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INEQUALITY IN E-LEARNING IN EUROPEAN UNION COUNTRIES: ROLE OF GENDER, EDUCATION AND URBAN DEVELOPMENT

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ABSTRACT

E-learning is increasingly used in modern educational institutions, especially since the COVID-19 pandemic. By examining the role of gender, education, and urban growth in e-learning, we can learn more about possible differences and digital divides within and between EU countries. To successfully address inequality in education, legislators need to understand the causes of inequalities. The paper aims to examine e-learning inequality across European Union (EU) countries, comparing the most developed EU countries (namely the EU-15) with other EU countries. To avoid the possible biases that could occur due to the COVID-19 infection, we focus on two years before the pandemic, 2017 and 2019. To account for gender, education, and urban development differences, we compare the usage of e-learning among the individuals belonging to these groups. The results show that the EU-15 countries consistently perform better compared to the other EU countries. This suggests that the digital divide is difficult to overcome, as it persists despite the EU's strong efforts under the Digital Europe umbrella to align its member countries by technological level.

KEY WORDS

e-learning, inequality, gender, education, urban development, European Union

CLASSIFICATION

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INTRODUCTION

E-learning has become prevalent in higher education institutions worldwide [1] and especially became the predominant model for education delivery after COVID-19 [2]. In e-learning, the digital divide refers to inequalities or imbalances in accessing and using digital resources for educational or non -non-educational purposes [3]. The causes for the digital divide might range from age, cost, and know-how perspectives such as the "Z" and "X" generations, the devices' exorbitant cost, lack of know-how, availability of devices, internet access, digital skills, and affordability are all critical factors in online learning [4]. Furthermore, online participation can be hindered in rural or underserved areas by inadequate Internet connectivity, low digital literacy, and high costs [5]. The reduced digital divide in e-learning can promote social mobility, inclusion, and social cohesion and enable more people to participate actively in educational, economic, and social activities [6].

E-learning has also become a prominent mode of education in the European Union, offering numerous benefits such as flexibility and accessibility. However, despite its potential to bridge educational gaps, e-learning may inadvertently exacerbate existing inequalities. To bridge the digital divide in e-learning, governments and organisations must invest in infrastructure, provide subsidies for digital devices and Internet access, offer digital literacy training, and implement policies to promote inclusive e-learning initiatives. In this way, countries can help reduce the digital divide and provide equitable access to education and engagement in the digital age [7]. The European Union (EU) has actively supported the growth of e-learning through numerous programs, policies, and funding initiatives. The Digital Literacy Action Plan (2021-2027) aims to develop digital literacy, improve the quality of digital learning, and provide equitable access to high-quality, inclusive digital education for all learners, regardless of their socioeconomic background [8].

In addition to the vigorous efforts of the European Commission to promote digital literacy in e-learning, there are still significant differences between European countries [5]. Other factors such as gender, education level, and urbanicity also affect the level of e-learning adoption. Therefore, the study aims to explore the role of gender, education, and urban development in shaping the digital divide within the context of e-learning in EU countries, not only at the country level but also at the level of specific gender, education, and urban-rural groups. Since the two groups of European countries, i.e. the EU-15 and the other countries, differ significantly in their development, the use of e-learning at the level of specific gender, educational, and urban-rural groups is compared between these two groups of EU countries. Since Covid-19 significantly impacted e-learning adoption, we focus on the pre-pandemic period. To confirm the significance of our findings, we compare two years, 2017 and 2019.

The paper is organised as follows. After the introduction, the second part presents the theoretical background. In the third part, the methodological approach is presented and explained. The fourth part presents and discusses the results of the analyses, while the fifth part concludes the study.

BACKGROUND

E-LEARNING BENEFITS

The importance of education for human development is well documented and under percentages the catalytic role of education in developing national and human capital [1]. Education is a means of self-development through learning, knowledge, skills, and habits that are transmitted across generations. E-learning has become a widely used concept for higher education institutions as the use of Information and Communication Technologies (ICT) to

deliver educational content and learning support has become ubiquitous. Even before the COVID-19 pandemic, e-learning has become the accepted norm for many higher education institutions worldwide [9]. Various proponents of e-learning believe that it can significantly impact the quality of education, student achievement, and student engagement [10]. What is important and worth exploring is that the context and universities have shifted to online mode and radically changed their educational processes, as universities, even those that were previously reluctant to change their educational approach, had no choice but to shift to online teaching and learning [11] fully.

The role and popularity of ICT in society are evident, mainly its role in supporting education during the COVID-19 pandemic as institutions migrated to the online world [12]. Consequently, the pandemic pushed educational institutions to prioritise remote learning [13]. Large segments of the developed world have embraced the Internet, virtual reality, and related technologies to work and learn from home [14]. Researchers report that students prefer digital media to printed materials to support learning [15]. On the other hand, researchers are concerned that some educational institutions are using traditional, teacher-centred methods rather than 21st-century learning techniques that support critical thinking and independent and learner-centred learning [16]. Digital technologies allow learners to access rich multimedia materials that are more effective than printed materials beyond space and time constraints [17]. In the 21st century, online learning methods are increasingly used to support distance and blended learning for on-campus and off-campus students [18]. E-learning is a viable solution for people with busy and conflicting schedules that prevent them from attending face-to-face classes. e-Learning technologies improve knowledge sharing between students and instructors and strengthen communication channels, leading to better performance [19].

