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Digital Competence of Young Adults in Poland

Abstract: Digital transformation is a challenge for many areas of modern society functioning. The effects of digitalisation are particularly noticeable in the labour market and are expressed, among others, in new requirements of employers both for professionally active people and those entering the labour market. Technological advances and automation are reducing the number of low-skilled jobs. Moreover, employees are required to be more flexible. As a consequence, there is a need to adapt to changing trends in the labour market, and to constantly learn and acquire new competences, including digital competences.

This paper aims to identify vulnerabilities regarding digital competences and their determinants amongst young adults in Poland. Furthermore, detailed objectives were defined: (1) assessment of the level of digital competences of young adults in Poland; (2) identification of the gaps in this area; (3) identification of factors differentiating the level of digital competences. The catalogue of competences under study was taken from the European Digital Competence Framework, which includes 21 digital competences grouped into five areas: (information and data literacy; communication and collaboration; digital content creation; safety; problem solving). To achieve the objective, a nationwide survey was conducted. The sample consisted of 1,000 young adult respondents (aged 18–30), with at least secondary education, selected by quotas from panel participants.

The research methods used statistical analysis, including descriptive statistics, regression modelling (stepwise regression), as well as t-tests for independent samples, and One-Way ANOVA.
Research results indicate that digital competences of young adults vary depending on the area. The respondents are aware of their insufficient skills, especially in the area of digital content creation (skills connected with programming). A relatively considerable share of individuals have no intention of acquiring these competences as part of lifelong learning. Self-assessment of competences also indicates that their level differs due to individuals' gender, age, level of education, and profile of education.

Keywords: education, e-inclusion/exclusion, information society, competence, survey data

JEL: I21, I24, I29

1. Introduction

Ongoing technological transformations as well as digitisation as part of the Fourth Industrial Revolution are one of the most important challenges for education systems. Consequently, a need arises for a multifaceted educational reform that would cover all entities in the education process, i.e., students, teachers, and educational institutions. These changes must also be introduced in the curricula, methods and information & communication technology (ICT) used. The main source of these shifts includes the Internet of Things, artificial intelligence, blockchain, autonomous vehicles, 3D printing, and advanced robotisation (Schwab, 2016). As the global economy moves towards the widespread use of digital tools, employers' requirements for people starting their professional activity in terms of their digital competences and the ability to use, manage, and work with new technologies are growing (Butler-Adam, 2018). Hence, it is important that – from the very beginning – digital competences are developed consciously and systematically in the process of formal education. However, the development of these competences cannot be limited only to the stage of formal education; in view of continuous digital progress, they should be developed and improved as part of lifelong learning. Broadly understood digital and technical competences, which go beyond merely the ability to program, data analysis, and machine operation, and also encompass knowledge of cybersecurity and the ability to solve digital problems (Śledziewska, Włoch, 2020), are one of the key factors preventing digital exclusion. In the 4.0 economy, digital competences are essential skills, hence they are included in the group of key competences (Eger et al., 2018). For the purposes of this article, the definition of digital competences proposed by Ferrari (2012) was adopted. It presents a broad approach to this issue and treats digital competences as a set of knowledge, skills, attitudes, strategies, values, and awareness that are required when using information and communication technologies (ICT) and digital media. On the one hand, this set allows one to perform tasks, solve problems,

communicate, create and share content, and build knowledge. On the other hand, these skills enable work, leisure, participation in digital life, learning, socialising, consumption, and empowerment (Ferrari, 2012).

Research on digital competences in Poland focuses on challenges for the education system and the impact of changes in the area of digitalisation on the labour market. Previous research was based on small samples or used proprietary tools that did not allow for the analysis of research results in an international context (Włoch, Śledziewska, 2019; Skibińska, 2022; Tomczyk, 2023; Tomczyk et al., 2023). Hence, in this article, there is an attempt to measure the level of digital competences of young adults in Poland and the competence gap in this area using the European Digital Competence Framework methodology. This methodology is used on a large scale for self-assessment of digital competences of citizens of individual European Union (EU) countries and enables international comparisons. This is also the novelty factor in the article.

Bearing in mind the above-presented premises, the research problem undertaken was formulated in the form of the following questions: (1) What is the level of digital competences of young adults in Poland? (2) What are the gaps in their digital competences? (3) What factors differentiate the level of individual digital competences in the surveyed group?

This paper aims to identify vulnerabilities regarding digital competences and their determinants among young adults in Poland. Furthermore, detailed objectives of the study were defined: (1) assessment of the level of digital competences of young adults in Poland; (2) identification of the gaps in this area; (3) identification of factors differentiating the level of digital competences. The research methods used in the paper include, in the review section, a critical analysis of the literature and a synthesis of the emerging conclusions. In the empirical part, we analysed the outcomes of the questionnaire conducted among young adults in Poland. The research used statistical analysis, including descriptive statistics, regression modelling (stepwise regression), as well as t-tests for independent samples, and One-Way ANOVA.

2. Literature Review

The term ‘digital competence’ was first mentioned in the literature in the late 1990s and was understood as the ability to use digital technologies (Gilster, 1997). Both the subject literature as well as public policy documents use the term digital competences interchangeably with other terms. For instance, Amiel and Sargent (2004) reaches for the term ‘technology literacy,’ Coiro, Knobel, and Lankshear (2014) – ‘new literacies,’ while other authors choose ‘information literacy’ (Buckingham, 2003; Andretta, 2007; Hartley et al., 2008). Nevertheless, the most common mentions are digital competence and digital literacy. Despite a close relationship between them, these words have a somewhat different meaning. Ilomäki et al. (2016) indicate that ‘digital competence’ refers to the skills that people in today’s society should possess. On the other hand, Paynton (2012) understands digital literacy as the integration of computer literacy, information literacy, and media literacy.

