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Digital Competencies in Selected European Countries among University and High-School Students: Programming is lagging behind

Dragana Draganac, Danica Jović
The University of Belgrade, Faculty of Economics and Business, Serbia
Ana Novak
The University of Zagreb, Faculty of Economics and Business, Croatia

Abstract

Background: Constant integration of digital technologies in economic and social life is rapidly and significantly shaping and changing our environment and ourselves. To function in such a world, even in daily routines, it is necessary to possess certain digital competencies. **Objectives:** This paper aims to examine how university and high-school students of economic orientations from selected European countries self-assess their digital competencies, and to analyse the identified differences. This will enable further understanding of university and high-school students' digital competencies that can serve as guidance for improving teaching practices and curricula. **Methods/Approach:** A survey was conducted to collect data that were analysed using non-parametric statistic tests (Mann-Whitney U test and Kruskal-Wallis H test) and Spearman Rank-Order Correlation coefficient. **Results:** University and high-school students consider to have below intermediate level of digital competencies. High-school students self-assessed digital competencies at a higher level than university students. University students of higher years of study self-assessed digital competencies at a higher level. There is no universal pattern among high-school students of different years of study. University students in the Accounting module and high-school students in the Tourism module assessed their digital competencies at the lowest level in several areas. There is a consistency in self-assessment of digital knowledge and digital skills. Conclusions: The identified below intermediate level of digital competencies and discovered discrepancies indicated the need for educational process improvements to provide university and high-school students with a higher degree of digital competencies. Programming is the most lagging behind in all the observed groups.

Keywords: economic education; digitalisation; digital knowledge; digital skills; self-perception; programming

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Introduction

The contemporary world is a digital world where it is crucial to demonstrate an appropriate level of digital knowledge and skills to increase the chances for professional and personal development. This statement is based on two indisputable facts. Firstly, information technologies are being broadly implemented in economic and social life. Secondly, information technologies are available to many of the world's population. Due to the wide application of information technology for private and business purposes and in education, there is a growing emphasis on the importance of possessing digital competencies. Digital competencies are of the utmost importance for the progress of society in general, quality of education, employability, successful integration in the labour market and progress in the career. The intense globalisation and the emergence of the COVID-19 pandemic highlighted the necessity for further development of digital knowledge and skills. The relationship between digitalisation and education is two-way.

On the one hand, education has to provide university and high-school students with an adequate level of digital competencies. On the other hand, the digitalisation fostered by the COVID-19 pandemic faced professors and teachers with the challenge of continuing high-quality teaching in new circumstances. The key motivation for our research was to investigate the relationship between digitalisation and education with the objectives to identify the current level of digital competencies among university and high-school students of economic orientation, find out the space for its improvement through innovations in the curricula and continuous advancement in teaching methods, and give a recommendation to education policymakers.

We strive to answer the following research questions:

- *RQ1. What is the level of university and high-school students' digital competencies by their perception, and are there significant differences across these two groups of respondents?*
- *RQ2. Is there a relationship between the self-assessment of digital knowledge and digital skills among university students as well as among high-school students?*
- *RQ3. Are there significant differences in the self-assessment of digital competencies between university students of different years of study and between high-school students of different years of study?*
- *RQ4. Are there significant differences in the self-assessment of digital competencies between university students of different major areas and between high-school students of different major areas?*

In the following part of this introductory section, we present several concepts related to digitalisation and their meaning and specify which particular definitions we are using in the paper. The term digitisation can be assigned a wide range of meanings depending on the context in which it is used. In its initial meaning, the term denotes the process of converting information stored in the form of text, sound, or image into binary code, in which information is presented in a string of only two digits (zero or one). The process of digitalisation began in the period of production of the first computers, in the sixth decade of the last century. From then to nowadays, the term has been used in more and more different fields in which its meaning was constantly broadening. A range of new terms related to the digitalisation concept has emerged: digitalisation of business, digitalisation of governance, digitalisation of communications, digitalisation of education, digital knowledge, digital skills, digital literacy, and so on.

The terms competence, knowledge, skills, digital competence, digital knowledge and digital skills are defined in the existing literature in many different ways. According to the Council of the European Union (2017, p. 20) "competence means the proven ability to use knowledge, skills and personal, social and/or methodological abilities in work or study situations and professional and personal development", while the term skill means "the ability to apply knowledge and use know-how to complete tasks and solve problems". "In the context of the European Qualifications Framework for lifelong learning (EQF), skills are described as cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments)" (Council of the European Union, 2017, p. 20). The European Parliament and the Council of the European Union (2006, p. 13) define competence as "a combination of knowledge, skills and attitudes appropriate to the context". They recognise "eight key competencies that all individuals need for personal development, active citizenship, social inclusion and employment: 1. communication in the mother tongue, 2. communication in foreign languages, 3. mathematical competence and basic competencies in science and technology, 4. digital competence, 5. learning to learn, 6. social and civic competencies, 7. sense of initiative and entrepreneurship, and 8. cultural awareness and expression" (European Parliament and the Council of the European Union, 2006, p. 13). European Commission (2016, p. 2) considers that the term skills "refers broadly to what a person knows, understands and can do".

A basic definition of the concept of digital competence is that it is the ability to use information and communication technologies (ICTs). However, like the definition of the term competence in general, the meaning and scope of the concept of digital competence vary between authors (such as Ilomäki et al., 2011; Krumsvik, 2011, 2012; Käck et al., 2012). Digital competencies are "the confident, critical and creative use of ICTs to achieve goals related to work, employability, learning, leisure, inclusion and/or participation in society" (Ferrari, 2013, p. 2). Ferrari (2013, p. 2) states that "digital competence is a transversal key competence which, as such, enables us to acquire other key competencies (e.g. language, mathematics, learning to learn, cultural awareness)". According to the European Parliament and the Council of the European Union (2006, p. 15), "digital competence involves the confident and critical use of information society technology for work, leisure, and communication, including basic skills in ICTs: the use of computers to retrieve, assess, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the Internet". In the European Digital Competence Framework for Citizens (DigComp), digital competence is grouped into five areas: "information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving" (Carretero et al., 2017, p. 11).

