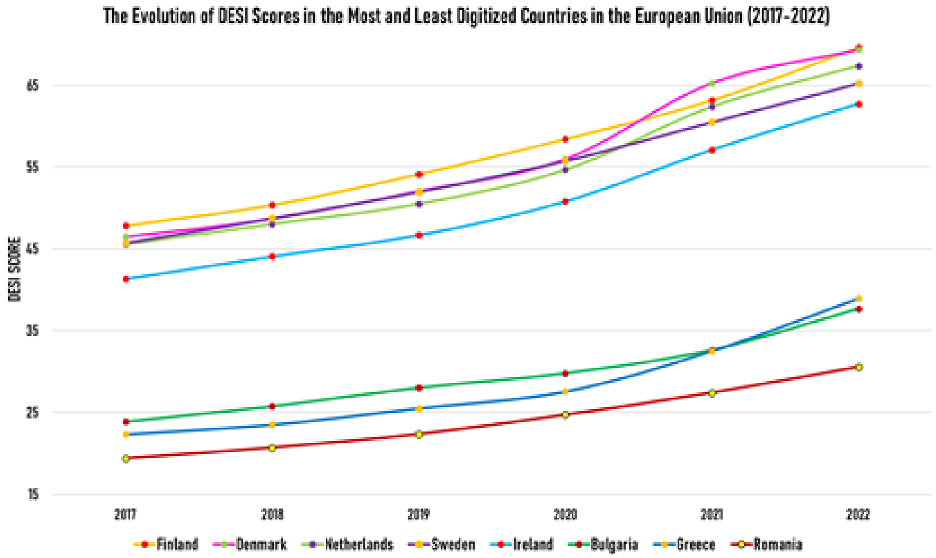

Figure 1. The Evolution of DESI scores in the most and least digitized contries in the European Union (2017-2022)

Source: own processing according Eurostat database, 2024.

A middle position was occupied by Latvia, which had a steady evolution, being close to the European average (Figure 2). With a DESI score of 37.4 in 2017 and 49.71 in 2022, Latvia has shown progress in digitalization but at a slower pace than the leading countries. This reflects a balance between developing digital infrastructure and the moderate digital skills of the population.

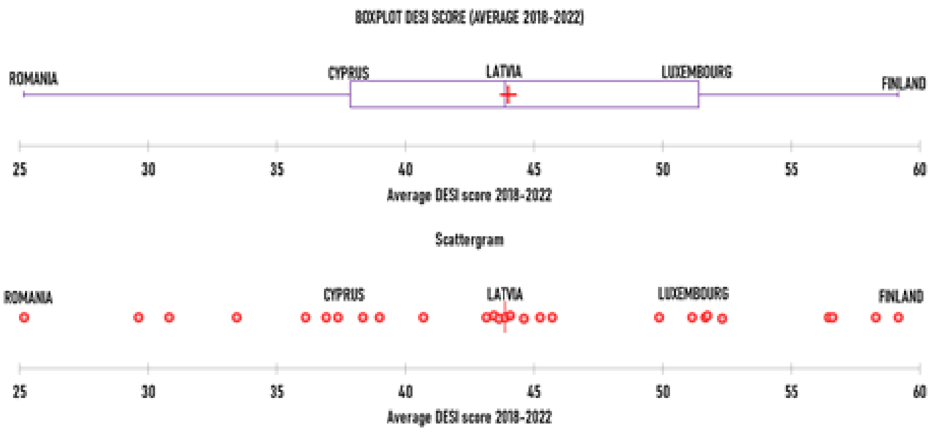

Figure 2. Boxplot DESI Score, Average 2018-2022)

Source: Iftimoaei & Vevera, 2024.

4.1 Boxplot analysis of social and economic indicators

In the context of global digitalization and new educational challenges, the analysis of educational and economic indicators in the European Union provides us with an overview of the social and economic factors that influence the digital skills of the population. The boxplots resulting from this analysis (Figure 3) reveal not only the disparities between the EU Member States, but also the visually observable correlations between the educational and economic levels and the development of digital skills.

