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CAPABILITY OF HIGHER EDUCATION IN OVERCOMING DIGITAL INEQUALITY IN THE CONDITIONS OF THE CRISIS IN UKRAINE

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ABSTRACT

The purpose of the article is to assess the gap between people's readiness for effective activity in the digital economy and to identify the functional capabilities of universities to reduce this gap. The research used methods of generalizations, logical, systematic, and comparative analysis, and statistical-economic, sociological, and economic-mathematical methods and techniques. The results of the study showed that the digitalization of the economy, the state, and society, which is taking place in Ukraine, requires a significant increase in the level of society's readiness for digital changes. For effective integration into the digital environment, in particular in the field of education, it is necessary to create a digital infrastructure that meets EU standards. The authors conducted a study of the development of the digital inclusive component of the regions of Ukraine.Proposed ways of digital development of society. In particular, it has been proven that promoting the development of the provision of educational services improves the digital literacy of the population for daily tasks and for employers to minimize the gaps between the digital environment and people's skills. It is substantiated that the acquisition of new digital skills and competencies of employees requires the development of training networks and the improvement of foreign language knowledge, both for young people and for other generations.

Keywords: *sustainable development, sustainable development goals, digital inequalities, digital education, Ukraine*

1. INTRODUCTION

The right to education is one of the basic inalienable rights proclaimed by the Universal Declaration of Human Rights. From the point of view of human development, education significantly expands a person's capabilities, as it positively affects various aspects of his life, health, social and political activity, access to knowledge, and the ability to use it both at work and at home - in everyday life, education children, etc. One of the prerequisites for achieving a balanced (sustainable) development of society is science and education, which are also the most important tools for effective management, informed decision-making, and the development of democracy. Education is a particularly striking example of how different populations can come into conflict due to the introduction of new technologies. Recent G20 communiques in 2015 and 2016 made statements about addressing the digital divide, but mainly focused on infrastruc-

ture development, financial inclusion and digital trade. Insufficient attention has been paid to the need to develop digital skills in part due to difficulties in defining and measuring digital literacy. Without digitalization of the economy, that is, without changes in communication channels, training and the labor market, the functioning of the system of medicine and education, public management and administration, making payments, methods of production and sales, various routine operations to ensure life, etc., human freedom is already becoming incomplete. Nowadays, it is difficult to name a sphere of life in Ukraine where changes are not taking place under the influence of digitalization. At the same time, the rates of its introduction in individual sectors of the economy, or in individual regions or settlements, are different. The education system is no exception. Here, too, there are examples of both institutional and territorial unpreparedness of the population for digital changes. Problems arise in terms of the effectiveness of the implementation of measures in work, earnings, all types of activities, self-affirmation, etc.

Among the factors of modern human development, a special place is occupied by the digitalization of social life and the fight against COVID-19. And if the spread of the pandemic is a challenge to humanity, which must be overcome as soon as possible (and armed with the latest medical, biomedical and other knowledge and technologies), then the situation with the development of the IT sphere needs all possible assistance and support. Another program for financing the development of digital infrastructure has been created - Digital Europe Program (DIGITAL), designed for 2021-2027. Its goal is to accelerate the digital transformation of public administration in all European countries, to improve the digital skills of the population. The program provides funding in such areas as supercomputers, artificial intelligence, cyber security, improving digital skills, as well as the widespread use of digital technologies in the economy and public life. However, despite the successes of the EU in the field of digital infrastructure development, the question of its further development remains open. European researchers proposed four scenarios for further development: (1) ultra-liberal, which involves weak controls and negligible data protection, i.e. governments hardly intervene, but market mechanisms are in place; (2) A dystopia where there is strong control but weak data protection; (3) Ultra-social, which includes tight control of infrastructure and reliable data protection, which involves the development of detailed regulation at the legislative level of all aspects of digital infrastructure; (4) A utopia where control over the infrastructure is almost non-existent but data protection is strong, meaning organizations that provide the physical aspect of the digital infrastructure will have almost no government restrictions (EIT Digital, 2022).

2. LITERATURE REVIEW

The authors write that by examining the use of the Internet for learning among students and faculty in higher education, clarity can be gained about how institutional tensions around technology can interfere with their smooth functioning implementation. In this case, faculties are constantly trying to catch up with technology, and students are often dissatisfied or bored with technological possibilities. This situation reinforces the general concern that closing the digital divide alone is not enough (Radovanović et al, 2015). Other authors note that the digital divide is also a literacy and skills divide (Radovanović, 2013; Van Dijk, 2005). (Hincu et al., 2011) believes that the digital divide also persists in settings where information technology penetration is high, highlighting examples where new technologies and tools emerge and the population must improve their skills before they can fully adopt and use the new tools available. The authors (Mićić and Mastilo, 2022) claim that one of the consequences of COVID-19 is the digital transformation of the workplace, which gives advantages to the employee, but only if he has sufficient digital literacy. In particular, the authors claim that modern methods of information

processing using computer technology and the latest software allow for significant expand the monitoring of natural and social processes, which in turn affects the provision and improvement of the sustainable development of the economy (Kuzmak O. et al., 2021). The use of digital tools in the practical activities of public administration bodies contains significant reserves for its optimization but requires the preparation of personnel (Zhuk et al, 2022). Digital skills should also refer to a person's awareness, attitudes, and ability to use digital tools for communication, self-expression, and social action in specific life situations (Goodfellow R, 2011). It is essential that education, including digital literacy, is the basis of future economic growth in the conditions of irreversible demographic decline and the formation of the "knowledge economy" (Pašalić at al, 2020). Another research (Vasyltsiv et al, 2022) substantiates that society's readiness for digital changes creates a favorable environment and ensures the infrastructural development of the modern economy along with other factors (efficiency, involvement, cooperation, etc.).