Spante et al. (2018, p. 1), in a systematic review of higher education research for the period 1997 - 2017, found out there are a lot of definitions for the concept of digital competence depending on whether the concept is defined by policy, by researchers, or both, and whether it is focused on social practices or technical skills. Spante et al. (2018, p. 15) conclude that the perspective of the digital competence concept has been transformed from solely operational and technical-oriented to knowledge and cognitive-oriented. Krumsvik (2011, p. 40) argues that "it is not clear whether the underlying epistemology of digital competencies within education is steered by policymakers or by academics".

In the existing literature, digital competence is mainly used as a comprehensive term that includes both digital knowledge and digital skills. This paper is based on the data obtained in a questionnaire conducted for the project "Challenges and

practices of teaching economic disciplines in the era of digitalisation“ - DIGI4Teach. Particularly, the section “Self-assessment of digital competencies” was the focus of our analysis. All questions are divided into two categories: one refers to digital knowledge (proficiency) and the other to digital skills. Digital knowledge means that participants have some theoretical knowledge, while digital skill means they know how to apply their theoretical knowledge in practice. The most common verb used in the questions about digital knowledge is ‘know’, while the verbs ‘apply’, ‘perform’, and ‘conduct’ are most frequently used in part about digital skills. In the paper, we use these definitions of digital competence, digital knowledge and digital skills.

The remainder of the paper is organised as follows. A literature review follows the introduction. The next section describes the methodology used in the data collection process and analysis of the results. After that, the results are presented and discussed. Concluding remarks are given in the last section.

Literature review

Numerous international studies indicate that a lot of people lack digital competencies despite the fact they need to be digitally competent for education, employment, and lifelong learning (Ferrari, 2013, p. 4). Almost half of the European Union population lacks basic digital skills (European Commission, 2016, p. 7). The COVID-19 pandemic highlighted the lack of digital skills in the labour market (European Commission, 2020, p. 3). Eurostat’s (2020) publication states a significant difference between the two age groups in having basic or above basic digital skills. Namely, in 2019 in the group aged between 16 and 74, 56% of individuals had basic or above basic digital skills, while for the group aged 16 to 24, this number was 80%.

Araiza-Vazquez and Pedraza-Sanchez (2019) study revealed that university students perceive having high ICT competencies. The respondents were university students of business administration, accounting and international business, and the accounting students self-reported to have the highest ICT competencies. Martzoukou et al. (2020, p. 1413) conducted a study where university students from Scotland, Ireland and Greece with library and information science as major areas self-assessed their digital competencies. The authors concluded that students’ digital competencies were low in several areas: “development of information literacy, digital creation, digital research and digital identity management” (Martzoukou et al., 2020, p. 1413). Crawford-Visbal et al. (2020) adopted the European Commission’s Digital Competence Framework 2.0 (2017) to analyse the digital competencies of university students of communication in Argentina, Colombia, Peru, and Venezuela. Questionnaires, focus groups and semi-structured interviews were used to gather the data. The results showed that students have a high internet connectivity level but a low level of information literacy. Also, the study found that students overestimate their digital competencies, although they often do not meet minimum job market standards. The recommendation for education policymakers was to take action to improve students’ digital competencies and ICT skills.

Colas-Bravo et al. (2017) concluded that non-university students in Spain self-perceive to have an average level of digital skills. The sample consisted of 50.3% of primary school and 49.7% of high-school students.

Studies comparing employers’ expectations and potential employees’ self-perception of digital competence are very important. The study of Torres-Coronas (2015) identified the gap in the perception of digital competencies between university students and employers, which represents a discrepancy between education and labour market needs. The participants in a study by Sicilia et al. (2018) were university students, employers, and representatives of civic institutions from Spain, Poland, the

UK, Ireland and Belgium. The DigComp 2.1. framework was used as a reference for digital competencies to assess the relative importance of digital competencies and the possibilities and best approaches to acquire them. The study pointed out differences in self-perception of digital competencies across examined groups and a gap between the requirements of the labour market and the actual students' competencies.

Methodology

As noted above, the research conducted in this paper is based on the data obtained through a questionnaire prepared by the project members from the University of Zagreb, Faculty of Economics & Business, as the project coordinator. The "Self-assessment of digital competencies" section of the questionnaire is based on the following sources: CARNet (2016), Ferrari (2013) and Ferrari et al. (2014). Following these authors, a three-point Likert scale was used, meaning that respondents could report having a basic, intermediate or advanced level of digital knowledge and skills. The project members who prepared the questionnaire defined respondents as students from universities of economics and high-school students of economics in the fields of Accounting, Finance, Trade and Tourism, coming from Croatia, Germany, Poland and Serbia. The survey participants filled out the questionnaire in November and December 2021 and January 2022. The sample consists of 2482 respondents, where 1679 are university students and 795 are high-school students. All years of studies were represented in the sample.

The distribution of the respondents between countries, years of study and major areas are provided in Table 1.