Irrespective of the nomenclature used in the so-called e-permeated society (Martin, Grudziecki, 2006) of today, command of ICT is a basic skill needed to function in society (Gilster, 1997), an essential requirement for life (Bawden, 2008); some researchers even perceive it as a survival skill (Eshet-Alkalai, 2004).

In 2011, Ala-Mutka extended the definition of digital competences, indicating that 'digital competences encompass instrumental knowledge and the skills for tool and media usage; advanced skills and knowledge for communication and collaboration, information management, learning and problem solving, and meaningful participation; and attitudes towards strategic skill usage in intercultural, critical, creative, responsible and autonomous ways' (Ala-Mutka, 2011). The proposed approach is universal and requires further conceptualisation to make it applicable to specific target groups. Hoel and Holtkamp (2012) also indicate the need for a specific context in defining digital competences.

In turn, Calvani, Fini, and Ranieri (2010) highlighted the interdependence between the three dimensions of digital competence, namely technological, cognitive, and ethical. Ilomäki et al. (2016) also point out that it is a complex matter. The authors have put forward that digital competences include practical skills in using digital technologies, the ability to use them in a meaningful manner, understanding digital technologies, as well as engaging and participating in digital culture. A systematic overview of the definition of digital competences according to five criteria (terminology used, framework proposed, publication, empirical evidence, sample) can be found in Oberländer, Beinicke, and Bipp (2020). On the other hand, Brown, George, and Mehaffey-Kultgen (2018: 84) define digital competence as 'the set of knowledge, skills, attitudes, abilities, strategies and awareness that is required when using ICT and digital media to perform tasks, solve problems, communicate, manage information, behave in an ethical and responsible way, collaborate, create and share content and knowledge for work, leisure, participation, learning, socialising, empowerment and consumerism.'

Digital competences can be classified into four general categories: 1) professional, 2) methodical expertise, 3) social competence and 4) self-competence (Hubschmid-Vierheilig et al., 2019). The interconnection of machines, products, materials, robots and other technologies (Hubschmid-Vierheilig et al., 2019) has increased the significance of technological expertise. Although not all employees are engaged in professions connected to new technologies, it is more and more common for the modern labour market to require skilled use of information systems. Hence, Abele (2017) claim that every employee should understand how technologies work and how they can be 'operated.' Moreover, employees of the future should have programming skills, legal knowledge (e.g., in the field of data protection regulations and the ability to protect their own identity), and general business know-how (Abele, 2017). The conclusion must therefore be that a person with professional digital competences has a general interdisciplinary knowledge and understanding of the connections between different disciplines (Davies, 2011).

The demand for methodical expertise is rooted in the exponentially growing number of information streams and the era of data overload. Hence, data must be prioritised and selected according to the needs of a given entity. This is impossible in the absence of analytical competences

such as critical, process-oriented and networked thinking (Davies, 2011; Ashoff, 2017). Alongside the ability to operate and select Big Data, employees must also be able to analyse, evaluate and contextualise the data provided (Grzybowska, Lupicka, 2017).

Digital social competences refer to advanced skills in using electronic communication and creating relevant web content, as well as the ability to communicate freely via social media, along with tools that enable distance participation in meetings (Susskind, Susskind, 2015). These competences become essential in connection with the evolution of business models, the development of e-commerce, and online consulting services. In the context of digitisation, social competences take on a new meaning due to progressing virtualisation of remote cooperation.

Digitisation also involves the continuous evolution of digital self-competence, because it influences the behaviour, attitudes, and sometimes even the personality of people who use technology. Technological progress creates opportunities for employees, and these opportunities result from new forms of work, but it also poses a threat of exclusion from the labour market due to the competency gap. The special influence of digitisation on the labour market was especially prominent amidst the COVID–19 pandemic, when working from home was the most popular option instead of the employer's headquarters (Gajdzik, 2018; Iordache et al., 2021). One of the major challenges in the age of remote work is to maintain work-life balance (Wood et al., 2020). Given the changes in the labour market, the employee of the 21st century should be flexible, resilient, quick to act, open to new solutions, creative, and have the ability to learn and think creatively (Hilton, 2008; Brynjolfsson, McAfee, 2014).

In 2006, the European Union recognised digital skills as key competences that should be developed as part of lifelong learning (Recommendation of the European Parliament and of the Council, 2006). Following the recommendation, digital skills include the use of Information Society Technology (IST) for work, leisure, and communication thanks to ICT skills. These acquirements are associated with the 'use of computers to retrieve, assess, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the Internet' (Recommendation of the European Parliament and of the Council, 2006). The European Commission has predefined digital competence as 'the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society' (Recommendations Council, 2018).

With an intention to support the sustainable and effective adaptation of EU Member States' education and training systems to the digital age, the European Commission has developed the Digital Education Action Plan (2021–2027), which contains a long-term strategic vision for high-quality, inclusive and accessible European digital education. The plan aims to establish a close cooperation between EU countries in order to adapt the education system to the digital era by enhancing the quality of teaching within digital technologies, supporting the digitisation of teaching methods, including distance learning, and providing appropriate infrastructure. The programme spells out two priority areas, namely fostering the development of a high-performing digital education ecosystem as well as enhancing digital skills and competences

for the digital transformation (European Commission, 2020). The paper underscores the need to develop not only basic digital competences but also a good command and understanding of advanced data processing technologies, such as artificial intelligence (AI).

In terms of the disputed digital competences, three documents are particularly vital. The key document on digital competence is the European Digital Competence Framework (Ferrari, 2012). DigComp serves the self-assessment of EU citizens in terms of their digital competences and the development thereof both at the European level and in individual countries. The digital literacy survey covers 21 competences grouped into five areas: information and data literacy, communication and collaboration, digital content creation, safety, and problem solving.