From our superficial understanding of online learning is a type of method in which (1) the learner is at a distance from the educator, (2) the learner uses some form of technology (Internet and a device-computer, laptop, tablet or smartphone, etc.) to access the learning materials or interact with an educator and other learners (3) some support is provided to learners [20].

It is essential to understand the impact of distance education on the effects of education and the social consequences of retaining this type of education. Many researchers have studied the effects of distance education on education in depth and have concluded that distance education has several advantages, such as ensuring continuity of education [21], ensuring lifelong learning [22], and reducing the high costs associated with traditional education [23]. Constraints such as teaching methods, scheduling, and time existed as teachers and learners were in different locations [24]. The impact was not limited to the educational system but also impacted the student learning experience when it comes to accessing research and study materials. For example, students' access to textbooks and resources to review may be hindered by a lack of copyright restrictions and exceptions. Hebebci et al. [25]conducted a study in Turkey to determine what teachers and students thought about the COVID-19 pandemic distance education applications. According to the study, students in distance education mode have difficulties in doing group projects because they lack socialisation on campus, as 42.9 percent of the respondents reported. Sadeghi [26] comprehensively explained the advantages and disadvantages of distance education. He argued that distance learning has the advantages of studying from anywhere at any time, saving significant amounts of money, not having to commute, having the flexibility to choose the learning course, and saving time. However, it also has some disadvantages, such as the high risk of distraction, the use of complicated technology, no social interaction, the difficulty of keeping in touch with instructors, and the fact that labour markets do not accept online degrees.

THE DIGITAL DIVIDE IN E-LEARNING

The digital divide is the difference between people or communities accessing and effectively using ICT and those without [27]. It is the inequality in access to digital devices, Internet connections, and digital navigation capabilities[3]. The digital divide is often measured at the national level, that is, between countries or regions with higher levels of advanced technology use and those with lower levels of use [5]. Recent research indicates that the digital divide is still strongly present in the European Union countries [28].

The digital divide in e-learning refers specifically to inequalities in access to and use of digital resources for educational purposes [3]. As education increasingly incorporates digital technologies such as online courses, educational apps, and digital learning platforms, students and faculty who do not have access to these tools are at a disadvantage. Access to devices, internet connections, digital literacy, and affordability are critical to online learning [29]. In rural or underprivileged areas, limited internet access, limited digital literacy, and high costs can hinder participation. Providing these resources can help disadvantaged students succeed in online learning and, consequently, succeed in education. The digital divide in e-learning is critical for several reasons, including educational equity, workforce readiness, economic growth, social mobility, and inclusivity [6]. Access to quality education is essential for personal development and socioeconomic advancement, but a digital divide creates inequities and makes it difficult for some students to access resources. A well-educated and technologically skilled population contributes to a country's growth and innovation [30]. Reducing the digital divide in e-learning can also improve social mobility and promote inclusivity and social cohesion, allowing more people to participate fully in educational, economic, and social activities [31].

To bridge the digital divide in e-learning, governments and organisations must invest in infrastructure, subsidise digital devices and Internet access, provide digital literacy training, and adopt policies to promote inclusive e-learning efforts [7]. In this way, countries can work to close the digital divide and ensure that all citizens have equal access to education and participation in the digital age. The EU has actively supported the development of e-learning through various programs, policies, and funding initiatives. The Digital Education Action Plan (2021-2027) aims to improve digital literacy, enhance the quality of digital learning, and ensure equitable access to high-quality and inclusive digital education for all learners, regardless of their socioeconomic background [8].

The Erasmus+ program supports education, training, and youth projects and provides funding opportunities for e-learning projects, virtual mobility, and digital innovation. The European Institute of Innovation and Technology (EIT) drives innovation and entrepreneurship across Europe and fosters partnerships between academia, research, and industry to promote digital skills and technologies in education. Horizon Europe is the EU's research and innovation program that provides funding opportunities for research projects in digital education and e-learning. The European Structural and Investment Funds (ESIF) provide financial support to EU member states to address regional disparities and promote economic and social cohesion. EU Code Week encourages citizens to engage with programming and digital literacy while policy frameworks promote technology use, data protection, and innovation in e-learning. The European Digital Skills Awards recognise individuals, organisations, and initiatives that make an outstanding contribution to the development of digital skills and e-learning. The EU also supports the development and deployment of e-learning platforms and tools through various funding programs and partnerships that provide accessible and interactive learning experiences for learners across Europe.