The educational participation rate is a key indicator for understanding access to education and the capacity of education systems to prepare young people for the challenges of the digital economy. Countries such as Sweden and Denmark, with high educational participation rates, are more likely to have a workforce with strong digital skills. In contrast, in countries such as Bulgaria and Greece, with low participation rates, young people are at risk of not acquiring the skills needed to cope with the demands of the digital economy. This disparity suggests that a more inclusive and better-funded education policy is crucial to ensure the development of digital skills in all regions of the European Union.

The low performance of students in mathematics, especially in countries like Bulgaria and Greece, highlights another important dimension in the development of digital skills: STEM (Science, Technology, Engineering and Mathematics) education. Mathematical skills are fundamental for understanding and using digital technologies, and education systems that fail to improve these skills risk leaving a significant part of the population behind in the digitalization process. Thus, poor performance in mathematics is a predictor of lower digital skills, and investments in STEM education have become a priority to support the development of digital-ready human capital (Larson & Miller, 2011).

Economic indicators, such as real GDP per capita, bring to the fore another crucial dimension in the development of digital skills. EU Member States with robust economies, such as Luxembourg and Ireland, have a much more advanced digital infrastructure, which allows them to offer better opportunities for the development of citizens' digital skills. These countries are also able to invest more in education and continuing professional training, thus supporting the adaptation forced by rapid technological developments. On the other hand, in countries with low GDP, such as Romania, the lack of economic resources is reflected in limited access to quality education and in the reduced opportunities for the development of the population's digital skills. This underlines the importance of adopting economic and educational public policies that contribute to reducing the digital disparities between EU Member States.

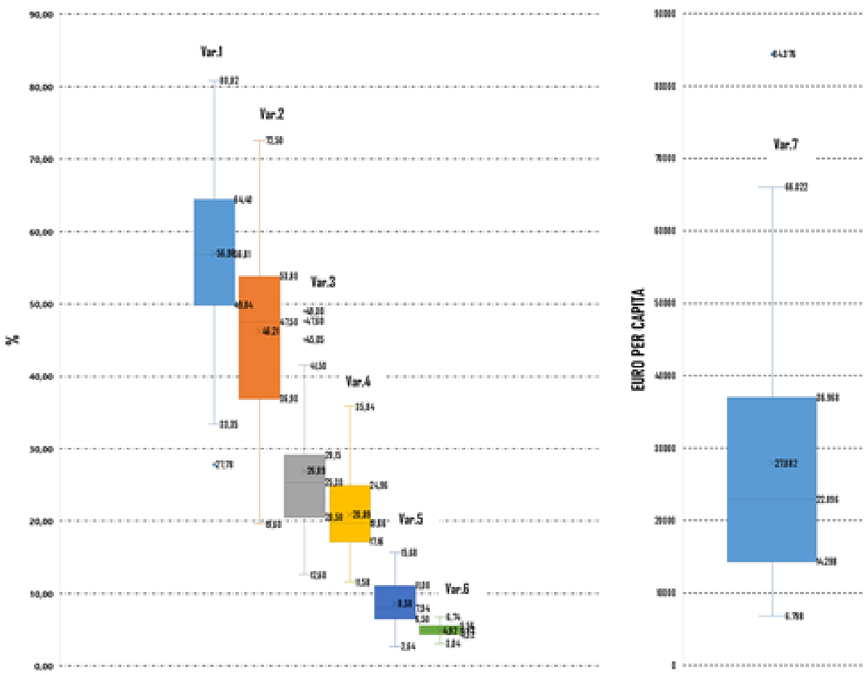

Figure 3. Boxplot analysis of socio-educational and economic indicators in EU Member States (2018-2022)

Source: own processing according Eurostat database, 2024.