Table 1
Distribution of University and High-school students between Countries, Years of Study and Major Areas

	University students		High-school students	
	#	%	#	%
Country				
Croatia	656	39.07	642	80.75
Germany	29	1.73	16	2.01
Poland	699	41.63	0	0.00
Serbia	295	17.57	137	17.23
Total	1679	100.00	795	100.00
Year of Study				
1st	411	24.48	124	15.60
2nd	455	27.10	182	22.89
3rd	449	26.74	298	37.48
4th	239	14.23	186	23.40
5th	125	7.44	5	0.63
Major Area				
Accounting	355	21.14	134	16.86
Finance	438	26.09	189	23.77
Trade	404	24.06	117	14.72
Tourism	162	9.65	220	27.67
Other	320	19.06	135	16.98
Total	1679	100.00	795	100.00

Source: Authors' calculation

To investigate whether there are differences in self-assessment of digital competencies between the university and high-school students, we applied the Mann-Whitney U test for two independent samples. To answer whether there are differences in self-assessment of digital competencies between university/high-school students of different years of study and whether there are differences in self-assessment of digital competencies between university/high-school students of different major areas, we used the Kruskal-Wallis H test for five independent samples. We also applied post hoc analysis to identify where the differences came from. We calculated the Spearman Rank-Order Correlation coefficient to investigate if there is a correlation between the self-assessment of digital knowledge and the self-assessment of digital skills.

Results

Comparison between university and high-school students

The average levels of self-assessed digital knowledge and skills for university and high-school students are presented in Table 2.

Table 2
Average values of the self-assessed digital knowledge and skills for university and high-school students

Digital Competence	University students		High-school students	
	Knowledge	Skills	Knowledge	Skills
Browsing, searching and filtering data, information, and digital content	2.01	1.71	2.04	1.77
Data, information, and digital content management	1.85	1.93	1.88	1.76
Data, information, and content sharing via digital technologies	1.92	1.79	1.91	1.79
Interacting (collaboration) through digital technologies	1.86	1.86	1.84	1.81
Developing digital content	1.81	1.86	1.88	1.85
Programming	1.40	1.37	1.51	1.51
Protecting devices	1.70	1.58	1.76	1.58
Protecting personal data and privacy	1.78	1.72	1.86	1.77
Solving technical problems	1.58	1.59	1.61	1.65
Creative problem-solving by using digital technologies	1.57	1.53	1.66	1.64

Note: The level of digital knowledge was estimated with grades: 1-foundation level, 2-intermediate level, 3-advanced level
Source: Authors' work

The average value of self-assessed digital knowledge for university students is 1.75, the minimum value is 1.40, and the maximum value is 2.01. Regarding digital skills for university students, the average value is 1.69, the minimum value is 1.37, and the maximum value is 1.93. In the sample of high-school students, the average value of self-assessed digital knowledge is 1.80, the minimum value is 1.51, and the maximum value is 2.04. High-school students self-assessed their digital skills at an average value of 1.71, with a minimum value of 1.51 and a maximum of 1.85. It can be concluded that, on average, both university and high-school students self-perceive to have below intermediate-level digital competencies. High-school students reported higher levels of digital competencies than university students, while both university and high-school students reported having a lower level of digital skills than digital knowledge.

Such results open space for the analysis of the digital adequacy of teaching methods. Professors, teachers and educational policymakers need to constantly modernise curricula and apply contemporary digital tools in teaching.

In Table 3, standardised Mann-Whitney U test statistics and p-values are reported to examine differences in the self-assessment of digital competencies between students and high-school students.

Table 3
Differences in the self-assessment of digital competencies between university and high-school students

Question	Knowledge		Skills	
	Z	p-value	Z	p-value
Browsing, searching and filtering data, information, and digital content	-0.999	0.318	-1.983	0.047*
Data, information, and digital content management	0.892	0.372	-5.102	<0.001*
Data, information, and content sharing via digital technologies	-0.273	0.785	-0.096	0.924
Interacting (collaboration) through digital technologies	-0.523	0.601	-1.711	0.087
Developing digital content	-2.627	0.009*	-0.210	0.834
Programming	-4.290	<0.001*	-5.848	<0.001*
Protecting devices	-1.700	0.089	-0.261	0.794
Protecting personal data and privacy	-2.035	0.042*	-1.740	0.082
Solving technical problems	-1.252	0.211	-1.955	0.051
Creative problem-solving by using digital technologies	-3.575	<0.001*	-4.367	<0.001*

Note: The asterisk * indicates a 5% significance level. Z shows standardised Mann-Whitney U test statistics.
Source: Authors' work

Based on the results shown in Table 3, we can conclude: university students self-reported lower digital knowledge than high-school students in Developing digital content, Programming, Protecting personal data and privacy, and Creative problem-solving by using digital technologies. Regarding digital skills, university students self-assessed them at a higher level than high-school students in the area of Data, information, and digital content management, while high-school students self-reported higher digital skills than university students in the areas of Browsing, searching and filtering data, information, and digital content, Programming, and Creative problem solving by using digital technologies.

There are no statistically significant differences in digital knowledge between university and high-school students in the following areas: Browsing, searching and filtering data, information, and digital content, Data, information, and digital content management, Data, information, and content sharing via digital technologies, Interacting (collaboration) through digital technologies, Protecting devices, and Solving technical problems. There are no statistically significant differences in digital skills between university and high-school students in the following areas: Data, information, and content sharing via digital technologies, Interacting (collaboration) through digital technologies, Developing digital content, Protecting devices, Protecting personal data and privacy, and Solving technical problems.

Accordingly, there are differences in self-assessment of digital knowledge between university and high-school students in four out of 10 areas, always in favour of high-school students. Concerning digital skills, there are differences in four out of 10 areas:

high-school students self-reported higher levels in three areas, while university students only in one.