The European digital agenda primarily aims to stimulate the European economy by ensuring sustainable economic and social benefits from a market perspective. The European Commission distinguishes between basic and transversal skills needed for the modern labor market (European Commission, 2013). Basic skills such as literacy, numeracy, science, and technology are crucial for entering the labor market. Transversal skills include other skills, including linguistic digital skills. Although the European Commission recognizes this skill set as part of cross-skilling, it notes that most jobs require such skills.

Managing digital skills training is critical to attracting infrastructure investment, but this requires accurate, relevant, and representative data that represents the overall reality of digital illiteracy in a way that can be used by policymakers and digital trainers to ensure that such training programs are properly aligned to meet the needs of the rapidly changing labor market, which is accompanied by the demands of digitalization of the developing and growing political economy. Such management should be targeted and based on reasonable assessments concerning the spatial dimension: national or regional. In this context, the question arises about the gradation of territories according to certain quality criteria (in this case, the differentiation of digital inequality) and the target setting, that is, about the classification or typology of regions. Global indices rank countries according to digital development (for example, (E-Participation Index, and E-Government Development Index), and qualitative research conducted in Ukraine evaluates the currently formed digital skills in general (Digital literacy of the population of Ukraine, 2021). Thus, the gap in the methodologies is: (a) insufficient consideration of the regional aspect, especially the depth of differentiation of regions by digital inequality; (b) not taking into account the readiness of the population to acquire digital skills (for example, English language proficiency); (c) the extent of use and the effect of the level of digital skills (employment on digital platforms and the use of these skills in daily activities). The proposed technique, which is based on discriminant and taxonomic analyses, should fill this gap. Discriminant and taxonomic analyzes serve as tools for researching the differentiation of digital inequality of regions and assessing the conformity of deviations of actual (achieved) values of digital equal-

ity indicators from potential or reference values, as well as meeting current needs through the achievement of sufficient levels of digital skills and the possibility of its development.

3. AIM OF THE RESEARCH

The purpose of the research is to assess the depth of the gap between people's readiness for effective activity in the conditions of the digital economy and to identify the functional capabilities of educational institutions to reduce this gap.

4. METHODS

Discriminant analysis refers to object classification methods with "training", that is, with preformed groups. Based on the purpose of the research, the classification problem is formulated as the division of observation objects (regions of Ukraine) into a certain predetermined number of groups (or its refinement in the process of analytical calculations) based on the criterion of distance from the centers of groups (centroids). The analysis results in the assignment of each observation object (region of Ukraine) to only one classification group.

Similar tasks are also solved by cluster analysis. However, its primary purpose is forming new groups and calculating distances from the centroids of groups based on the usually Euclidean distance, which does not consider the relationships between variables. The discriminant analysis aims to identify the difference between classification groups and formulate patterns based on which objects belong to a particular group. At the same time, calculations and classification are based on the Mahalanobis distance, which considers the relationships between data sets. The justification for the choice of discriminant analysis is also based on the possibility of including the semantic category of higher or lower digital inequality (equality) as a grouping feature

The main requirements for the data that will be included in the model for discriminant analysis are:

discriminant variables (variables used to distinguish between groups) should not be functionally dependent or have a close relationship with each other;

discriminant variables must obey the multivariate ordinary distribution law;

the difference between the covariance matrices of the groups should be statistically insignificant (for Fisher's linear discriminant analysis).

All inputs are pre-standardized. The most sharing method of standardization, which provides the most convenient data arrays for further processing and is used when the issue of a standard or norm of indicators does not have an unambiguous interpretation, is a comparison with the standard squared deviation.

Standardization is carried out according to the formula:

$$Z_{ij} = \frac{x_{ij} - \overline{x_j}}{\sigma_j} \quad (1)$$

where $\overline{x_j}$ – is the average value of the *j*-th feature in the data set; σ_j – is the mean squared deviation of the *j*-th feature in the set.

There are three approaches to object classification in discriminant analysis:

based on classification functions: the object belongs to the group for which the value of the function calculated for it is maximum;

based on a posteriori probability: the object belongs to the group for which the probability value of its belonging to it is maximum;

based on the calculation of Mahalanobis distances, the object belongs to the group whose distance to the centroid (center of gravity) is minimal.

Classification functions are linear combinations of discriminant variables that describe the maximization of distinction between groups and the minimization of variance within groups (Blahun et al, 2022). Classification functions have no meaningful interpretation but serve as a tool for assigning a new object to one or another group.