Var 1. INDIC_avg_2021-2023

Var 2. Participation rate in education 2022

Var 3. Low achieving 15-year-olds math (PISA) 2018-2022

Var 4. AROPE 2018-2022

Var 5. Early leavers from education 2018-2022

Var 6. Education GDP % 2018-2022

Var 7. Real GDP per capita 2018-2022

4.2 Analysis of digital skills at European level: social and economic predictors

Digitalization plays an increasing role in everyday life and economic development. In this respect, digital skills have become a crucial indicator of the ability to adapt to new labour market requirements. In the analysis presented, data on the digital skills of the population in different EU countries provide a clear picture of the degree of preparation of citizens for the 4.0 Revolution challenges. These data are essential in shaping public policies that respond to the need for continuous training of digital skills among the population, taking into account the social and economic context.

The first aspect that stands out is the significant disparity between EU Member countries in terms of the proportion of individuals with digital skills at a basic level or higher. For example, in countries such as the Netherlands (82.7%) and Finland (81.99%), the majority of the population has solid digital skills, reflecting not only investments in education and digital infrastructure but also a favourable economic context that supports the development of these skills. In contrast, countries such as Romania (27.73%) and Bulgaria (35.52%) have a much lower share of individuals with basic or higher digital skills, which suggests deficiencies in educational systems and a less developed digital infrastructure.

This difference highlights an important factor in the analysis of digital skills: the existence of a minimum "threshold" of skills required to actively participate in a digitalized society. Thus, countries with a higher percentage of people with basic or superior digital skills, such as Sweden (66.44%) and Finland, are in a better position to implement public policies that support the transition to more efficient digital economies. Conversely, countries with a higher share of individuals with limited or no digital skills, such as Romania and Greece, risk falling behind in the digitalization process, thus affecting not only the economic competitiveness but also the social integration of their citizens.

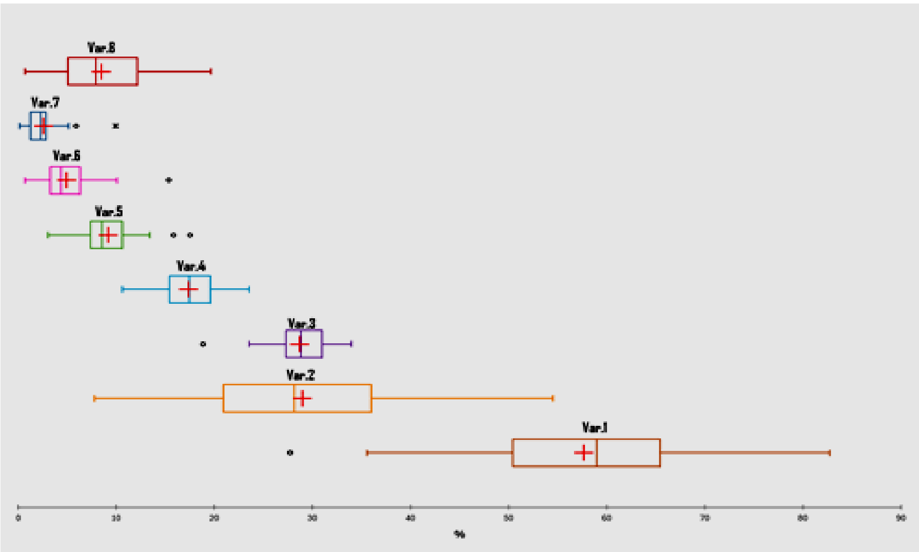

Figure 4. Level of Digital Skills in the EU Member States

Source: own processing according Eurostat database, 2024.

Another determining factor in this context is the educational level of the population and the economic resources allocated to education. Countries with developed economies, such as Germany and the Netherlands, have strong educational systems that are capable of forming advanced digital skills among citizens. In contrast, countries with less developed economies, such as Romania and Bulgaria, face difficulties in ensuring equitable access to quality digital education, which contributes to the perpetuation of digital divides. This is a major challenge for the development of effective public policies that take into account the diversity of social and economic contexts in the European Union.