The second document referring to digital competences is the European Framework for the Digital Competence of Educators (DigCompEdu) (Redecker, 2017). The paper encompasses a general reference framework to support the development of digital competences relevant to teachers in Europe at all levels of education, including adult education, general and vocational education and training, education for people with special needs, and non-formal learning.

Finally, the third of the European Framework for Digitally Competent Educational Organisations (DigCompOrg) documents refers to organisational digital capacity. DigCompOrg can be used by learning organisations (i.e., primary, secondary, and VET schools, as well as higher education institutions) to direct the design of tools for the integration and successful implementation of digital learning technologies (Kampylis, Punie, Devine, 2015). There also functions an online tool based on the aforementioned document which is used for the self-assessment of schools: Self-reflection on Effective Learning by Fostering the Use of Innovative Educational Technologies.

The above-mentioned European reference framework (DigComp, DigCompEdu, DigCompOrg/SELFIE) constitutes a platform for exchanging experiences and developing competences at the national, regional, and local level. What is also important is its transnational dimension – a coherent set of tools makes possible self-assessment of digital competences for citizens, students (DigComp), educators (DigCompEdu), and schools (DigCompOrg/SELFIE).

Some important studies have been conducted concerning the phenomena of digital competences and their impact on the labour market in the era of economy 4.0 in Poland. The role of digital competences in the context of achieving sustainable development goals was studied by Bugowski and Trzaska (2023). They pointed out that without an appropriate level of digital skills, it was impossible to achieve sustainable development. In turn, Tomczyk (2023) identifies methodological challenges in the area of measuring digital competences. He recognised ten problems that may affect the proper assessment of the level of digital competences. Among them, he mentioned, for example, the multitude of definitions of digital competences and, consequently, the lack of comparability of research resulting from the use of different indicators. In turn, in the work of Skibińska (2022), potential directions for incorporating digital technologies into educational practice were proposed. Tomczyk et al. (2023) compared digital competences of pedagogical students in Poland and Italy. To achieve the research goal, the authors developed their own survey and used original measurement tools. The research indicates that Polish students have greater theoretical knowledge (e.g., about e-threats and opportunities

resulting from digitalisation), while Italian students assess their digital competences higher in most areas. A slightly different perspective on the issue of digital competences was presented by Włoch and Śledziewska (2019), who examined the relationship between the level of digital, social, and cognitive competences. The justification for this approach to research was the thesis about the complementarity of these three types of competences. However, a detailed set of digital skills was not used in these studies.

3. Research Method

The level of digital competences and the identification of the competence gap were evaluated on the basis of primary data obtained in the course of own research. The original survey questionnaire was based on the subject literature and EU documents, which, among others, enable self-assessment of the level of competences of EU citizens using a coherent set of tools. A nationwide survey using the Computer Assisted Web Interview (CAWI) method on an online panel was conducted by the Public Opinion Research Centre in the fourth quarter of 2020. The survey covered 1,000 young adult respondents (aged 18–30), with at least secondary education, selected by quotas from panel participants. The selection of the age group for the study was dictated by the fact that these are people who will be undertaking professional activity in the near future or have already undertaken it. Their ICT skills are crucial from the point of view of progressive digitalisation. Deficiencies in digital competences of young adults are indicated by employers as one of the most serious threats to the development of the competitiveness of enterprises and the entire economy.

The sample is representative in terms of age, gender, and education. A total 52.4% of respondents were women; 39.9% of the group was formed by people at the age of 18–24, and the remaining 60.1% consisted of people at the age of 25–30. In the study sample, 57.5% had secondary education (completed technical school or high school), while 42.5% had tertiary education (first-cycle, first- and second-cycle studies, or uniform master's degree). As regards the education profile, 26% studied or graduated with a degree in economics, 24% with a degree in humanities (including law), 33% with a degree in exact sciences (mathematics, physics, engineering, computer science), and 16% with degrees in other fields (medicine, tourism, physical education, etc.).

The catalogue of competences under study was taken from the European Digital Competence Framework (DigComp) (Ferrari, 2013). The digital competence survey covered 21 competences grouped into five areas:

1) information and data literacy,
2) communication and collaboration,
3) digital content creation,
4) safety,
5) problem solving.

The respondents evaluated individual skills on a Likert scale (from 1 to 5); additionally, a possible answer was that one is unable to self-assess the level of a given competence in themselves. According to the DigComp methodology, an individual fluent in these five areas who is able to use the functions of digital technologies is considered a person with digital competence.

The research methods used statistical analysis, including descriptive statistics, regression modelling (stepwise regression), as well as t-tests for independent samples. Stepwise regression involves a step-by-step iterative selection of independent variables to be used in a final model. It consists in adding or removing potential explanatory variables in succession and testing for statistical significance and measuring the coefficient of determination after each iteration (Ruengvirayudh, Brooks, 2016). The most common application of the t-test is to examine whether the means of two populations are different. Here, the null hypothesis assumes that the mean values in the studied populations are equal to the alternative hypothesis, which is that the mean values in the studied populations vary. Demonstrating that the mean values in two populations differ from each other in a statistically significant manner proves that the differentiating factor for these populations affects the level of the examined variable (Aczel, Sounderpandian, 2008). The t-test was conducted for individual diagnostic variables (21), competence areas (5), and total digital competences by gender, age, and education level. The impact of education profile on diagnostic variables was examined using One-Way ANOVA. This test enables to compare the average level of variables between more than two populations. Rejecting the null hypothesis means that not all pairs of means are equal. Determining between which groups there exist statistically significant differences requires conducting appropriate post-hoc tests (Aczel, Sounderpandian, 2008).