The equation generally describes classification functions:

$$h_k = b_{k0} + b_{k1}x_1 + b_{k2}x_2 + \ldots + b_{km}x_m \quad (k = \overline{1,K}) \tag{2}$$

where h_k – are classification functions for the *k*-th group; b_{ki} – are parameters of the classification equation.

An essential issue in the methods of classification and ranking of statistical populations is the determination of the coordinates of the reference indicator (for discussion see Stepura, 2020). In this context, we rely on taxonomic methods that allow projecting conditional points, taking them as a standard. So, it is advisable to solve the problem by taking the highest values achieved in the regions according to the standardized indicators included in the model as the benchmark for the stimulator indicators and the lowest values for the destimulators (in this research all indicators will be stimulators). As a result, reference points with corresponding coordinates are determined.

An important task that needs to be solved during the quality assessment is its quantitative assessment and finding the optimal values of quality indicators, taking into account the conditions of its formation and use, as well as the degree of deviation of observation objects from the optimal value.

The simplest way to measure the similarity between two objects is the Euclidean distance between two points x_i and x_e, which is determined by the formula:

$$d_{ij} = \sqrt{\sum_{i=1}^{n} (x_{ij} - x_{ej})^2}, \tag{3}$$

where x_{ij} – is the actual value of the *i*-th feature of the *j*-th object ($i=1, \ldots, n$); x_{ej} – is the reference value of the *i*-th characteristic of the *j*-th object. It should be noted that a significant drawback when classifying an array of objects using the Euclidean distance is that it does not take into account the relationships between all objects. The distance between two points is not affected by the position of other points. Therefore, the Mahalanobis distance is used to calculate the position of points in multidimensional space, considering all independent variables and the position of all objects. It is the distance of an object from the centroid in multidimensional space determined by relative independent variables.

Mahalanobis distance takes into account the relationships between the variables in the model that define the multidimensional space and is determined by the formula:

$$d_{ij}^{M} = \sqrt{(X-Y)^{T}S^{-1}(X-Y)} \quad (4)$$

where X, Y – vectors of features; S – covariance matrix of features; T – transposition operation.

Discriminant analysis is based on the calculation of this distance. Therefore, a necessary step for discriminant analysis is the preliminary classification of regions by groups. For this, taxonomic methods are used to divide the range of values of the calculated Euclidean distance into uniform intervals (Table 1).

Table 1. Euclidean distance rating scale

Value d_{ij}	$< (\mu - 2\sigma)$	$\{(\mu - 2\sigma); (\mu - \sigma)\}$	$\{(\mu - \sigma); \mu\}$	$\{\mu; (\mu + \sigma)\}$	$\{(\mu + \sigma); (\mu + 2\sigma)\}$	$> (\mu + 2\sigma)$
Quality assessment of digital inequality	Extremely low	Low	Average	Above average	High	Extremely high

where μ – average value Euclidean distance; σ – standard deviation of the Euclidean distance.

Source: Author's calculation

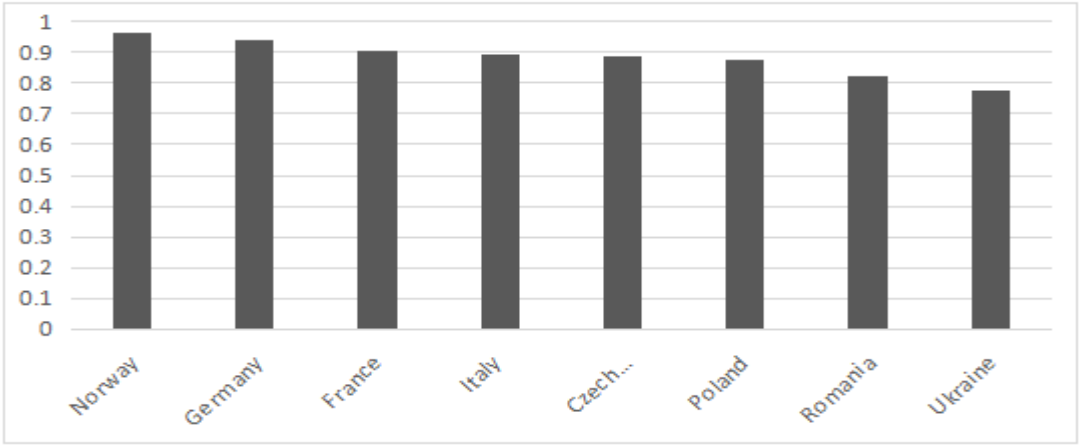
The constructed discriminant model must be checked for adequacy and significance. The criterion of classification quality is the Mahalanobis distance calculated as a result of analytical procedures. Other statistical criteria for the adequacy of the model are the Wilks' statistic (lambda) and the F-criterion, the value of the probability of the error extracting variables from the discrimination procedure.

5. RESULTS

Universities and institutions of higher education in general have long played an important role in the life of cities. They can act as primary mechanisms in society, economy, and environment at local and even international levels. As important platforms for the production of knowledge, research, innovation, and training for the future workforce, these institutions play an important role and impact on society. In practice, modern Ukrainian universities perform socially significant functions. In particular, they participate in the development of national, sectoral, and regional programs for the development of cities and territories, the implementation of modern technologies in various spheres of life, the dissemination of the best global experience and practices, etc. Since the beginning of the war, universities have become centers of volunteerism, and university premises and university campuses have become centers of assistance for internally displaced people fleeing the war. University campuses have become homes for hundreds of families.