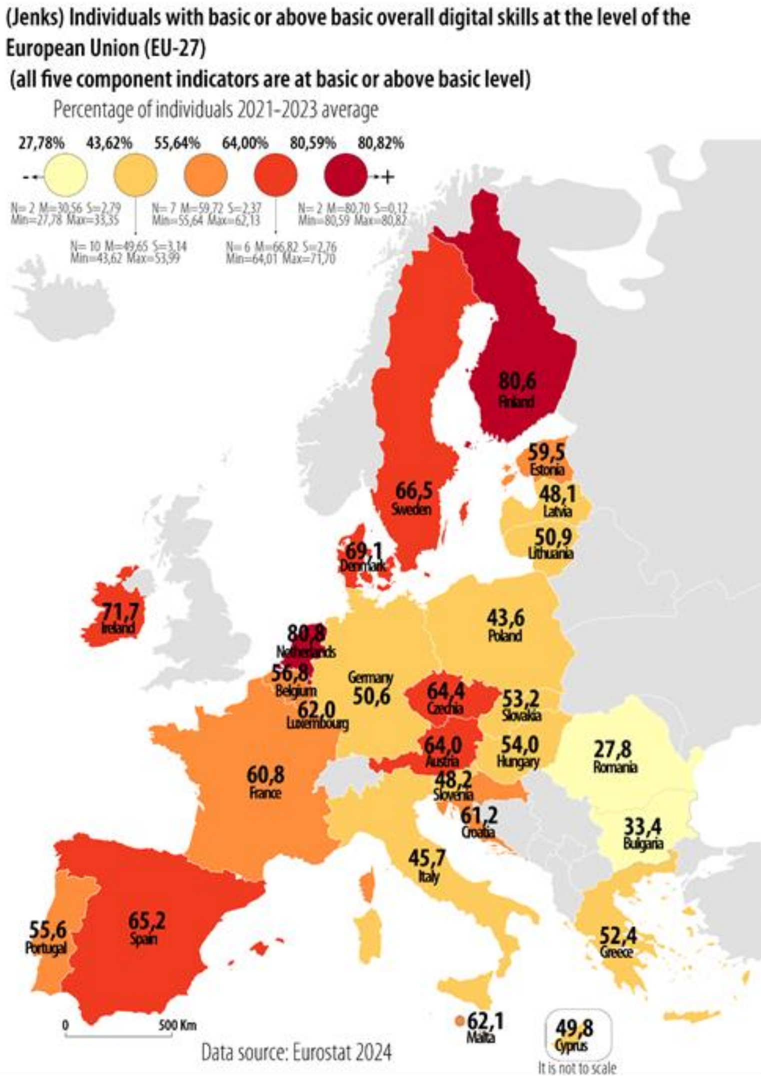

Figure 5. Individuals with basic or above basic overall digital skills at the level of the EU Member States

Source: own processing according Eurostat data, 2024.

4.3 Results of linear regression analysis

The quantitative analysis of the obtained data reveals a complex set of relationships between the different socio-economic variables and the level of digital skills, measured by the average INDIC_avg_2021-2023. The values of the coefficient of determination R^2 obtained from the regression of the variable INDIC_avg_2021-2023 (0.6148) indicate that the model explains approximately 61.5% of the variation in digital skills, which suggests a significant correlation with the socio-economic factors analyzed (Figure 6).

From the correlation matrix, it is observed that the variable "AROPE 2018-2022" has a significant negative correlation with digital skills (INDIC_avg_2021-2023), having a coefficient of -0.6071. This indicates that a higher rate of risk of poverty and social exclusion is associated with a lower level of digital skills. Similarly, the variables "Low achieving 15-year-olds math (PISA)" and "Early leavers from education" also have negative correlations, respectively -0.5922 and -0.2957, with digital skills, which underlines the importance of education in developing digital skills in young people (Figure 7).

Var 1. INDIC_avg_2021-2023

Var 2. Participation rate in education 2022

Var 3. Low achieving 15-year-olds math (PISA) 2018-2022

Var 4. AROPE 2018-2022

Var 5. Early leavers from education 2018-2022

Var 6. Education GDP % 2018-2022

Var 7. Real GDPper capita 2018-2022

In terms of positive impact, "Participation rate in education 2022" is positively correlated with INDIC_avg_2021-2023 (0.6378), suggesting that higher participation in education is associated with higher levels of digital skills. Also, "Real GDP per capita 2018-2022" has a moderate positive correlation (0.5786), indicating a link between economic prosperity and the development of digital skills.