4. Results

The results presented in Table 1 and Figure 1 were obtained based on the research questions posed and the objectives set. As a starting point, the descriptive statistics for general digital competence as well as the five analysed areas of digital competence were calculated (Table 1).

Table 1. Descriptive statistics for areas of digital competence

Area	Mean	Std. Dev.	Median	Q25	Q75
Information and data literacy	4.13	0.78	4.33	3.67	4.67
Communication and collaboration	3.77	0.78	3.83	3.33	4.33
Digital content creation	3.33	0.84	3.25	2.75	4.00
Safety	3.65	0.82	3.75	3.00	4.25
Problem solving	3.64	0.85	3.75	3.00	4.25
General digital competence	3.69	0.71	3.71	3.29	4.19

Source: own elaboration

The overall assessment of digital competence is 3.69, which should be considered insufficient because a digitally competent person should not only use the functions of digital technologies but also possess digital skills in all five areas (Ferrari, 2013). The highest-rated area is information and data literacy, where the average is 4.13, which is higher than that for other areas by 9% to 24%. In the first area, the respondents rated their skills in browsing, searching and filtering data, information and digital content as the highest (average 4.33). This is also the highest-rated skill among the 21 surveyed skills. However, in the cases of the other two types of skills in the same area, i.e., 1) evaluating data, information and digital content, and 2) managing data, information and digital content, the average rating was 4.00 and 4.04, respectively (Figure 1).

The lowest score in the self-assessment performed by the respondents concerns digital content creation. Here, the average rating is merely 3.33. The greatest impact on such a low overall rating was the self-assessment of programming skills, which averages 2.33. This is the lowest rated competence among all the respondents. The self-assessment of other skills in this group (developing digital content, integrating and re-elaborating digital content, copyright and licenses) ranged from 3.58 to 3.83.

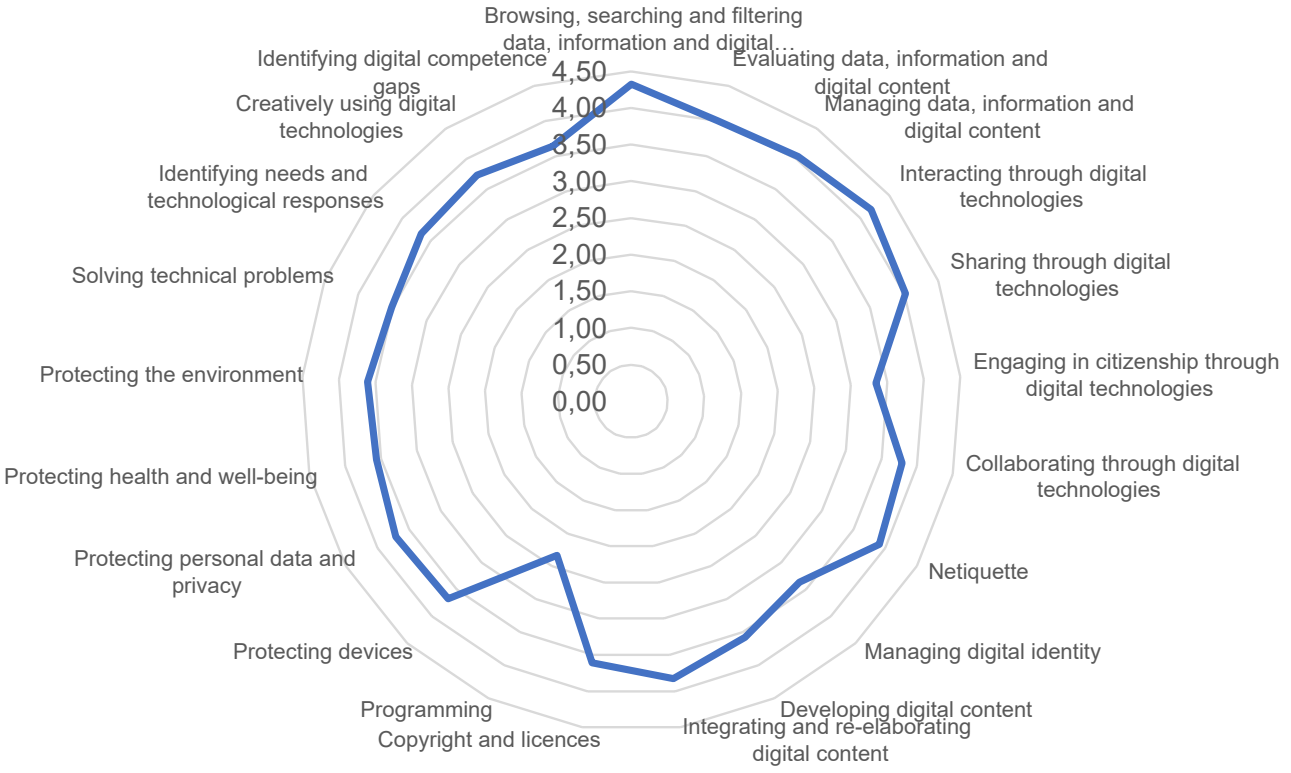

Figure 1. Radar chart of average grades for individual digital competences
Source: own elaboration

The competences in the remaining areas (communication and collaboration, safety, problem solving) were rated at a similar level (3.77, 3.65 and 3.64, respectively). The greatest differences in the assessment of individual skills are visible in the case of communication and collaboration. The respondents rated their skills regarding interacting and sharing through digital technologies the highest (average rating is 4.19 and 4.01, respectively), but their skills in engaging

in citizenship through digital technologies and managing digital identity scored much lower (average 3.35 and 3.37, respectively). As regards safety and problem solving, all competences were rated between 3.5 and 3.75.

In order to determine the impact of particular digital competences on the overall assessment made by the respondents, a backward stepwise regression was used. The results are summarised in Table 2.