The level of education is one of the three components of the human development index (along with GDP per capita and life expectancy). The Human Development Index (HDI), which is presented in three dimensions, which reflect key opportunities in ensuring the entire process of human development, is considered a generalized indicator: to live a long and healthy life (dimension - longevity); acquire, expand and update knowledge (dimension – education); to have access to means of livelihood that ensure a decent standard of living (dimension – the material standard of living).

Figure 3. Human Development Index, 2021



Source: Built on data (EIT Digital, 2022)

The dynamics of the human development index of Ukraine over the years are interesting. As of November 2022, according to the Ministry of Education and Culture of Ukraine, 2,783 educational institutions were damaged by bombings and shelling. 337 of them were destroyed. The share of damaged/destroyed objects was 6.8% of the total number of educational institutions. Of course, it is not surprising that the Human Development Index will decrease in 2022 due to the war because, at the beginning of the war, all educational institutions temporarily stopped working and then switched to online learning mode. Many children were forced to leave their homes and move to other regions of Ukraine that were relatively calm or to other countries. Universities were the most affected:

- Kharkiv region (1 institution destroyed, 19 – damaged);
- Donetsk region (6 – damaged);
- Zaporizhzhia region (4 – destroyed);
- Chernihiv region (3 – damaged);
- Mykolaiv region (3 – damaged).

Classrooms, equipment, sports halls, dormitories, assembly halls, and buildings of educational institutions were destroyed.

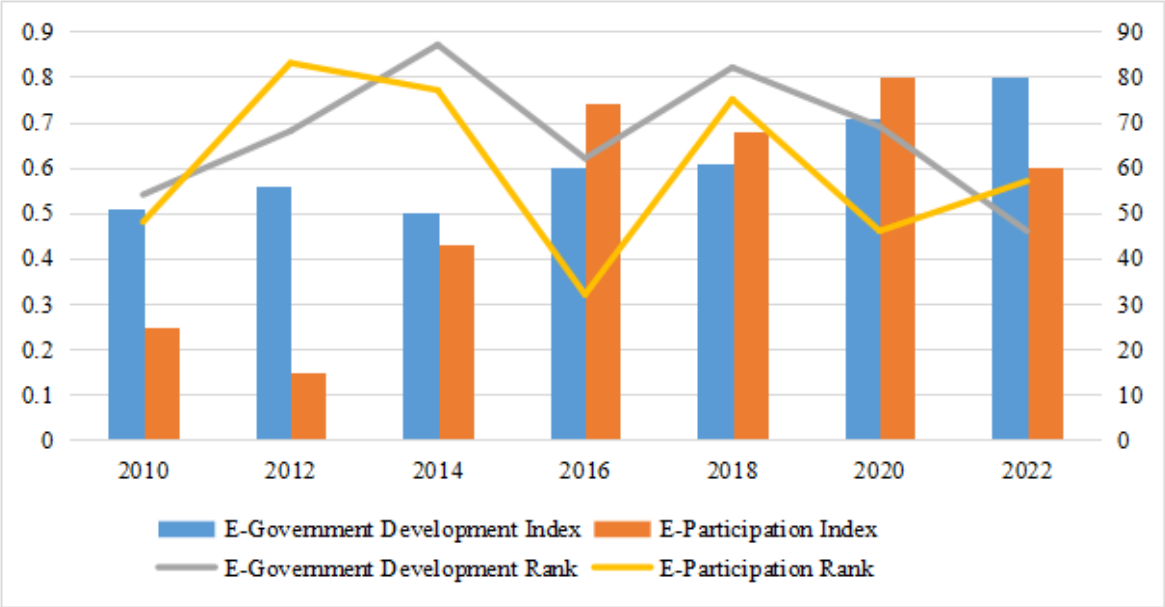
According to the Ministry of Education and Science of Ukraine, during the 10 months of the war, there are 7 million children in the war (Ministry of Education and Science of Ukraine, 2022).

EU members consider education as one of their priorities, so they adopted an action plan to support digital education. The Digital Education Action Plan (2021-2027) was created as a political initiative for EU members, which includes the common goal of high-quality, inclusive, and accessible digital education in all European countries, and it aims to support the adaptation of national education and training systems to the digital age. It includes several areas, such as the creation of a modern common digital infrastructure, the development of the necessary digital skills and competencies to use the aforementioned infrastructure, and the creation of a European Center for Digital Education to strengthen cooperation and exchange best practices in digital education at the EU level (European Commission, 2023). Ukraine's long-term goal is to become a member of the EU. For effective integration into the digital environment, in particular, in the field of education, it is necessary to create a digital infrastructure that meets EU

standards. At this point, several important aspects need to be addressed. First, it is the physical aspect of the infrastructure. Given the state of war in Ukraine, the economic crisis, and the destruction of infrastructure, we will have to change this aspect in the post-war period. Second, it is important to create a regulatory model for the digital infrastructure, including the protection of data and market participants. Thirdly, all the specified measures should be targeted and based on an analytical examination of the depth of the problem of insufficient digital skills and the possibilities of their development and implementation.