The regression model of the variable INDIC_avg_2021-2023 shows that "AROPE 2018-2022", "Low achieving 15-year-olds math (PISA)", and "Early leavers from education" have negative coefficients, suggesting that these variables have a reducing effect on digital skills. In contrast, "Participation rate in education 2022" and "Real GDP per capita 2018-2022" have positive coefficients, confirming the role of education and economic prosperity in improving digital skills. The coefficient for "Education GDP %" is, however, insignificant (0.4764), indicating that investment in education, measured by the percentage of GDP dedicated to education, does not have a significant impact on digital skills in this model.

Overall, the analysis suggests that socio-economic factors, such as education and GDP, significantly influence the level of digital skills, but there are also elements of social exclusion that reduce these skills.

Multicolinearity statistics:

	AROPE 2018-2	-year-olds math	rs from education	n rate in ed	per capita 2	on GDP % 2018-2022
Tolerance	0,4058	0,5277	0,5564	0,3670	0,6557	0,6725
VIF	2,4643	1,8951	1,7973	2,7249	1,5250	1,4869

Regression of variable INDIC_avg_2021-2023:

Goodness of fit statistics (INDIC_avg_2021-2023):

Observations	27,0000
Sum of weights	27,0000
DF	20,0000
R2	0,6148
Adjusted R2	0,4992
MSE	74,9483
RMSE	8,6573
DW	2,4259

Analysis of variance (INDIC_avg_2021-2023):

Source	DF	Sum of squares	Mean squares	F	Pr > F
Model	6	2392,4975	398,7496	5,3203	**0,0020**
Error	20	1498,9650	74,9483		
Corrected Total	26	3891,4626			

Computed against model Y=Mean(Y)

Figure 6. Linear regression results

Source: own processing according Eurostat database, 2024.

Correlation matrix (Pearson (n-1)):

Variables		Var.1	Var.2	Var.3	Var.4	Var.5	Var.6	Var.7
INDIC_avg_2021-2023	Var.1	**1**	**-0,6071**	**-0,5922**	-0,2957	**0,6378**	**0,5786**	0,3666
AROPE 2018-2022	Var.2	**-0,6071**	**1**	**0,5756**	**0,4621**	**-0,5480**	-0,3363	**-0,4710**
Low achieving 15-year-olds math (PISA) 2018-2022	Var.3	**-0,5922**	**0,5756**	**1**	0,3057	**-0,5403**	-0,3540	**-0,4757**
Early leavers from education 2018-2022	Var.4	-0,2957	**0,4621**	0,3057	**1**	0,0847	-0,1525	-0,1903
Participation rate in education 2022	Var.5	**0,6378**	**-0,5480**	**-0,5403**	0,0847	**1**	**0,5158**	**0,3981**
Real GDPper capita 2018-2022	Var.6	**0,5786**	-0,3363	-0,3540	-0,1525	**0,5158**	**1**	0,0842
Education GDP % 2018-2022	Var.7	0,3666	**-0,4710**	**-0,4757**	-0,1903	**0,3981**	0,0842	**1**

Values in bold are different from 0 with a significance level alpha=0,05

Figure 7. Pearson Corelation matrix

Source: own processing according Eurostat database, 2024.

4.4 The results of principal component analysis

The results of the principal component analysis (PCA – Figure 8) performed on the dataset comprising economic and social indicators reveal a clear structure of the factors contributing to the observed variability among the analyzed variables. The first principal component (F1) explains 50.42% of the total variability, followed by the second component (F2), which adds 16.64%. Together, these two components explain 67.06% of the diversity of the data, highlighting that a large part of the variability can be attributed to these two main dimensions.

The correlations between the individual variables and the principal components show a series of significant relationships. For example, "INDIC_avg_2021-2023" has a significant negative correlation with F1 (-0.8526), indicating that it negatively influences the first principal component. At the same time, "AROPE 2018-2022" shows a significant positive correlation with F1 (0.8200), which suggests a close link between social exclusion indicators and the general economic component.