Table 2. The results of parameter estimation of the stepwise regression model for general digital competences

Specification	Coefficient	Standard error	t(773)	p-value
Intercept	0.709 863	0.120 009	5.915 068	0.000 000
Managing data, information and digital content	0.109 014	0.031 755	3.432 951	0.000 629
Collaborating through digital technologies	0.137 235	0.032 245	4.256 011	0.000 023
Managing digital identity	0.119 008	0.029 120	4.086 748	0.000 048
Developing digital content	0.091 333	0.028 702	3.182 107	0.001 521
Programming	0.081 808	0.023 533	3.476 261	0.000 537
Solving technical problems	0.147 555	0.029 632	4.979 513	0.000 001
Identifying digital competence gaps	0.155 046	0.033 277	4.659 225	0.000 004
R = 0.68692892, R^2 = 0.47187134, Adjusted R^2 = 0.46708881, F(7.773) = 98.666, p < 0.0000				

Source: own elaboration

The results of the regression analysis indicate that the overall assessment of digital competences is most affected by problem solving skills, which are related to the possession of specialist knowledge, specifically identifying digital competence gaps and solving technical problems. Other relevant skills are collaborating through digital technologies (from the area of communication and collaboration) and managing data, information and digital content (included in information and data literacy). The first of them consists in using digital tools and technologies to collaborate and to jointly create resources and knowledge. Meanwhile, the other involves organising, storing and retrieving data, information and content in digital environments. Communication and collaboration skills, which also affect the overall assessment of digital competences, involve managing digital identity and programming as well as developing digital content (from the field of digital content creation), whereby the latter are among the lowest rated by the respondents.

In a further step, we verified whether the assessment of competences depends on gender. As can be seen in Table 3, the average overall digital competence rating for men is 3.75, while for women this value is lower by 0.15. The difference is statistically significant (p = 0.0143).

Table 3. Gender-based t-test for general digital competences

Specification	Mean men	Mean women	t	df	p-value	Std. dev. men	Std. dev. women
General digital competences	3.75	3.60	2.45	967	0.0143	1.0074	0.9407

Source: own elaboration

Despite the fact that the general assessment of digital competences is unequivocally higher among men, this assessment is diversified in the case of individual digital skills. For competences from the first of these areas, the average score for all skills was higher in women, while the difference for evaluating data, information and digital content was statistically insignificant. From among the six skills from the second area, the average score for men was higher only for managing digital identity (3.47 for men and 3.29 for women, $p = 0.0166$). Interacting through digital technologies, engaging in citizenship through digital technologies and netiquette achieved higher average scores for women. The differences were statistically significant. The major difference in the ratings concerned civic activity (for men the rating was 3.19, and for women it was higher by 0.31, $p = 0.000056$). For the remaining variables (sharing through digital technologies and collaborating through digital technologies), the scores were slightly higher among women, but the difference was not statistically significant. In the area of digital content creation, a statistically significant difference was observed only for programming. The mean score for men was 2.56, which was higher by 0.44 than in women ($p = 0.0000$). As with the previous area, also in the case of safety, there was a statistically significant difference for one skill, namely protecting health and well-being. Skills in this field were rated much higher by women (3.70, average rating for men 3.42, $p = 0.000024$). In the last of the studied areas, problem solving, the assessment of only one skill was statistically significantly different between men and women. As is the case with programming, men rated the solving technical problems competence higher. The mean score was 3.76 and only 3.28 for women ($p = 0.0000$).

Considerably smaller differences in the assessment of competencies occur due to age. In the group of young adults, there were statistically significant differences only in the assessment of three competences. This concerned collaborating through digital technologies, netiquette and protecting health and well-being. With the first two, higher average ratings were recorded for the 18–24 age group – 3.87 and 3.99, respectively. For the age group 25–30, they were lower by about 0.15 (p-values were 0.042467 and 0.038429 respectively). The average assessment of skills in the field of protecting health and well-being is higher in the age group 25–30, specifically, it is 3.63, i.e., 0.16 higher than in the age group 18–24 ($p = 0.0197$). If we consider somebody who is digitally competent to be a person who self-assessed that they possessed those skills to a high or very high degree, then the greatest number of digitally competent people can be found in the age group of 21-year-olds (70.77%). Amongst 18- and 19-year-olds, these individuals constitute a share of 66.67%. As for the other age groups, the percentage ranges from 53.33 to 61.54.

To evaluate the impact of education on the level of digital competences, a t-test was conducted in order to assess competences given the level of education. For all statistically significant differences, higher mean scores were recorded among the respondents with higher education (Table 4). The biggest difference in the assessment within the area of information and data literacy concerns browsing, searching and filtering data. People with higher education self-assessed their level of these competences on average at 4.46, while the average rating among the respondents with secondary education was 4.23.

As regards communication and collaboration, the largest statistically significant differences concern netiquette and sharing through digital technologies. The assessments of these variables in the group of respondents with higher education are higher by 0.22 and 0.20, respectively than in those with secondary education. There were also significant statistical differences for interacting through digital technologies and engaging in citizenship through digital technologies.