In the summer of 2021, the Law of Ukraine "On stimulating the development of the digital economy in Ukraine" (Law of Ukraine) was adopted, which introduced the legal regime of Diya City. The place and achievements of Ukraine in these areas can be evidenced by the data of world ratings. Thus, according to the website (e-Government), Ukraine rose in the ranking of the UN E-Participation Index (from 75th position in 2018 to 46th in 2020), but in 2022 due to war, Ukraine fell again in the rating to 57th position. This index is additional to the E-Government Development Index, in which Ukraine ranked 69th in 2020 (against 82nd in 2018), although in 2022 Ukraine ranked 46th. (Figure 1).

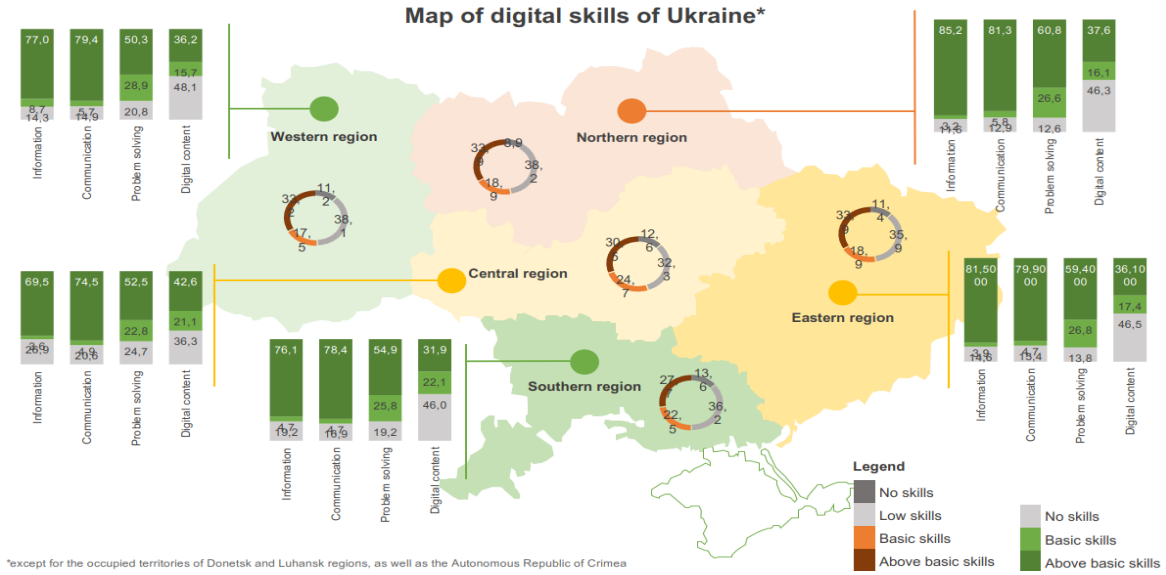
Figure 1. Dynamic of the E-Government Development Index and E-Participation Index, 2008-2022



Source: (UN e-Government Knowledgebase, 2022)

That is, despite the war in Ukraine, according to the E-Government Development Index, Ukraine has risen significantly in the rating, which indicates the effective activity of the government in the field of digitalization. Ukraine has the lowest indicators of the population's skills in using information and communication technologies - both basic and advanced - in Europe. Thus, according to the Ministry of Digital Transformation of Ukraine, the number of the population of Ukraine that does not have digital skills at all in 2021 decreased from 15.1% to 11.2% or 1.09 million people. The share of the population that has basic skills increased from 47.0% to 52.2% (Digital Literacy of the Population of Ukraine, 2021). To understand the level of complexity of these skills: basic involves writing an email, and standard involves creating an electronic presentation.

Figure 2. Digital skills map of Ukraine, 2021



Source: (Digital literacy of the population of Ukraine, Ministry of Digital Transformation, 2021)

At the same time, 31% of the population of Ukraine is concerned that their digital skills are not good enough. 44.4% of Ukrainians aged 18-70 are interested in improving their digital skills. From the above, we conclude that Ukraine is undergoing a stage of rapid adaptation to the mass introduction and spread of digital technologies in society and the economy: among the population, businesses, and government officials. Digital development in Ukraine is gaining momentum. At the same time, there is a gap between its capabilities and access to it, that is, a dysfunction of human needs and the ability of the environment to satisfy them.

Eight indicators were selected for each of Ukraine's regions using the above-described methodology to study the digital inequality of Ukraine's regions. The input indicators are given in Table 2; their actual values are in Table 3. Since such statistics are not collected regularly, dynamic generalizations were excluded - the indicators were formed as possible, so the year is displayed in the table with input indicators (Tables 2 and Table 3). For meaningful interpretation, they are grouped into signs of the development of digital inequality. At the same time, all indicators were stimulants.