Such results may seem a little bit counterintuitive since it is expected that a higher level of education means a higher level of knowledge and skills. However, we analysed a special kind of knowledge and skills – digital ones. Possible factors of observed differences between analysed groups of respondents can be age differences: younger respondents started to be exposed to the digital world and content at an earlier stage of their life; they adapt to the digital world faster; high-school students have more free time than university students. The additional possible explanatory factor that has to be further examined may be higher self-confidence in high-school students compared to university students.

Table 4 contains correlation coefficients and p-values calculated to investigate the association between digital knowledge and skills: the left panel contains results for university students, while the right one is for high-school students.

Table 4
Correlation between digital knowledge and skills among university and high-school students

Digital Competence	*University students*		*High-school students*	
	r	p-value	r	p-value
Browsing, searching and filtering data, information, and digital content	0.456	< 0.001*	0.405	< 0.001*
Data, information, and digital content management	0.462	< 0.001*	0.426	< 0.001*
Data, information, and content sharing via digital technologies	0.539	< 0.001*	0.489	< 0.001*
Interacting (collaboration) through digital technologies	0.563	< 0.001*	0.537	< 0.001*
Developing digital content	0.562	< 0.001*	0.533	< 0.001*
Programming	0.576	< 0.001*	0.542	< 0.001*
Protecting devices	0.512	< 0.001*	0.532	< 0.001*
Protecting personal data and privacy	0.521	< 0.001*	0.519	< 0.001*
Solving technical problems	0.605	< 0.001*	0.485	< 0.001*
Creative problem-solving by using digital technologies	0.621	< 0.001*	0.553	< 0.001*

Note: The asterisk * indicates a 5% significance level. Spearman rank correlation coefficient (r) is reported.
Source: Authors' work

There is a significant positive correlation in the self-assessment of digital competencies (digital knowledge and digital skills) for both groups of respondents (university and high-school students). Further, this means that there is consistency in the self-assessment of digital knowledge, on the one hand, and digital skills, on the other hand, in the same areas.

Comparison according to the year of study of university students

Tables 5 and 6 show the average values of the self-assessed digital knowledge and digital skills, respectively, for university students of different years of study.

Table 5
Average values of the digital knowledge of university students of different years of study

The average level of digital knowledge	1st	2nd	3rd	4th	5th
Browsing, searching and filtering data, information, and digital content	1.82	2.00	2.06	2.17	2.18
Data, information, and digital content management	1.71	1.83	1.92	1.98	1.96
Data, information, and content sharing via digital technologies	1.81	1.89	2.01	1.92	2.02
Interacting (collaboration) through digital technologies	1.65	1.89	1.98	1.85	2.04
Developing digital content	1.72	1.81	1.87	1.80	1.86
Programming	1.37	1.40	1.41	1.36	1.58
Protecting devices	1.64	1.73	1.73	1.67	1.69
Protecting personal data and privacy	1.76	1.78	1.86	1.68	1.80
Solving technical problems	1.55	1.55	1.64	1.55	1.64
Creative problem-solving by using digital technologies	1.51	1.55	1.61	1.59	1.64

Note: Level was estimated with grades: 1-foundation level, 2-intermediate level, 3-advanced level
Source: Authors' work

Table 6
Average values of the digital skills of university students of different years of study

The average level of digital skills	1st	2nd	3rd	4th	5th
Browsing, Searching and filtering data, information, and digital content	1.62	1.63	1.84	1.77	1.76
Data, information, and digital content management	1.73	1.96	2.00	2.01	2.09
Data, information, and content sharing via digital technologies	1.69	1.75	1.87	1.80	1.91
Interacting (collaboration) through digital technologies	1.75	1.89	1.92	1.87	1.92
Developing digital content	1.80	1.82	1.94	1.81	2.02
Programming	1.38	1.33	1.39	1.37	1.44
Protecting devices	1.51	1.56	1.65	1.60	1.65
Protecting personal data and privacy	1.68	1.71	1.76	1.71	1.74
Solving technical problems	1.55	1.53	1.66	1.60	1.70
Creative problem-solving by using digital technologies	1.43	1.53	1.54	1.51	1.66

Note: Level was estimated with grades: 1-foundation level, 2-intermediate level, 3-advanced level
Source: Authors' work

Table 7 presents Kruskal-Wallis H test statistics and p-values, which are calculated to investigate possible differences in the self-assessment of digital competencies between university students of different years of study.

Table 7
Differences in the self-assessment of digital competencies between university students of different years of study

	Knowledge		*Skills*	
Digital competence	**KW**	**p-value**	**KW**	**p-value**
Browsing, searching and filtering data, information, and digital content	54.197	< 0.001*	36.646	< 0.001*
Data, information, and digital content management	37.716	< 0.001*	37.834	< 0.001*
Data, information, and content sharing via digital technologies	21.724	< 0.001*	20.793	< 0.001*
Interacting (collaboration) through digital technologies	45.003	< 0.001*	15.930	0.003*
Developing digital content	11.970	0.018*	16.831	0.002*
Programming	14.090	0.007*	4.551	0.337
Protecting devices	5.062	0.281	11.644	0.020*
Protecting personal data and privacy	11.521	0.021*	2.786	0.594
Solving technical problems	8.858	0.065	14.604	0.006*
Creative problem-solving by using digital technologies	7.176	0.127	15.880	0.003*

Note: The asterisk * indicates a 5% significance level. KW shows Kruskal-Wallis H test statistics.
Source: Authors' work

The results presented in Table 7 reveal that there are statistically significant differences in digital knowledge between university students of different years of study in the following areas: Browsing, searching and filtering data, information, and digital content (between the first and all higher years of study and between the second and fourth year of study), Data, information, and digital content management (between the first year and all higher years of study and between the second and fourth year of study), Data, information and content sharing via digital technologies (between the first and third, and between the first and fifth year of study), Interacting (collaboration) through digital technologies (between the first and all higher years of study), Developing digital content (between the first and third year of study), Programming (between the first and fifth and between the fourth and fifth year of study), and Protecting personal data and privacy (between the third and fourth year of study).