Table 4. T-test for digital competences due to the level of education

Specification	Mean secondary	Mean tertiary	t	df	p-value	Std. dev. secondary	Std. dev. tertiary
Browsing, searching and filtering data, information and digital content	4.23	4.46	– 4.1068	942	0.0000	0.94	0.78
Evaluating data, information and digital content	3.93	4.10	– 2.8872	962	0.0040	0.94	0.87
Managing data, information and digital content	3.96	4.15	– 2.9031	956	0.0038	1.07	0.96
Interacting through digital technologies	4.13	4.27	– 2.3055	940	0.0214	0.92	0.88
Sharing through digital technologies	3.93	4.13	– 3.2020	955	0.0014	0.98	0.95
Engaging in citizenship through digital technologies	3.28	3.44	– 1.9866	964	0.0472	1.20	1.17
Collaborating through digital technologies	3.73	3.86	– 1.8564	955	0.0637	1.07	1.04
Netiquette	3.81	4.03	– 3.1432	956	0.0017	1.11	1.02
Managing digital identity	3.38	3.36	0.2864	960	0.7746	1.19	1.14
Developing digital content	3.51	3.67	– 2.2022	966	0.0279	1.12	1.14
Integrating and re-elaborating digital content	3.74	3.95	– 3.2115	957	0.0014	1.06	0.98
Copyright and licences	3.51	3.74	– 3.1707	943	0.0016	1.10	1.11
Programming	2.38	2.26	1.4105	983	0.1587	1.23	1.30
Protecting devices	3.60	3.79	– 2.7072	968	0.0069	1.10	1.02
Protecting personal data and privacy	3.68	3.74	– 0.8374	970	0.4026	1.06	1.04

Specification	Mean secondary	Mean tertiary	t	df	p-value	Std. dev. secondary	Std. dev. tertiary
Protecting health and well-being	3.46	3.72	– 3.8353	961	0.0001	1.07	0.98
Protecting the environment	3.56	3.67	– 1.6041	964	0.1090	1.05	0.97
Solving technical problems	3.55	3.45	1.4125	972	0.1581	1.12	1.06
Identifying needs and technological responses	3.62	3.73	– 1.6282	954	0.1038	1.03	1.01
Creatively using digital technologies	3.69	3.80	– 1.7533	966	0.0799	1.06	1.01
Identifying digital competence gaps	3.61	3.67	– 0.8476	968	0.3969	1.08	1.06

Source: own elaboration

Looking at the field of digital content creation, it is only in the case of programming that the differences in ratings were statistically insignificant. The biggest difference in the assessment between those with higher vs. secondary education amongst the other three skills concerned copyright and licences and amounted to 0.23. In the fourth area, namely safety, people with higher education rated their skills in protecting devices as well as health and well-being higher than individuals with secondary education. The largest difference was evident for the second of these skills and amounted to 0.26, making it the biggest variation between the assessment of competences among people with secondary and higher education. On the other hand, education does not differentiate the level of assessment of any of the possessed skills that are part of problem solving.

Analysis of the assessment of competences according to education profile brings interesting conclusions. The respondents who graduated from technical and engineering studies (including IT and telecommunications) rank their general digital competences significantly higher. The average score in this group is 3.79, while for people with a different education profile it is 3.45 ($p = 0.0426$). However, the analysis of the assessment of each individual skill amongst a total of 21 makes it clear that a significantly higher rating in the group with a technical and engineering education profile applies only to the skill of developing digital content (average equal to 3.79, 0.39 higher than in individuals with a different education profile, $p = 0.0177$).

5. Discussion

The research shows that the respondents are aware of their insufficient knowledge and skills in the area of new technologies. The competence gap concerns the advanced use and creation of digital content in particular. Especially worrying are gaps in competences that allow to participate in society through public and private digital services. This tendency results from a low level of digital self-sufficiency which is part of digital self-competence (Hubschmid-Vierheilig

et al., 2019). The diversified level of digital competence within individual areas is confirmed by the results obtained by López-Meneses et al. (2020). The surveyed students had clearly higher competences in information and data literacy and communication and collaboration, which were rated at the upper intermediate level, than in digital content creation. Here the assessment was at the lower intermediate level. In light of these results, the creation and management of a digital identity is also an issue. In conjunction with a relatively low self-assessment of competence in the area of safety, this raises concerns about the proper protection of one's own 'digital reputation' in the context of ever-developing cybercrime. Failure to ensure an adequate level of safety when using digital tools can cause irreparable material, financial, and personal damage (AT&T, 2016).

Stepwise regression allowed us to identify individual digital skills that have the greatest impact on the assessment of the overall level of competence. In this context, it should be stated that the mere awareness of the lack of knowledge or skills in a specific ICT area is essential to improve or update one's own digital competences. This requires constantly keeping up-to-date with the digital evolution, which in turn facilitates identifying and solving technical problems when working in a digital environment. On the other hand, collaborating through digital technologies is largely vital in working with big data, which is one of the basic sources of competitive advantage for enterprises in the era of digitisation (Sharma, Mithas, Kankanhalli, 2014). In light of the conducted research, the most important among the identified skills are those that were rated particularly low by the respondents (programming and developing digital content). This indicates that the respondents are aware of the existence of a competency gap and that they recognise the necessity of developing and improving skills in various areas related to digitisation, even as advanced as programming, in order to be considered a digitally competent person (Wong, Cheung, 2020; Wei et al., 2021).

While in the case of available research results regarding the differentiation of the level of individual digital skills, programming is one of the lowest rated competences, taking into account the impact of gender on the level of competences, there is no consensus in the literature. The higher self-assessment of general digital competences in men is confirmed by the results of research conducted by Eurostat. At the level of all European Union countries, the share of individuals having at least basic digital skills for men was 55.62, while for women it was 52.26 (Eurostat, 2021a). The overall higher assessment of men's digital competences has also been demonstrated in Wild and Heuling (2020), Lucas et al. (2021), and Gnambs (2021). However, the results of Bordas-Beltrán and de Guadalupe Arras-Vota (2018) and Siddiq and Scherer (2019) indicate that women possess higher digital competences.