Table 2. Input indicators for the study of digital inequality in the regions of Ukraine

Feature	Indicators	Year of indicators forming
Digital skills and possibilities of their formation	digital skills (the level of possession of digital skills at the level of "average" and above), % of respondents in the survey (x_1);	2021
	the average score of the final exam for the matriculation certificate in English (x_6);	average for 2018-2019
Employment in IT sphere	the number of individuals - entrepreneurs for the provision of IT services, per 1000 people of the population[a] (x_2);	2020
	median salary level of IT specialists, $ per month (x_5);	2020
Employment on digital platforms	distribution of digital platform workers by region of residence, % (x_4);	2017
Ability to solve everyday problems through digital platforms	distribution of Monobank cardholders by region[b], % (x_3);	2019
Availability of digital networks	share of households with access to Internet services at home, % (x_7); the volume of implemented services to the population in the field of telecommunications and postal communication, in actual prices including VAT; UAH (national currency) per person of permanent population (x_8)	average for 2018-2019

[a] most specialists working in IT in Ukraine are registered individuals – entrepreneurs.

[b] Monobank – a fully digital Ukrainian bank.

Source: concluded by the authors on the basis of (SSSU; Rating of DOU cities, 2021; ILO, 2018; MDT, 2021; UCEQA, 2020; Monobank, 2019)

Table 3. Actual values of input indicators for the study of digital inequality in the regions of Ukraine.

Region	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8
Vinnytsia region	47,9	2,21	3,1	1,9	1340	155,4	59,75	420,99
Volyn region	52,2	1,13	1,9	0,7	1000	146,3	51,30	449,79
Dnipropetrovsk region	47,2	3,24	11,8	9,2	1500	149,0	78,60	444,59
Donetsk region	47,2	0,64	4,0	2,3	1000	144,8	60,80	454,93
Zhytomyr region	52,1	1,81	1,9	1,3	1400	141,5	46,30	444,65
Zakarpattia region	52,2	0,90	1,9	0,5	1500	144,3	73,30	440,96
Zaporizhzhia region	47,2	2,33	5,0	4,2	1050	146,0	66,25	542,38
Ivano-Frankivsk region	52,2	1,45	1,9	1,4	1400	144,5	59,15	415,33
Kiev region	52,1	7,86	6,1	6,0	2300	150,5	57,50	414,49
Kirovohrad region	47,9	1,26	1,9	1,0	1120	146,0	52,20	460,49
Lugansk region	47,2	0,56	1,9	0,9	1000	145,7	60,85	393,34
Lviv region	52,2	4,95	6,7	6,1	1825	140,0	65,80	456,90
Mykolaiv region	36,0	3,35	1,9	1,5	1200	151,9	63,05	582,36

Odessa region	36,0	2,44	6,5	5,4	1500	142,4	66,50	834,06
Poltava region	47,9	1,57	3,1	3,1	1300	145,0	55,40	593,16
Rivne region	52,2	1,29	1,9	1,7	1387	146,6	58,40	385,87
Sumy region	52,1	1,53	1,9	1,7	960	147,8	65,00	528,46
Ternopil region	52,2	1,22	1,9	0,6	1000	145,8	61,90	461,58
Kharkiv region	47,2	6,35	7,8	7,6	1600	150,0	64,10	597,03
Kherson region	36,0	1,47	1,9	1,9	1140	148,1	52,00	599,07
Khmelnytsky region	52,2	1,36	1,9	2,2	1100	142,9	50,40	353,46
Cherkasy region	47,9	2,22	1,9	2,2	1150	145,9	54,10	465,95
Chernivtsi region	52,2	1,31	1,9	0,6	1275	147,1	71,60	470,62
Chernihiv region	52,1	1,92	1,9	2,5	1100	149,7	55,25	626,32

Source: concluded by the authors on the basis of (SSSU; Rating of DOU cities, 2021; ILO, 2018; MDT, 2021; UCEQA, 2020; Monobank, 2019)

Some notes to indicators. The indicator of digital skills is obtained from a survey conducted by the Ministry of Digital Transformation in 2021 according to the methodology of the European Commission for calculating the Digital economy and society index, which includes, in particular, the indicator of the level of possession of digital skills (basic, above basic, basic software skills) by the population (MDT, 2021). The latter is formed based on the premise that the respondents during the last three months carried out a specific activity on the Internet, which refers to their performance of informational (working with files, data), communication (messaging, using social networks, correspondence, calls on the Internet) functions, problem-solving skills (online banking, online learning, online shopping, etc.) and software skills (using programs, writing them, etc.). In this context, the content of the indicator of Monobank cardholders (x_3) precisely reflects the level of formation of problem-solving skills through digital platforms.

The average score from the final exams for the matriculation certificate English language test was entered into the data set because, according to focus group surveys and in-depth interviews conducted within the scope of the study (ILO, 2018), most often among all, including Ukrainian, English is the primary working language in employment on digital platforms. Therefore, having it is necessary for success in the digital sphere. The data source is the website of the Ukrainian Center for Educational Quality Assessment (UCEQA, 2020).

The median salary level of IT specialists is obtained from a survey conducted by the DOU platform (Rating of DOU cities, 2021). It refers to wages in regional centers, which form the most employment in this field by region.