Previous research on e-learning adoption has examined in depth the differences in usage patterns by gender, education level, and residential setting. Several studies have reported notable differences in the use of e-learning by men and women. In general, women are more likely to participate in e-learning, especially in higher education, suggesting that they are more likely to prefer digital learning platforms. According to one study, female students have a stronger intrinsic motivation to take online courses than their male peers [32]. Another study suggests that women are more confident online than in a face-to-face setting, more willing to learn from other students and seek support, more self-directed than men, and strongly desire to engage academically [33]. A growing body of research suggests that women are particularly suited to online learning [34]. However, the reasons for this trend are unclear and require further research.

Regarding educational level, research has consistently shown that individuals with higher levels of formal education are more likely to engage in e-learning activities than those with lower levels of education [35]. This trend may be due to the fact that individuals with higher levels of education have better digital skills and access to technology, which makes it easier for them to participate in online learning environments. In addition, research has shown that the acceptance of e-learning varies greatly depending on where people live [36]. In urban areas, e-learning adoption tends to be higher due to better Internet connectivity and access to digital devices. In contrast, rural areas face challenges related to Internet infrastructure and limited access to technology, resulting in lower e-learning participation among residents.

METHODOLOGY

DATA

To analyse the level of e-government in European countries, we use data collected by statistical offices and available at Eurostat. Respondents were asked many questions about e-learning. We focused on a broad question in which respondents answered whether they had done at least one of the following in the last year: (i) participated in an online course (of any subject); (ii) used online learning materials; (iii) communicated with teachers or students via educational websites/portals. The level of e-learning adoption, as measured by the broad question above, was examined for different statistical groups, as shown in Table 1. For example, the variable ALL measures the percentage of individuals at the country level who have completed at least one of the e-learning measures in the last year. On the other hand, the variable F- HIGH measures the percentage of women with high formal education who have done at least one of the e-learning actions in the last year.

To determine the extent of e-learning inequality in European Union countries, two groups of countries were observed: EU-15 and rest of the countries. The term EU-15 (EU-15) refers to the 15 Member States of the European Union as of December 31, 2003, before the new Member States joined the EU. The 15 Member States are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom. Since in 2017 and 2019, the UK was still a member country, we take it into account as member of EU-15. On the other hand, EU-Other is the abbreviation for the member states of the European Union (EU), which consists of a group of 13 countries (Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia). The variable EU-GROUP indicates the group to which the country belongs.

Table 1. Indicators used in the analysis.

Indicator	Code	Statistical groups	Measurement
Any of the following activities: (i) doing an online course (of any subject); (ii) using online learning material; (iii) communicating with instructors or students using educational websites/ portals	ALL	All Individuals	% of individuals
	M_LOW	Males with low formal education	
	F_LOW	Females with low formal education	
	M_MED	Males with medium formal education	
	F_MED	Females with medium formal education	
	M_HIGH	Males with high formal education	
	F_HIGH	Females with high formal education	
	ALL_LOW	Individuals with no or low formal education	
	ALL_MED	Individuals with medium formal education	
	ALL_HIGH	Individuals with high formal education	
	CITY	Individuals living in cities	
	TOWN	Individuals living in towns and suburbs	
	RURAL	Individuals living in rural areas	
	BROAD	Individuals living in a household with broadband access	
Country Group	EU_GROUP	EU-15 vs. EU-28	EU-15 (1); Other (2)

STATISTICAL ANALYSIS

The statistical analysis is conducted in two steps and answers to two research questions:

RQ_1: What is the impact of education, gender and urban development on e-learning inequality?

RQ_2: What are the differences between EU-15 and other countries on e-learning indicators?

For obtaining answer to the first research question, Paired Wilcoxon-signed rank test of differences in e-learning between 2017 and 2019 has been conducted. For obtaining the answer to the second research question, T-test comparison of e-learning adoption indicators between EU-15 and other countries has been conducted.

RESULTS

IMPACT OF EDUCATION, GENDER AND URBAN DEVELOPMENT ON INEQUALITY IN E-LEARNING

Figure 1 shows the mean values of the percentage of citizens using e-learning for different genders, educational groups, and groups with different levels of urbanisation. This information is used to answer the first research question (RQ1) about the influence of education, gender and urbanisation on e-learning inequality. For all observed groups, the indicator measuring the percentage of citizens using at least one form of e-learning increased. The highest increase was in the groups (all, male and female) of citizens with high formal education and citizens living in cities. Conversely, the lowest increase was among citizens with low and medium formal education. For all observed indicators, the percentage of males who used at least one type of e-learning activity was greater than that of females.