There are statistically significant differences in digital skills between university students of different years of study in the following areas: Browsing, searching and filtering data, information, and digital content (between the first and third; the first and fourth; and the second and third year of study), Data, information, and digital content management (between the first and all higher years of study), Data, information, and content sharing via digital technologies (between the first and third and the first and fifth year of study), Interacting (collaboration) through digital technologies (between the first and second and between the first and third year of study), Developing digital content (between the first and third and between the first and fifth year of study), Protecting devices (between the first and third year of study), Solving technical problems (between the second and third year of study), and Creative problem solving by using digital technologies (between the first and fifth year of study).

There are no statistically significant differences in digital knowledge between university students of different years of study in Protecting devices, Solving technical problems, and Creative problem-solving by using digital technologies. Also, there are no statistically significant differences in digital skills between university students of different years of study in the areas of Programming and Protecting personal data and privacy.

To summarise, there are differences in self-assessment of digital knowledge between university students of different years of study in seven out of 10 areas. In all areas, besides Protecting personal data and privacy, university students of higher years of study self-reported higher digital knowledge. Regarding digital skills, there are differences in self-assessment between university students of different years of study in eight out of 10 areas, where students of higher years of study self-assessed their digital skills at a higher level.

Comparison according to the year of study of high-school students

Average values of the self-assessed digital knowledge and digital skills among high-school students of different years of study are presented in Tables 8 and 9.

Table 8

Average values of the digital knowledge of high school students of different years of study

The average level of digital **knowledge**	1st	2nd	3rd	4th	5th
Browsing, searching and filtering data, information, and digital content	2.02	1.92	2.07	2.13	1.60
Data, information, and digital content management	1.83	1.81	1.94	1.90	1.40
Data, information, and content sharing via digital technologies	1.91	1.85	1.91	1.96	1.80
Interacting (collaboration) through digital technologies	1.75	1.84	1.84	1.90	1.80
Developing digital content	1.85	1.77	1.94	1.93	1.60
Programming	1.61	1.54	1.44	1.54	1.20
Protecting devices	1.72	1.76	1.77	1.76	1.60
Protecting personal data and privacy	1.89	1.81	1.88	1.84	1.60
Solving technical problems	1.58	1.52	1.62	1.72	1.20
Creative problem-solving by using digital technologies	1.69	1.59	1.63	1.76	1.60

Note: Level was estimated with grades: 1-foundation level, 2-intermediate level, 3-advanced level; Source: Authors' work

Table 9

Average values of the digital skills of high school students of different years of study

The average level of digital skills	1st	2nd	3rd	4th	5th
Browsing, searching and filtering data, information, and digital content	1.78	1.75	1.80	1.77	1.40
Data, information, and digital content management	1.62	1.75	1.76	1.86	1.40
Data, information, and content sharing via digital technologies	1.70	1.74	1.81	1.89	1.80
Interacting (collaboration) through digital technologies	1.76	1.71	1.86	1.85	1.60
Developing digital content	1.84	1.77	1.88	1.91	1.20
Programming	1.65	1.55	1.44	1.50	1.00
Protecting devices	1.55	1.57	1.58	1.63	1.40
Protecting personal data and privacy	1.84	1.77	1.73	1.81	1.40
Solving technical problems	1.67	1.65	1.61	1.72	1.20
Creative problem-solving by using digital technologies	1.62	1.60	1.63	1.69	1.40

Note: Level was estimated with grades: 1-foundation level, 2-intermediate level, 3-advanced level; Source: Authors' work

Table 10 contains Kruskal-Wallis H test statistics and p-values for testing if there are differences in the self-assessment of digital competencies between high-school students of different years of study.

Based on the results from Table 10, it can be concluded that there are statistically significant differences in digital knowledge between high-school students in the second and fourth years of study in the areas of Browsing, searching and filtering data, information, and digital content, and Solving technical problems. Fourth-year high-school students self-reported higher digital knowledge in both areas than second-year high-school students. Also, there are differences in digital knowledge between high-school students in the first and fifth year of study in Programming, where, unexpectedly, fifth-year high-school students reported a lower level of digital knowledge than first-year high-school students. This counterintuitive result is because only five high-school students are in their fifth year of study. All fifth-year high-school students come from Germany, which education system has a little bit different structure. In all other areas, there is no statistically significant difference in digital knowledge between high-school students of different years of study. Programming is the only area where high-school students of different years of study self-reported statistically significant differences in digital skills. Unexpectedly, first-year high-school students reported a higher level of digital skills than third-year high-school students.

Table 10

Differences in the Self-Assessment of Digital Competencies between High-school students of Different Years of Study

	Knowledge		*Skills*	
Digital comptence	**KW**	**p-value**	**KW**	**p-value**
Browsing, searching and filtering data, information, and digital content	12.141	0.016*	2.644	0.619
Data, information, and digital content management	7.247	0.123	8.652	0.070
Data, information, and content sharing via digital technologies	2.699	0.609	7.054	0.133
Interacting (collaboration) through digital technologies	2.887	0.577	7.005	0.136
Developing digital content	8.499	0.075	8.253	0.083
Programming	9.680	0.046*	12.90	0.012*
Protecting devices	0.649	0.957	1.545	0.819
Protecting personal data and privacy	1.907	0.753	3.884	0.422
Solving technical problems	11.549	0.021*	5.397	0.249
Creative problem-solving by using digital technologies	6.610	0.158	2.631	0.621