Guillén Gámez and Perrino Peña (2020), Basantes-Andrade, Cabezas-González, and Casillas-Martín (2020) and Rodríguez, Cantabrana, and Cervera (2020) obtained different results, pointing to the lack of differentiation of the general level of competences by gender. Basantes-Andrade, Cabezas-González, and Casillas-Martín (2020) only prove gender dependence in terms of two out of five groups of competences analysed: the cloud storage and the interaction of social network. Vázquez-Cano, Meneses, and García-Garzón (2017), who performed a study among students which examined their basic digital competences, indicate that men assess

their competences higher in digital cartography and in developing online presentations. Women, on the other hand, prefer personal tutorials to solve technology-related problems and rate their e-mail skills higher. Students' digital competences have also been studied by Casillas et al. (2017). Based on students' self-assessment, they found that men score higher than women on ICT knowledge and use, while women achieve a higher score in positive attitudes towards new technologies.

The results of hitherto studies do not allow for an unambiguous evaluation of the influence of gender on the level of perceived competence. In view of most findings, it is men who rate their general digital competences higher, while the analysis of the assessment of individual competences does not confirm this thesis.

While there are no consistent research results on the impact of gender on the level of digital competences, the research results on the impact of age available in the literature confirm the conclusions obtained as a result of our research. The differences in perceiving own digital competences in favour of those in the group up to 24 compared to people aged 25–29 are confirmed by the results from Eurostat (2021b). Rodríguez, Cantabrana, and Cervera (2020) have reached the same conclusions as well.

The explanation behind such high self-assessment of digital competences in the younger of the surveyed cohorts can be found in Martzoukou et al. (2020), who emphasise that students starting studies are considered a priori competent in the field of digital technologies. In light of research conducted by Bernate et al. (2020), students' competences are at a good level as far as creativity and ICT innovation for the development of new projects are concerned. That said, they have basic digital skills in the scope of evaluating, organising, searching, and processing information. On the other hand, Eger et al. (2018) conducted surveys among students from three countries which did not allow them to clearly state that young people have a high level of ICT skills. It should be noted that regardless of the adopted criteria for evaluating students' digital competences, their level has in fact increased as a result of the COVID–19 pandemic (García-Prieto, López-Aguilar, Delgado-García, 2022).

Meanwhile, despite the current technological transformations, tertiary education approaches the development of digital competences in the same manner as any other literacy. Therefore, it is essential to ask whether this approach could be a source of students' self-assessment of digital competences that does not in fact reflect reality. A similar position is shared by Braverman (2016), who points out that students' belief about the high level of their digital competences may deepen the digital divide due to the lack of education in the field of correcting and developing these skills. Notably, some findings deny the existence of a relationship between age and the level of digital competence (Napal Fraile, Peñalva-Vélez, Mendióroz Lacambra, 2018).

A similarly consistent position concerns the impact of education on the level of digital skills. The results of our research were confirmed by the results of Eurostat studies (2021b) which demonstrate distinct differences in the perception of one's own digital competences. Self-assessment of the level of competence is positively correlated with the level of education. Notably, the variation in the percentage of individuals with at least basic digital competences between

those with the lowest and the highest level of education is very large and, in some countries, it even reaches 50 percentage points (examples include Bulgaria, Greece, and Romania) (Eurostat, 2021b).

The level of education, in addition to age and gender, has also been recognised as a determinant of digital competences by van Laar et al (2020) and Calderón, Sanmartín Ortí and Kuric (2022). Tertiary education has been also identified as an important factor for women's digital inclusion in developing countries (Rashid, 2016). The influence of socio-demographic variables, such as education (as well as gender, age, and employment situation) on ICT skills and the digital divide was studied by Calderón (2019). As a result, he presented the concept of 'technological capital' which enabled him to link the studied variables with the ways of using ICT.

Interestingly, it cannot be considered that people with a technical or even IT education profile have sufficient digital skills to be recognised as digitally competent. This is also an argument pointing toward the need to modify the curricula and to supplement them with courses that allow the development of methodical expertise, social competence, and self-competence not only in the process of formal education but also as part of lifelong learning. However, it is important that not only ICT professionals but everyone, regardless of their profession, participates in the process of acquiring and improving digital competences (Bejaković, Mrnjavac, 2020). More broadly about the importance of digital competences in the labour market and their impact on the quality of work may be found in a study of Curtarelli et al. (2016). In turn, the impact of digitalisation and automation on the labour market from the point of view of 1) differences between socio-demographic groups among European Union citizens, and 2) self-assessment of ICT skills was investigated by Vasilescu et al. (2020). They indicate that the level of education affects ICT skills, which confirms the results of our research. Moreover, they identified people at risk of digital exclusion. These are especially people with a low level of education, manual workers or not working, with a relatively low level of income.

6. Conclusions

New technologies and the knowledge-based economy have a substantial effect on how the labour market operates. The challenge faced by educational institutions, and especially universities, will be not only to keep their curricula up-to-date but also to adapt these curricula to the requirements of the modern labour market and the ongoing digitisation and automation (Williams, 2019). These processes make digital skills essential for having an active presence in the labour market and for preventing digital exclusion. This is true for both specialist digital competences (e.g., programming) and basic skills of using digital tools for performing tasks in various settings (Hecker, Loprest, 2019).

The results of research conducted in the field of self-assessing digital competences grouped into five areas in line with the DigComp methodology, i.e., information, communication, content creation, security and problem solving, clearly demonstrate that the respondents rated their competences highest in the first two areas. On the other end of the spectrum, the respondents

had the least skills in digital content creation. The greatest impact on this state of affairs was the self-assessment of programming skills, which is the lowest rated competence among all 21 surveyed skills. A low self-assessment of competences was also recorded in safety and problem solving. Meanwhile, the skills that make up the latter of the above-mentioned areas have the greatest impact on the overall assessment of digital competences. These skills involve having expertise and include identifying digital competence gaps and solving technical problems.