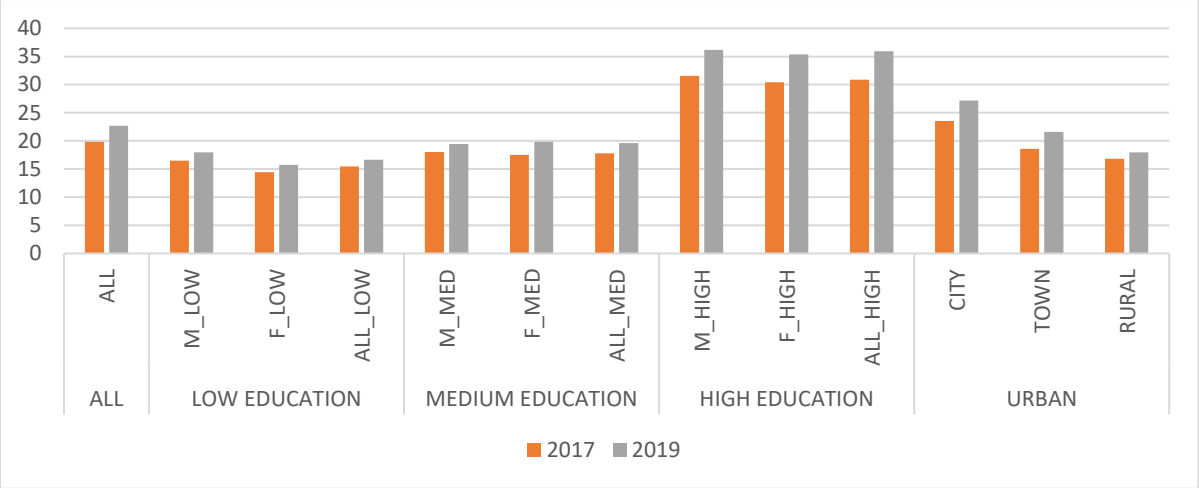

Figure 1. Mean values of e-learning indicators of EU countries; 2017 and 2019, $n = 28$ European Union member states.

Table 2 shows the descriptive statistics of the observed variables for all European Union Member States for 2017 and 2019. Individuals with low formal education use e-learning the least for both genders, but also experience the slowest growth in e-learning use. On the other hand, individuals of both genders with high formal education use e-learning to the highest extent and with the strongest growth, both in absolute and relative terms.

Table 2. Descriptive statistics of the observed variables; 2017 and 2019, $n = 28$ European Union member states.

Indicator	2017				2019				Mean difference (2017-2019)
	Min	Max	Mean	St. Dev.	Min	Max	Mean	St. Dev.	
All individuals									
ALL	7	40	19,82	8,794	8	41	22,68	8,90	2,86 (+14 %)
Individuals with low formal education									
M_LOW	0	39	16,50	11,574	2	41	17,96	11,34	1,46 (+9 %)
F_LOW	1	42	14,46	11,909	0	43	15,75	11,61	1,29 (+8 %)
ALL_LOW	1	40	15,46	11,542	2	42	16,64	11,30	1,18 (+8 %)
Individuals with medium formal education									
M_MED	6	40	18,00	10,077	7	37	19,46	9,90	1,46 (+8 %)
F_MED	4	37	17,54	9,712	7	37	19,82	9,83	2,28 (+13 %)
ALL_MED	5	35	17,79	9,739	7	35	19,64	9,71	1,85 (+10 %)
Individuals with high formal education									
M_HIGH	14	55	31,54	11,536	15	56	36,18	10,07	4,64 (15 %)
F_HIGH	14	54	30,43	11,210	15	55	35,36	10,03	4,93 (+16 %)
ALL_HIGH	15	53	30,89	11,246	16	55	35,93	9,94	5,04 (+16 %)
Individuals, according to different urbanisation level									
CITY	9	46	23,57	9,086	10	48	27,21	9,90	3,64 (+15 %)
TOWN	4	39	18,57	8,813	6	41	21,61	8,82	3,04 (+16 %)
RURAL	3	39	16,86	9,395	4	34	17,96	8,26	1,1 (+7 %)

Table 3 shows the results of the paired Wilcoxon signed rank test. The differences between the level of e-learning in 2017 and 2019 among individuals with low levels of formal education and those living in rural areas are statistically significant at the 5 % level. On the other hand, the differences between the level of e-learning in 2017 and 2019 among individuals with high levels of formal education who live in urban areas are statistically significant at the 1 % level.

Table 3. Paired Wilcoxon-signed rank test of differences in e-learning between 2017 and 2019.

Measure 1	Measure 2	W	Z	p	VS-MPR[a]	Rank-Biserial Correlation
ALL_2017	ALL_2019	33,000	–3,748	< ,001***	450,991	–0,825
M_LOW_2017	M_LOW_2019	89,500	–1,729	0,043**	2,724	–0,403
F_LOW_2017	F_LOW_2019	96,500	–2,006	0,023**	4,286	–0,450
ALL_LOW_2017	ALL_LOW_2019	101,000	–2,114	0,017**	5,229	–0,466
M_MED_2017	M_MED_2019	62,500	–2,500	0,006***	11,588	–0,583
F_MED_2017	F_MED_2019	31,000	–3,400	< ,001***	135,252	–0,793
ALL_MED_2017	ALL_MED_2019	55,000	–3,030	< ,001***	49,467	–0,687
M_HIGH_2017	M_HIGH_2019	21,500	–3,911	< ,001***	787,130	–0,877
F_HIGH_2017	F_HIGH_2019	28,000	–3,985	< ,001***	1.057,314	–0,862
ALL_HIGH_2017	ALL_HIGH_2019	12,500	–4,240	< ,001***	2.865,929	–0,934
CITY_2017	CITY_2019	20,500	–3,821	< ,001***	581,387	–0,874
TOWN_2017	TOWN_2019	30,000	–3,695	< ,001***	367,772	–0,829
RURAL_2017	RURAL_2019	87,500	–2,018	0,022**	4,358	–0,462
BROAD_2017	BROAD_2019	35,000	–3,431	< ,001***	158,053	–0,785