Note: The asterisk * indicates a 5% significance level. KW shows Kruskal-Wallis H test statistics.
Source: Authors' work

Comparison according to the major of study of university students

Average values of the self-assessed digital knowledge and digital skills between university students of different major areas are presented in Table 11 and Table 12

Table 11
Average values of the digital knowledge of university students of different major of study

The average level of digital knowledge	Accounting	Finance	Trade	Tourism	Other
Browsing, searching and filtering data, information, and digital content	1.95	2.04	2.00	1.98	2.08
Data, information, and digital content management	1.78	1.89	1.86	1.86	1.87
Data, information, and content sharing via digital technologies	1.81	1.96	1.90	1.97	1.98
Interacting (collaboration) through digital technologies	1.78	1.94	1.84	1.80	1.90
Developing digital content	1.72	1.77	1.84	1.83	1.89
Programming	1.35	1.40	1.40	1.36	1.49
Protecting devices	1.66	1.76	1.66	1.70	1.70
Protecting personal data and privacy	1.76	1.80	1.77	1.78	1.80
Solving technical problems	1.51	1.61	1.57	1.56	1.65
Creative problem-solving by using digital technologies	1.50	1.58	1.57	1.59	1.63

Note: Level was estimated with grades: 1-foundation level, 2-intermediate level, 3-advanced level; Source: Authors' work

Table 12
Average values of the digital skills of university students of different major of study

The average level of digital skills	Accounting	Finance	Trade	Tourism	Other
Browsing, searching and filtering data, information, and digital content	1.66	1.78	1.71	1.69	1.71
Data, information, and digital content management	1.91	1.95	1.88	1.88	2.01
Data, information, and content sharing via digital technologies	1.74	1.79	1.82	1.73	1.82
Interacting (collaboration) through digital technologies	1.78	1.89	1.86	1.89	1.90
Developing digital content	1.78	1.86	1.89	1.83	1.93
Programming	1.30	1.41	1.37	1.33	1.42
Protecting devices	1.51	1.61	1.65	1.54	1.57
Protecting personal data and privacy	1.66	1.75	1.75	1.64	1.73
Solving technical problems	1.55	1.63	1.59	1.56	1.62
Creative problem-solving by using digital technologies	1.43	1.53	1.57	1.48	1.55

Note: Level was estimated with grades: 1-foundation level, 2-intermediate, 3-advanced level Source: Authors' work

The Kruskal-Wallis H test statistics and p-values for testing if there are differences in the self-assessment of digital competencies between university students of different major areas are shown in Table 13.

Table 13
Differences in the Self-Assessment of Digital Competencies between University Students of Different Major of Study

	Knowledge		*Skills*	
Digital competence	**KW**	**p-value**	**KW**	**p-value**
Browsing, searching and filtering data, information, and digital content	7.189	0.126	7.717	0.103
Data, information, and digital content management	6.217	0.184	6.002	0.199
Data, information, and content sharing via digital technologies	14.026	0.007*	4.142	0.387
Interacting (collaboration) through digital technologies	9.279	0.054	6.724	0.151
Developing digital content	11.097	0.026*	7.215	0.125
Programming	8.455	0.076	9.702	0.046*
Protecting devices	5.353	0.253	8.397	0.078
Protecting personal data and privacy	0.688	0.953	5.764	0.217
Solving technical problems	8.919	0.063	2.873	0.579
Creative problem-solving by using digital technologies	5.769	0.217	11.657	0.020*

Note: The asterisk * indicates a 5% significance level. KW shows Kruskal-Wallis H test statistics.
Source: Authors' work

Results from Table 13 indicate that there are statistically significant differences in digital knowledge between university students of different major areas regarding Data, information, and content sharing via digital technologies (between students of Accounting and Finance modules, between students of Accounting and Tourism modules, and between students of Accounting and Other modules), and regarding Developing digital content area (between students of Accounting and Other modules). There are statistically significant differences in digital skills between university students of Accounting and Finance modules in Programming and between students of Accounting and Trade modules in Creative problem-solving, with Accounting students reported a lower level of digital knowledge and skills.

Comparison according to the major of study of high-school students

Average values of the self-assessed digital knowledge and digital skills between high-school students of different major areas are presented in Tables 14 and 15.

Table 14
Average values of the digital knowledge of high-school students of different majors of study

The average level of digital knowledge	**Accounting**	**Finance**	**Trade**	**Tourism**	**Other**
Browsing, searching and filtering data, information, and digital content	2.02	2.05	2.09	1.98	2.10
Data, information, and digital content management	1.84	1.89	1.94	1.83	1.95
Data, information, and content sharing via digital technologies	1.87	1.90	1.99	1.79	2.07
Interacting (collaboration) through digital technologies	1.84	1.81	1.97	1.74	1.91
Developing digital content	1.87	1.86	1.97	1.75	2.07
Programming	1.54	1.53	1.68	1.40	1.50
Protecting devices	1.78	1.75	1.88	1.68	1.76
Protecting personal data and privacy	1.84	1.86	1.98	1.72	1.97
Solving technical problems	1.60	1.63	1.75	1.48	1.67
Creative problem-solving by using digital technologies	1.63	1.70	1.75	1.55	1.75

Note: Level was estimated with grades: 1-foundation level, 2-intermediate, 3-advanced level
Source: Authors' work

Table 15
Average values of the digital skills of high-school students of different majors of study

The average level of digital skills	Accounting	Finance	Trade	Tourism	Other
Browsing, searching and filtering data, information, and digital content	1.81	1.75	1.87	1.71	1.79
Data, information, and digital content management	1.76	1.78	1.85	1.65	1.80
Data, information, and content sharing via digital technologies	1.81	1.80	1.90	1.71	1.81
Interacting (collaboration) through digital technologies	1.81	1.78	1.89	1.72	1.93
Developing digital content	1.90	1.79	1.92	1.73	2.04
Programming	1.56	1.52	1.58	1.44	1.50
Protecting devices	1.60	1.62	1.73	1.46	1.59
Protecting personal data and privacy	1.81	1.80	1.84	1.63	1.88
Solving technical problems	1.62	1.66	1.74	1.59	1.71
Creative problem-solving by using digital technologies	1.65	1.65	1.67	1.54	1.74

Note: Level was estimated with grades: 1-foundation level, 2-intermediate, 3-advanced level
Source: Authors' work

In Table 16, Kruskal-Wallis H test statistics and p-values for testing if there are differences in the self-assessment of digital competencies between high-school students of different major areas are reported.