As for the second principal component (F2), it explains 16.64% of the variability and shows significant correlations with variables such as “Low achieving 15-year-olds math (PISA) 2018-2022” (0.7982) and “Early leavers from education 2018-2022” (0.7873). This suggests that F2 reflects an educational dimension related to low school performance and school dropout, two important aspects of the education system.

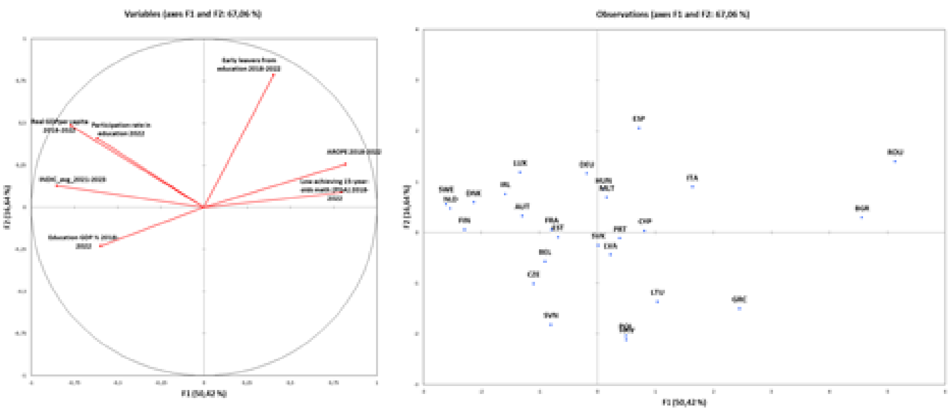

Figure 8. Principal Component Analysis
Source: own processing according Eurostat database, 2024.

The additional factors (F3, F4, F5, etc.) explain increasingly smaller proportions of the total variability, but continue to add relevant information about the various interactions between economic and educational indicators. F3, for example, is associated with “Low achieving 15-year-olds math” and “Real GDP per capita”, indicating a link between economic and educational performance at the national level.

These results suggest that there is a significant interdependence between economic and socio-educational indicators, which underlines the importance of an integrated approach in public policy. Economic variables, such as GDP per capital and the percentage of GDP dedicated to education, are strongly correlated with educational performance, while socio-economic factors, such as the social exclusion rate, are associated with lower educational outcomes.

5. Conclusions

Multivariate statistical analysis performed in our study highlighted the complex interactions between economic and socio-educational indicators, suggesting that public policies should be oriented towards simultaneously improving economic and educational performance to support the sustainable development of society. The disparities observed between EU Member States draw attention to the importance of strategic investments in digital infrastructure, digital literacy, ICT education and training, and the promotion of technological innovations in public administration, the business sector, non-governmental organizations, culture, sport and leisure. While the Nordic countries and Western Europe dominate the DESI ranking, the countries of Eastern and Southern Europe need to accelerate the pace of reforms to reduce the digital divsparities and benefit from the opportunities of the global digital economy.

Analyzing the evolution of the DESI score, it is estimated that, by 2030, the percentage of Romanian citizens with basic digital skills will reach 38%, which means an annual increase of approximately 1%. Public policy documents show that to reach the 50% target, an average annual increase of 3.1 percentage points would be necessary. In order to reduce the digital skills gap between Romania and the EU Member States, it is necessary to achieve the objectives set by public policies in digitalization (Eurostat, 2023).

Currently, a series of European and government-funded programs are being implemented focused on the training and development of digital skills, both in public administration and in the business environment. Older people are also included in the target groups of digital skills training projects, especially those carried out by private sector organizations/enterprises. The results of the implementation of these public policies will be evaluated annually through qualitative (independent research centers and academia) and quantitative (Eurostat - DESI Index; National Institute of Statistics) research, such as people's access to information and communications technology, continuous professional training in enterprises, research and development in the public and private sectors, in order to see progress in relation to the assumed targets.

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