Vovk-Sellke Maximum p -Ratio: Based on a two-sided p-value, the maximum possible odds in favour of H_1 over H_0 equals $1/(-e\ p \log(p))$ for $p \leq .37$ [36]
***statistically significant at 1 %
**statistically significant at 5 %

DIFFERENCES IN E-LEARNING INDICATORS BETWEEN EU-15 AND OTHER EU COUNTRIES

The descriptive statistics of e-learning indicators for the EU-15 and other EU countries in 2017 and 2019 are summarised in Table 5 and Table 6 to provide an answer to the following second research question (RQ2), which examines the differences between the EU-15 and other countries in terms of e-learning indicators.

Country-by-country data for the variable ALL can be found in Appendix. The lowest percentages of e-learning use stand out in several countries. The percentage of all individuals using at least one form of e-learning varied widely across EU countries. In Bulgaria, for example, it was among the lowest at around 8,20 % in 2017 and increased slightly to 9,23 % in 2019. In Greece, e-learning adoption was also relatively low, at 6,57 % in 2017 and 8,35 % in 2019. The use of e-learning was also down in Hungary, at about 9,61 % in 2017 and 10,38 % in 2019.

On the other hand, in Sweden, about 40.04 % of students used e-learning in 2017 and 41,20 % in 2019. Finland showed significant e-learning penetration, with 31,35 % in 2017 and 37,27 % in 2019. These figures show how widespread e-learning is in these countries, where a higher percentage of the population actively used e-learning platforms for educational purposes during this period.

It is noteworthy that the leaders in the use of e-learning are all EU-15 members: Finland and Sweden. This observation shows that the EU-15 countries have adopted e-learning to a greater extent than the rest of the EU during the study period. This result is in line with the theoretical conclusions of the study, as it supports the idea that the more developed EU countries are more successful in adopting e-learning than their less developed counterparts.

Table 4 shows the descriptive statistics of the 2017 e-learning indicators comparing the EU-15 countries and other EU countries. As before, the indicators are grouped by different categories such as gender, education level, and living environment.

Table 4. Descriptive statistics of e-learning indicators in EU-15 and other EU countries in 2017.

Indicator	Groups	N	Mean	SD	Var. C., %	Mean difference (EU-15 vs. other)
ALL	Other EU	13	15,85	6,829	43,1 %	7,42
	EU15	15	23,27	9,043	38,9 %	
M_LOW	Other EU	13	15,92	11,729	73,7 %	1,08
	EU15	15	17,00	11,826	69,6 %	
F_LOW	Other EU	13	13,62	11,384	83,6 %	1,58
	EU15	15	15,20	12,695	83,5 %	
M_MED	Other EU	13	12,38	7,974	64,4 %	10,48
	EU15	15	22,87	9,311	40,7 %	
F_MED	Other EU	13	13,15	8,802	66,9 %	8,18
	EU15	15	21,33	9,069	42,5 %	
M_HIGH	Other EU	13	27,62	10,767	39,0 %	7,32
	EU15	15	34,93	11,430	32,7 %	
F_HIGH	Other EU	13	27,23	10,232	37,6 %	5,97
	EU15	15	33,20	11,614	35,0 %	
ALL_LOW	Other EU	13	14,85	11,379	76,6 %	1,15
	EU15	15	16,00	12,053	75,3 %	
ALL_MED	Other EU	13	12,69	8,230	64,8 %	9,51
	EU15	15	22,20	8,938	40,3 %	
ALL_HIGH	Other EU	13	27,38	10,276	37,5 %	6,55
	EU15	15	33,93	11,492	33,9 %	
CITY	Other EU	13	19,46	6,267	32,2 %	7,67
	EU15	15	27,13	9,812	36,2 %	
TOWN	Other EU	13	14,69	7,598	51,7 %	7,24
	EU15	15	21,93	8,614	39,3 %	
RURAL	Other EU	13	13,77	8,418	61,1 %	5,76
	EU15	15	19,53	9,643	49,4 %	

The results suggest that EU-15 countries had slightly higher rates of e-learning adoption than other EU countries in 2017. Significantly higher e-learning rates were observed in the EU-15 countries, particularly in the M_MED and ALL_MED categories, which include men and women with intermediate formal education and those with middle formal education. In contrast, differences in the groups M_LOW, F_LOW, and ALL_LOW, which include individuals with limited or no formal education, were quite small in the EU-15 and other countries.