Table 16
Differences in the self-assessment of digital competencies between high-school students of different majors of study

Digital competence	*Knowledge*		*Skills*	
	KW	**p-value**	**KW**	**p-value**
Browsing, searching and filtering data, information, and digital content	3.400	0.493	5.395	0.249
Data, information, and digital content management	4.484	0.344	6.742	0.150
Data, information, and content sharing via digital technologies	15.888	0.003*	4.963	0.291
Interacting (collaboration) through digital technologies	8.709	0.069	9.324	0.054
Developing digital content	20.940	< 0.001*	16.696	0.002*
Programming	17.400	0.002*	6.319	0.177
Protecting devices	5.747	0.219	14.033	0.007*
Protecting personal data and privacy	13.514	0.009*	14.040	0.007*
Solving technical problems	16.325	0.003*	5.857	0.210
Creative problem-solving by using digital technologies	12.371	0.015*	8.420	0.077

Note: The asterisk * indicates a 5% significance level. KW shows Kruskal-Wallis H test statistics.
Source: Authors' work

High-school students of different majors differ in digital knowledge in the following areas: Data, information, and content sharing via digital technologies (between modules Tourism and Others), Developing digital content (between Tourism and Trade and between Tourism and Others), Programming (between Tourism and Trade), Protecting personal data and privacy (between Tourism and Trade, and between Tourism and Others), Solving technical problems (between Tourism and Trade), and

Creative problem solving by using digital technologies (between Tourism and Trade). In all cases, high-school students of Tourism as their major area self-reported a lower level of digital knowledge.

Statistically significant differences in digital skills between high-school students of different main areas of interest exist in Developing digital content (between Tourism and Others, and between Finance and Others), Protecting devices (between Tourism and Trade), and Protecting personal data and privacy (between Tourism and Others). High-school students in the Tourism module have a lower level of digital skills than high-school students in all other modules. In contrast, in the mentioned pair Finance and Others, high-school students of modules grouped as Others have a higher level of digital skills.

Conclusion

In this paper, we investigated how university and high-school students in economics self-assess their digital competencies. We aimed to identify university and high-school students' current levels of digital knowledge and skills and to propose ways to improve their digital competencies with the ultimate goal of facilitating the learning process and providing a smooth transition and inclusion of university and high-school students in the labour market. Additionally, our goal was to propose ways to improve teaching methods to ensure a high-quality teaching process despite the challenges caused by the COVID-19 pandemic. To this end, we analysed data on self-perception of digital competencies obtained through conducting a questionnaire. Our main findings can be summarised as follows: (1) university and high-school students self-assess their digital competencies at the below intermediate level; (2) high-school students' digital knowledge self-assessment is higher than university students' ones in four out of 10 analysed areas; (3) high-school students' digital skills self-assessment is higher than university students' ones in three out of 10 analysed areas, while the opposite is the case in one out of 10 analysed areas; (4) there is the accordance in the self-assessment of digital knowledge and skills for the same areas, but self-assessment of digital skills is lower than self-assessment of digital knowledge; (5) university students of higher years of study self-assessed digital knowledge at a higher level in six out of 10 areas, while in one out of 10 the direction is the opposite; (6) university students of higher years of study self-assessed digital skills at a higher level in eight out of 10 areas; (7) there is no universal pattern in self-assessment of digital competencies between high-school students of different years of study; and (8) university students of Accounting module and high-school students of Tourism module reported lowest levels of digital competencies .

Like in Eurostat's (2020) study, we discovered differences between the two age groups regarding digital competencies. However, our respondents are much younger (university and high-school students), and there is no large difference in age as in Eurostat's (2020) research.

Contrary to Araiza-Vazquez and Pedraza-Sanchez (2019), our results show that all university students self-report to have below intermediate level of digital competencies, while university students in the Accounting module perceive to have the lowest level of digital competencies. Like Martzoukou et al. (2020), we identified that university students self-reported to have a below-average level of digital competencies in most investigated areas. Contrary to the results of Colas-Bravo et al. (2017), we identified that high-school students self-perceive to have below intermediate level of digital competencies.

The below intermediate level of digital competencies of both university and high-school students suggests that education policymakers must innovate teaching

methods and curricula by including new courses that will allow university and high-school students to improve their digital competencies. Education policymakers should pay special attention to the Accounting module at universities and the Tourism module at high schools of economics due to identified lowest levels of digital competencies for these groups of respondents. The monitoring of the digital aspects of the quality of teaching methods and the quality of teaching outcomes by educational policymakers must be continuous due to the fast-paced digital world.

The reasons why high-school students self-assess their digital competencies at a higher level than university students could be that they belong to the younger cohort of Generation Z that began to be influenced by the fast-changing digital world in early childhood and that they have less intense school assignments and therefore more free time to explore digital contents. The explanation for higher levels of self-reported digital competencies among university students of higher years of study may be that higher-level courses are more specialised and applicative. More digital tools are used at those courses compared to theoretical courses in lower years of study.