The research shows that the self-assessment of the level of digital competence depends on several factors. The first of these factors is gender. While in the case of general assessment of digital competences, men assessed their skills significantly higher, this assessment was varied for individual digital skills. Men rated their skills in programming and solving technical problems as well as managing digital identity higher, and women indicated higher scores for interaction by means of digital tools, online civic activity, health protection, and netiquette. The second factor considered was age. Here too, there were differences in the self-assessment of digital competences, whereby it was higher in younger people. The studies also report that self-assessment of digital competences is positively correlated with the level of education. People who have higher education rate both their general level of digital competences and individual skills much better. Higher average skills are also declared by individuals with a technical and engineering education profile.

It needs to be positively assessed that the respondents are aware of their insufficient knowledge and skills in the area of new technologies. Awareness of the lack of knowledge or skills in a specific ICT area is necessary to develop or improve one's own digital competences. This requires following the current trends in digital evolution, which in turn facilitates identifying and solving technical issues when working in a digital setting. Recent years have seen the implementation of various types of programmes aimed at enhancing and developing the society's digital competences, both at the European Union level and in individual countries. Despite the efforts, the deficit of competences is indisputable.

The raised research problem relates to the level of digital competences of young adults in Poland. The conducted research allowed for the identification of theoretical and practical implications. Firstly, developing key competences is a source of benefits both in the economic and social areas. Taking into account the first one, they concern the functioning of the labour market in the era of digitalisation. These competences not only counteract digital exclusion but, above all, increase the productivity of human resources. However, in the social layer, their importance in the context of the education system can be indicated. It results from the need to improve competences through participation in the lifelong learning process, which in turn affects social inclusion. Development of competences includes digital, social and cognitive competences, which are complementary to one another and allow for comprehensive human development.

Whereas in practical dimension, research results can be useful for policy makers. There is a necessity for a comprehensive redefinition of educational policy, in terms of its subjects, goals, content of teaching, and recipients. Changes in education are necessary at all levels, both in compulsory and non-compulsory education. Hence, it is necessary to intensify actions aimed

at reducing the gap in digital competences, which concerns in particular the advanced use and creation of digital content. Especially worrying are insufficient skills in participating in society by means of public and private digital services.

Considering, on the one hand, the respondents' awareness of their deficits in digital competence and, on the other hand, the relatively considerable share of individuals who have no intention of acquiring these competences as part of lifelong learning, further research should centre around recognising the reasons for young adults' lack of interest in developing digital competences. Evaluating the effectiveness of individual tools for shaping digital competences, those used in formal, informal as well as non-formal education, also seems to be an interesting issue.

The presented research is not free from limitations. Firstly, digital competences were analysed only in terms of selected socio-demographic variables (gender, age, level of education, and education profile). Some of the results, such as the relationship between the level of digital competences and gender, are ambiguous, hence there is a need for continued research to develop a model for linking socio-demographic factors with the self-assessment of digital competences. Moreover, due to the time frame of the study in 2020, it is necessary to conduct further research to determine the impact of intensified digitisation processes during and after the COVID–19 pandemic on the level of ICT skills.

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Kompetencje cyfrowe młodych dorosłych w Polsce

Streszczenie: Cyfrowa transformacja stanowi wyzwanie dla wielu obszarów funkcjonowania współczesnego społeczeństwa. Jej skutki są szczególnie zauważalne w przypadku rynku pracy i wyrażają się m.in. nowymi wymaganiami pracodawców – zarówno względem osób aktywnych zawodowo, jak i wchodzących na rynek pracy. Postęp technologiczny i automatyzacja zmniejszają liczbę prac wymagających niskich kwalifikacji. Co więcej, od pracowników wymaga się większej elastyczności. Oznacza to konieczność ciągłego dostosowywania się do zmieniających się trendów na rynku pracy, nieustannego uczenia się i nabywania nowych kompetencji, w tym kompetencji cyfrowych.

Celem niniejszego artykułu jest identyfikacja luk w zakresie kompetencji cyfrowych wśród młodych dorosłych w Polsce i determinant poziomu kompetencji. Ponadto określono cele szczegółowe: 1) ocenę poziomu kompetencji cyfrowych młodych dorosłych w Polsce, 2) identyfikację luk w tym obszarze, 3) identyfikację czynników różnicujących poziom kompetencji cyfrowych.
Katalog kompetencji został zaczerpnięty z European Digital Competence Framework, który obejmuje 21 kompetencji cyfrowych pogrupowanych w pięciu obszarach (umiejętność korzystania z informacji i danych; komunikacja i współpraca; tworzenie treści cyfrowych; bezpieczeństwo; rozwiązywanie problemów). W tym celu przeprowadzono ogólnopolskie badanie na próbie liczącej 1000 respondentów, obejmującej młodych dorosłych (w wieku 18–30 lat) z co najmniej średnim wykształceniem, dobranych kwotowo spośród uczestników panelu. W badaniach zastosowano analizę statystyczną, w tym statystyki opisowe, modelowanie regresyjne (regresja krokowa) oraz test t dla prób niezależnych i jednoczynnikową analizę wariancji.
Wyniki badań wskazują, że kompetencje cyfrowe młodych dorosłych różnią się w zależności od analizowanych obszarów. Respondenci są świadomi swoich niewystarczających kompetencji, szczególnie w obszarze tworzenia treści cyfrowych (umiejętności związane z programowaniem). Znaczny odsetek osób nie ma zamiaru nabywać tych kompetencji w ramach uczenia się przez całe życie. Samoocena kompetencji wskazuje także, że ich poziom różni się ze względu na płeć, wiek, profil i poziom wykształcenia.

Słowa kluczowe: edukacja, e-włączenie/wykluczenie, społeczeństwo informacyjne, kompetencje, badania ankietowe

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