In terms of the urbanisation situation, there was a notable discrepancy in the use of e-learning by people living in cities in the EU-15 countries, as shown by the category CITY. Conversely, the discrepancies in the use of e-learning were comparatively smaller among residents of cities and suburbs, characterised by the category TOWN, and among residents of rural areas, represented by the category RURAL.

Regarding the urbanisation situation, there was a remarkable discrepancy in the use of e-learning by people living in the cities of the EU-15 countries, as shown by the category CITY. Conversely, the discrepancies in the use of e-learning were comparatively smaller among the inhabitants of cities and suburbs, characterised by the category TOWN, and among the inhabitants of rural areas, represented by the category RURAL.

Table 5 provides an overview of the descriptive statistics of e-learning indicators in the EU-15 and other EU countries in 2019. The indicators are divided into two groups: Other EU, which includes 13 observations, and EU-15, which includes 15 observations.

Table 5. Descriptive statistics of e-learning indicators in EU-15 and other EU countries in 2019.

Indicator	Groups	N	Mean	SD	SE	Var. C., %	Mean difference (EU-15 vs. Other)
ALL	Other EU	13	18,15	7,175	1,990	39,5 %	8,45
	EU15	15	26,60	8,559	2,210	32,2 %	
M_LOW	Other EU	13	17,85	12,335	3,421	69,1 %	0,22
	EU15	15	18,07	10,840	2,799	60,0 %	
F_LOW	Other EU	13	15,85	13,133	3,642	82,9 %	0,179
	EU15	15	15,67	10,581	2,732	67,5 %	
M_MED	Other EU	13	13,08	6,639	1,841	50,8 %	11,92
	EU15	15	25,00	8,968	2,316	35,9 %	
F_MED	Other EU	13	14,69	8,548	2,371	58,2 %	9,58
	EU15	15	24,27	8,836	2,281	36,4 %	
M_HIGH	Other EU	13	31,69	9,105	2,525	28,7 %	8,37
	EU15	15	40,07	9,460	2,443	23,6 %	
F_HIGH	Other EU	13	31,69	8,410	2,333	26,5 %	6,84
	EU15	15	38,53	10,494	2,710	27,2 %	
ALL_LOW	Other EU	13	16,54	12,421	3,445	75,1 %	0,20
	EU15	15	16,73	10,667	2,754	63,7 %	
ALL_MED	Other EU	13	13,92	7,455	2,068	53,5 %	10,68
	EU15	15	24,60	8,806	2,274	35,8 %	
ALL_HIGH	Other EU	13	32,00	8,813	2,444	27,5 %	7,33
	EU15	15	39,33	9,861	2,546	25,1 %	
CITY	Other EU	13	22,62	7,795	2,162	34,5 %	8,59
	EU15	15	31,20	10,009	2,584	32,1 %	
TOWN	Other EU	13	17,46	7,633	2,117	43,7 %	7,74
	EU15	15	25,20	8,377	2,163	33,2 %	
RURAL	Other EU	13	13,69	6,969	1,933	50,9 %	7,97
	EU15	15	21,67	7,641	1,973	35,3 %	

When analysing the use of e-learning across different levels of education (ALL_LOW, ALL_MED, and ALL_HIGH), it is clear that the EU-15 countries consistently have higher average percentages than other EU countries in each category. For individuals classified as having low or poor formal education (ALL_LOW), the average percentage for the EU-15 countries was 16,73, but for the other EU countries it was 16,54. For individuals with a moderate level of formal education (ALL_MED), the average percentage for the EU-15 countries was 24,60, while for the other EU countries it was 13,92. For individuals who have achieved a high level of formal education (ALL_HIGH), the average percentage for the EU-15 countries was 39,33, while it was 32,00 for the other EU countries.

Regarding the classification of residential areas (CITY, TOWN and RURAL), the EU-15 countries have continuously better average percentages in the respective category compared to other EU countries when evaluating the use of e-learning. To illustrate, the average percentage for those living in urban areas (CITY) was 31.20 for the EU-15 countries, but 22.62 for the other European Union (EU) countries.

Table 6 presents significant data results on the differences in e-learning adoption between the EU-15 countries and other countries within the European Union.

Table 6. T-test comparison of e-learning adoption indicators between EU-15 and other countries.