Employment on digital platforms is freelance, mainly, related to work with texts, programming, and creating and maintaining sites. The data are obtained from a survey conducted by the Kyiv International Institute of Sociology on behalf of the International Labour Office in the second half of 2017 (ILO, 2018).

The results of the calculations carried out in the application package of the Statistica program are presented in Table 4. Classification accuracy in all groups is 100, and Wilks's lambda is 0.02195 (the smaller the value, the higher the resolution of the discriminant function). Visualization and generalization of the classification are presented in Table 4 and Figures 4 and 5. Classification groups of regions with lower inequality are in a better position. The map visualizes in a darker color those regions with a low level of digital literacy and inclusion of the population in digital activities.

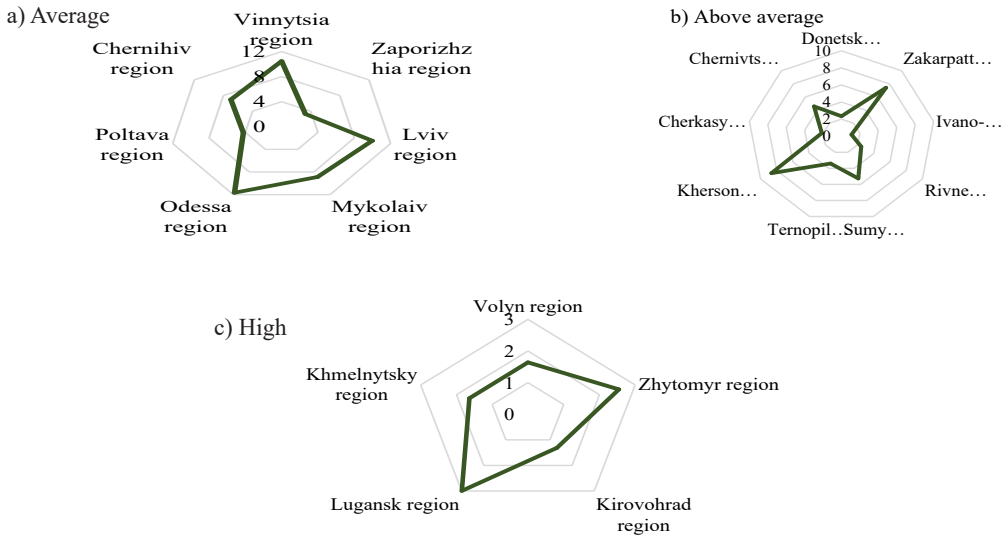
Table 4. Classification of regions of Ukraine according to digital inequality

Classification groups	Region
Extremely low	Kharkiv region
Low	Dnipropetrovsk region, Kiev region
Average	Vinnytsia region, Zaporizhzhia region, Lviv region, Mykolaiv region, Odessa region, Poltava region, Chernihiv region
Above average	Donetsk region, Ivano-Frankivsk region, Zakarpattia region, Rivne region, Sumy region, Ternopil region, Kherson region, Cherkasy region, Chernivtsi region
High	Volyn region, Zhytomyr region, Kirovohrad region, Lugansk region, Khmelnytsky region

Source: summarized by the authors based on their own calculations.

The results of the analysis are remarkable. By a significant margin, the Kharkiv region fell into the group with an extremely low level. The group with a low level was also represented by Kyiv and Dnipropetrovsk regions. The question arises about the Lviv region, in which IT and digital literacy development is one of the highest in Ukraine and which, according to the results, entered the group with an average level. The answer to this lies in the indicators that made the most significant contribution to the differentiation of groups: (a) employment on digital platforms (*F-remove* = 24.6); (b) the results of the English language test (16.75); (c) the salary of IT workers (4.28); (d) volume of telecommunication services per 1 inhabitant of the region (3.12), equipment of households with Internet access (1.39). Furthermore, if all other indicators (the number of individuals - entrepreneurs in the field of IT - third place in Ukraine after Kyiv and Kharkiv, wages in the IT sector - second after Kyiv) in Lviv region is at a very high level, then the quality of knowledge of the English language - on the last one, which pushed it into the middle group in the classification of regions by the level of digital inequality.