Indicator	2017.				2019.			
	T	df	P	VSMPR[a]	T	df	p	VSMPR[a]
ALL	2,418	26	0,023**	4,255	2,804	26	0,009***	8,367
M_LOW	0,241	26	0,811	1,000	0,050	26	0,960	1,000
F_LOW	0,345	26	0,733	1,000	0,040	26	0,968	1,000
M_MED	3,172	26	0,004***	17,160	3,944	26	< ,001***	90,387
F_MED	2,413	26	0,023**	4,215	2,903	26	0,007***	10,089
M_HIGH	1,735	26	0,095*	1,650	2,377	26	0,025**	3,977
F_HIGH	1,432	26	0,164	1,241	1,883	26	0,071*	1,959
ALL_LOW	0,259	26	0,798	1,000	0,045	26	0,965	1,000
ALL_MED	2,911	26	0,007***	10,253	3,432	26	0,002***	29,406
ALL_HIGH	1,579	26	0,127	1,407	2,061	26	0,049**	2,473
CITY	2,421	26	0,023**	4,270	2,502	26	0,019**	4,892
TOWN	2,341	26	0,027**	3,758	2,539	26	0,017**	5,212
RURAL	1,672	26	0,107	1,542	2,868	26	0,008***	9,437
BROAD	2,108	26	0,045**	2,644	2,611	26	0,015**	5,902

Vovk-Sellke Maximum p -Ratio: Based on a two-sided p-value, the maximum possible odds in favour of H_1 over H_0 equals 1/(-e p log(p)) for $p \leq .37$ [36]
***statistically significant at 1 %
** statistically significant at 5 %
*statistically significant at 10 %

The results of the t-test show a statistically significant difference in the overall indicator of e-learning adoption (ALL) between the EU-15 and the other countries in both 2017 (t = 2,418, p = 0,023**) and 2019 (t = 2,804, p = 0,009***). The results indicate that, on average, EU-15 member states have higher rates of e-learning adoption than other countries within the European Union in both years. When examining e-learning adoption in terms of gender and education level, the t-tests revealed intriguing trends. In both 2017 (t = 3,172, p = 0,004***) and 2019 (t = 3,944, p < 0,001***), there was a statistically significant difference in e-learning adoption between the EU-15 and the other countries, especially among men with an intermediate level of formal education (M_ MED). Similarly, for females with an intermediate level of formal education (F_ MED), the t-tests show a statistically significant difference between the EU-15 and other countries in both 2017 (t = 2,413, p = 0,023**) and 2019 (t = 2,903, p = 0,007***). The results indicate that EU-15 countries have higher adoption of e-learning among women and men with an intermediate level of formal education in both years.

The results of the t-tests show no statistically significant difference between EU-15 and other countries in 2017 (t = 1,579, p = 0,127) on the overall indicator of e-learning adoption for individuals with high formal education (ALL_HIGH). However, a statistically significant difference was found in 2019 (t = 2,061, p = 0,049**). This indicates that the rates of e-learning use among individuals with a high level of formal education were comparable in the EU-15 and other EU countries in 2017. However, in 2019, EU-15 countries had higher rates of e-learning use among this population. When we focus on women with a high level of formal education (denoted as F_HIGH), the results of the t-tests show that in 2017 there were no statistically significant differences in the rates of e-learning use between countries within and outside the EU-15 (t = 1,432, p = 0,164). In 2019, a slight but statistically striking difference was found between the two groups (t = 1,883, p = 0,071*). Looking more closely at men with a high level of formal education (M_HIGH), the t-tests performed show that there was a slight but statistically significant difference between the EU-15 countries and the other nations in terms of e-learning use in 2017 (t = 1,735, p = 0,095*). In addition, a statistically significant

difference was found in 2019 (t = 2,377, p = 0,025**). The results suggest that although there were no statistically significant differences in e-learning adoption rates among men and women with high levels of formal education in 2017, by 2019, the EU-15 countries had higher e-learning adoption rates among these groups. Nevertheless, t-tests performed for indicators such as M_LOW, F_LOW, M_HIGH, and F_HIGH did not reveal statistically significant differences between the EU-15 and other countries. This suggests that the adoption of e-learning within these groups showed comparable trends in the EU-15 and the other EU countries in the years studied. In addition, when the level of urbanisation (CITY, TOWN and RURAL) is taken into account, the t-tests show statistically significant differences between the EU-15 and other countries with respect to CITY for both 2017 (t = 2,421, p = 0,023**) and 2019 (t = 2,502, p = 0,019**), and for TOWN in both 2017 (t = 2,341, p = 0,027**) and 2019 (t = 2,539, p = 0,017**). The results of this study show that the adoption rate of e-learning was comparatively higher in the metropolitan regions of the EU-15 countries than in other countries in both years.

The findings provide important insights into the digital divide in e-learning use within the European Union. They underscore the need to take targeted initiatives to ensure equal access to digital education in all members countries.

CONCLUSION

SUMMARY OF FINDINGS

After the COVID-19 pandemic, e-learning has become popular in modern educational institutions, providing a new method of learning and knowledge acquisition. However, the widespread use of e-learning has made potential inequalities and digital divides between and within European Union (EU) member states more apparent. This scholarly article examines how gender, education, and urbanisation influence e-learning inequality across EU member states.

To reduce the impact of COVID-19 related biases, the study focuses on a comparative analysis between the most developed EU countries (EU-15) and other EU countries using data from the two years prior to the pandemic, 2017 and 2019. The researchers hope to learn about the discrepancies by looking at citizens of different groups by gender, education, and urban development standards.

According to the study's findings, the EU-15 countries consistently outperform other EU member states in e-learning. The digital divide persists despite significant EU efforts, including projects under the Digital Europe umbrella, to close technological gaps and promote equal access to online learning resources.

THEORETICAL AND PRACTICAL IMPLICATIONS

The study provides theoretical support for the claim that educational inequalities significantly affect the adoption of e-learning in European Union countries. The negative impact seen in rural areas and among those with less education highlights the need to close the digital divide by increasing access to e-learning tools and technology in underserved areas, confirming the conclusions of Vogels [37]. To promote the adoption of e-learning for all, policymakers and educators should focus on targeted interventions to improve educational opportunities in these marginalised groups.

Living in urban areas has a positive impact on the adoption of e-learning, highlighting the importance of these areas as centres for technological development and easy access to online resources, and reaffirming Vogels' findings [36]. According to the findings, targeted efforts to

improve technological infrastructure and e-learning resources in rural areas are needed to close the gap in access to online education between urban and rural areas. Policymakers should consider initiatives to close this gap, as they can have broader implications for socioeconomic development and regional expansion.

Living in urban areas has a positive impact on the adoption of e-learning, highlighting the importance of these areas as centres for technological development and easy access to online resources, and confirming the findings of Vogels [37]. According to the findings, targeted efforts to improve technological infrastructure and e-learning resources in rural areas are needed to close the gap in access to online education between urban and rural areas. Policymakers should consider initiatives to close this gap, as they can have far-reaching implications for socioeconomic development and regional expansion.

However, the results of our study suggest that women in disadvantaged situations, such as having little formal education and living in rural areas, were less likely to participate in e-learning. The study highlights the importance of gender in e-learning adoption, especially among people in rural areas with low levels of education, which is also pointed out by Almasri (2022) [38]. A more inclusive e-learning environment that empowers and encourages all genders to participate in online education is necessary to address these gender inequalities, which requires gender-sensitive policies and targeted interventions [39]. These findings are even more worrying considering that recent research indicates that girls had more anxiety related to the usage of e-learning during pandemics [40]. These findings are especially important, since higher inclusion of women overall has a positive impact on economic development, especially for the developing countries [41].

LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

The research results of this paper are preliminary, which is due to the limited methodological approach. However, these limitations also provide a good foundation for future research. First, the use of data from the two years preceding the COVID-19 pandemic is a limitation (2017 and 2019). This decision was made to avoid potential pandemic-related bias. Future studies could incorporate information from the post-pandemic years to provide a more thorough and up-to-date analysis of the changing e-learning landscape.

Second, the study is not able to establish a causal relationship between the variables since the effects of educational level, gender, and urbanisation level were not directly observed but were indirectly expressed through the analysis of different groups of individuals. Future research could use longitudinal or experimental designs to learn more about the causes of these relationships, such as [42]. Supplementing quantitative data with qualitative research techniques such as focus groups or interviews can shed light on the perspectives and life experiences of people affected by educational disparities in e-learning. Studies that track e-learning adoption and associated factors over time, or longitudinal studies, may be able to identify changing patterns and trends in educational inequality. Long-term analyses would be beneficial in understanding the impact of policies and technological advances on e-learning adoption.

Future research could also shed light on emerging trends and specific areas and conditions, such as pandemics. First, although the pandemic had a significant impact on e-learning, research indicated that the country's response significantly depended on the level of economic development, thus raising additional concerns about the digital divide in e-learning [43]. Since the pandemic stopped, researchers should investigate its long-term effects on e-learning since the question emerges whether the changes implemented in classrooms will pertain, how long and to what extent [44]. Second, research on the implementation of e-learning in specific

disciplines, such as economics and business, should shed light on the country differences. For example, research indicates that although there are some significant improvements in e-learning implementation at the country level, such as in Croatia [45][46], there are still significant differences between countries [47]. Finally, future research is strongly encouraged by emerging technologies, such as machine learning [48] and simulation games [49].

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APPENDIX

Table 7. Percentage of all individuals using at least one of the e-learning activities in 2017 and 2019 (source: Eurostat).

Country	2017	2019
Austria	19,92	22,22
Belgium	20,29	23,73
Bulgaria	8,20	9,23
Croatia	10,01	15,67
Cyprus	10,42	12,55
Czechia	12,99	15,54
Denmark	24,06	32,29
Estonia	30,90	35,29
Finland	31,35	37,27
France	14,66	18,18
Germany	17,51	20,56
Greece	6,57	8,35
Hungary	9,61	10,38
Ireland	13,27	26,38

Country	2017	2019
Italy	16,37	18,84
Latvia	19,11	22,26
Lithuania	20,99	23,77
Luxembourg	36,60	27,56
Malta	25,05	24,04
Netherlands	26,37	29,64
Poland	11,34	12,96
Portugal	24,41	25,49
Romania	16,68	16,35
Slovakia	13,05	14,84
Slovenia	18,14	22,93
Spain	27,65	30,89
Sweden	40,04	41,20
United Kingdom	29,57	36,83