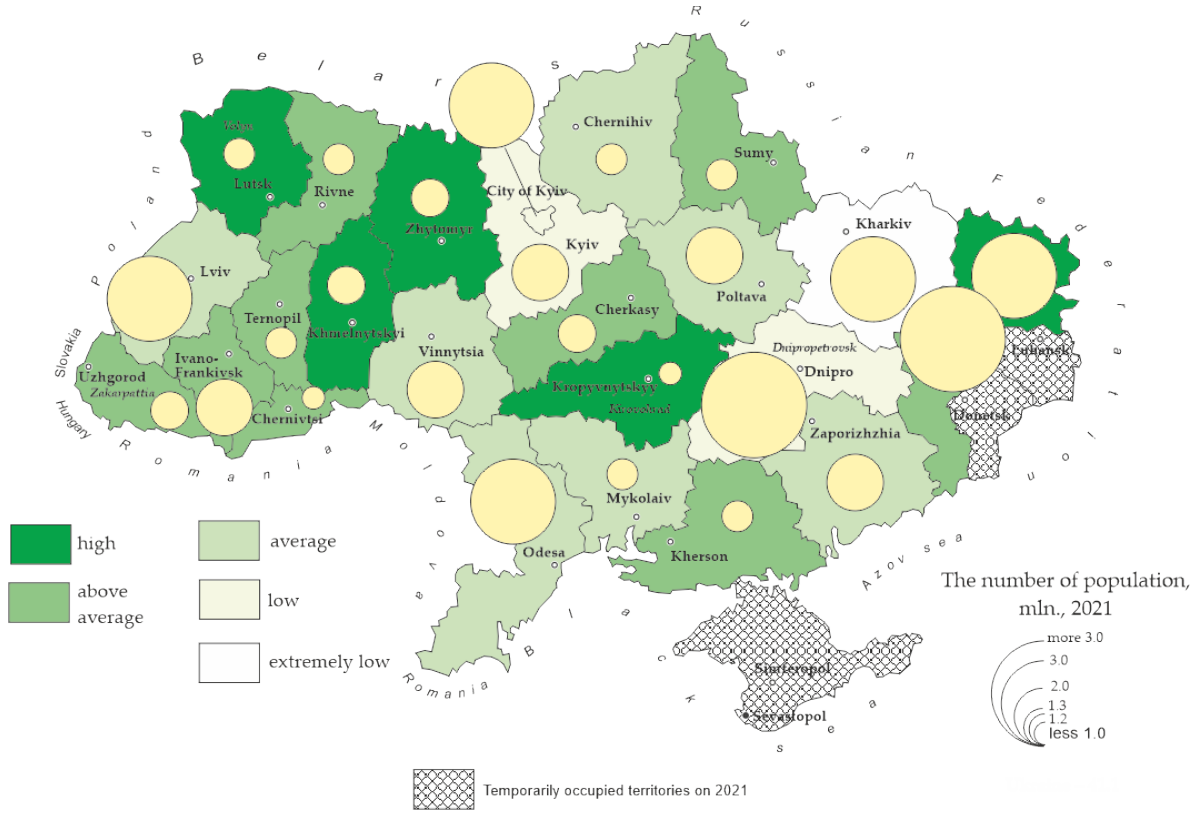
Figure 4. Discriminative groups and Mehalanobis distances from the centroids of groups of regions of Ukraine according to digital inequality:
a) Average; b) Above average; c) High



Source: built by the authors based on their own calculations

It should also be noted that employment on digital platforms, which made the most significant contribution to the differentiation of groups, has the highest value in the Dnipropetrovsk and Kharkiv regions and is not limited to programming (only 12% in the total structure) – it is a wide range of services for works with texts (including the work of bots, the execution of various orders that are not entirely in the sphere of legitimacy), as well as the development of sites. Therefore, the Lviv region is among the pioneers, but only in some digital work and literacy sectors. It should be noted that most indicators of digital literacy (information, communication, problem-solving skills), according to the survey of the Ministry of Digital Transformation (MDT, 2021), are higher in the southern regions of Ukraine.

Figure 5. Cartographic reproduction of the digital inequality differentiation in the regions of Ukraine



Source: visualized by the authors based on their own calculations

Only programming skills are above average in the Western region. Such conclusions testify in favor of the fact that in the formation of educational policy, these patterns should be taken into account, and the specifics of work on digital platforms should be distinguished. Varieties within this type of employment are significant in all respects: legitimization, the complexity of work, and, accordingly, the required level of training, duration of working hours, and earnings. For example, if the median salary of an IT specialist in the Lviv region is $1,825 in 2020 (Rating of DOU cities, 2021), then income is often a part-time job on digital platforms. Earnings for primary employment are, on average, $120 per week and $500 per month (at the rate of the National Bank of Ukraine), and as part-time jobs – $50 and $200, respectively (ILO, 2018).

6. CONCLUSIONS

Therefore, taking into account that the digital world is rapidly penetrating all spheres of life, that is, the processes of digitalization of the economy of Ukraine are objective and irreversible, and the fundamental principles of educational policy for the development of digital literacy and overcoming digital gaps should become:

1) Promoting the development and provision of educational services to increase the digital literacy of the population for daily tasks and employment to minimize the gaps between the digital environment and the skills of people, especially those who are more difficult to adapt.

2) Development of networks for learning and improving knowledge of a foreign language, both for young people and for other generations, taking into account the specifics of age and the necessary level of mastery for comfortable inclusion in digital reality.

3) Promotion of the development of all types of employment on digital platforms within the limits of legality in the context of future transformations of types of employment.

4) Taking into account the aspects of the differentiation of the regions of Ukraine by digital inequality to overcome it.

In performing the first two tasks, informal education operators can play an important role, since state institutions are not sufficiently mobile. When developing policy measures, it should be taken into account that digital reality, as a completely new sphere of life, contains risks: information risks, risks of loss of employment, and security risks. Another useful way to improve the digitalization of education is to involve as many students as possible, as well as teachers, in the online learning process on open online courses providers such as Coursera and Udemy, which collaborate with universities and other organizations and offer online courses, certificates and degrees in various subjects. Both online learning platforms have many advantages, including the fact that the courses are vetted and offered by prestigious universities, meaning they already have academic value.

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