Our study contributes to the existing literature in several ways. First, the research conducted during the COVID-19 pandemic emphasised the necessity for digitalisation of the teaching process and the advantage of possessing digital competencies. Second, the study is international, with respondents from four countries. Third, the perceptions of university and high-school students of all years of study and different economic disciplines as majors are analysed. Additionally, digital knowledge and skills as components of digital competencies are analysed separately. There are more studies about the digital competencies of professors and teachers than about the digital competencies of university and high-school students. In this regard, our study is an important addition to the existing literature.

The limitation of the research is that educational systems among analysed countries are not the same. The countries are at different levels of economic development with different abilities to buy access to digital content and tools.

The results of our study opened space for further research directions. Additional groups of respondents need to be included: employers, university and high-school students from all fields of social, natural and technical sciences, and primary school students. The motivation for including employers is the importance of digital competencies for employability and success in the labour market. University and high-school students from all fields of social, natural and technical sciences have to be included since all people need to be digitally competent. Primary school students have to be examined since it is crucial to start acquiring digital competencies correctly in the early stages of education. Additionally, the factors that affected the identified differences in self-assessment of digital competencies, such as the overconfidence of younger respondents, need to be further investigated.

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References

1. Araiza-Vazquez, M. J., Pedraza-Sanchez, E. Y. (2019), "Discernment of digital competences in students of a business school", in Gómez Chova L., López Martínez A., Candel Torres I. (Ed.), EDULEARN19 Proceedings, 11th International Conference on Education and New Learning Technologies, 1-3 July, 2019, Palma, Spain, pp. 4737-4747.
2. CARNet (2016), "Framework for digital competence of users in school: teachers, professional associates, directors and administrative staff" (in Croatian), Hrvatska akademska i istraživačka mreža – CARNet, Zagreb, Croatia.
3. Carretero, S., Vuorikari, R., Punie, Y. (2017), "DigComp 2.1: The Digital Competence Framework for Citizens with eight proficiency levels and examples of use", EUR 28558 EN, Publications Office of the European Union, Luxembourg, available at https://publications.jrc.ec.europa.eu/repository/handle/JRC106281 (02 February 2022)
4. Colas-Bravo, P., Conde-Jimenez, J., Reyes-de Cozar, S. (2017), "Digital competences of non-university students", Revista Latinoamericana de Tecnologia Educativa-Relatec, Vol. 16, No. 1, pp. 7-20.
5. Council of the European Union (2017), "Council recommendation of 22 May 2017 on the European Qualifications Framework for lifelong learning and repealing the recommendation of the European Parliament and of the Council of 23 April 2008 on the establishment of the European Qualifications Framework for lifelong learning" (2017/C 189/03), Official Journal of the European Union, available at https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32017H0615(01)&from=EN#d1e35-15-1 (02 February 2022)
6. Crawford-Visbal, J. L., Crawford-Tirado, L., Ortiz-Záccaro, Z. Z., Abalo, F. (2020), "Assessment of Digital Competences in Communication Students across four Latin American Universities", Education in the Knowledge Society, Vol. 21, No. 20, pp. 1-14.
7. European Commission (2016), "Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A New Skills Agenda for Europe, Working together to strengthen human capital, employability and competitiveness, SWD (2016) 195 final", available at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016DC0381&from=EN (02 February 2022)
8. European Commission (2020), "European Skills Agenda for Sustainable Competitiveness, Social Fairness and Resilience", available at https://ec.europa.eu/social/main.jsp?langId=en&catId=89&furtherNews=yes&newsId=9723 (02 February 2022)
9. European Parliament and the Council of the European Union (2006), "Recommendation of the European Parliament and of the Council of 18 December 2006 on key competences for lifelong learning (2006/962/EC)", Official Journal of the European Union, L 394, available at https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:394:0010:0018:en:PDF (02 February 2022)
10. Eurostat (2020), "Do young people in the EU have digital skills?", available at https://ec.europa.eu/eurostat/en/web/products-eurostat-news/-/edn-20200715-1 (02 February 2022)
11. Ferrari, A. (2013), "DIGCOMP: a framework for developing and understanding digital competence in Europe", available at https://data.europa.eu/doi/10.2788/52966 (02 February 2022)
12. Ferrari, A., Brečko, B. N., Punie, Y. (2014), "DIGCOMP: A Framework for Developing and Understanding Digital Competence in Europe, Transforming Education through Innovation and Technology", eLearning Papers.
13. Ilomäki, L., Kantosalo, A., Lakkala, M. (2011), "What is digital competence?" European Schoolnet, in Linked Portal, European Schoolnet (EUN), Brussels , pp. 1-12
14. Käck, A., Männikö-Barbutiu, S. (2012), Digital kompetens i lärarutbildningen, Studentliteratur AB, Lund.

15. Krumsvik, R. A. (2011), "Digital competence in Norwegian teacher education and schools", Högre Utbildning, Vol. 1, No. 1, pp. 39-51.
16. Krumsvik, R. A. (2012), "Teacher educators' digital competence", Scandinavian Journal of Educational Research, Vol. 1, No. 12, pp. 269-280.
17. Martzoukou, K., Fulton, C., Kostagiolas, P., Lavranos, C. (2020), "A study of higher education students' self-perceived digital competences for learning and everyday life online participation", Journal of Documentation [online], Vol. 76, No. 6, pp. 1413-1458.
18. Sicilia, M.A., García-Barriocanal, E., Sánchez-Alonso, S., Różewski, P., Kieruzel, M., Lipczyński, T., Royo, C., Uras F., Hamill, S. (2018), "Digital skills training in Higher Education: insights about the perceptions of different stakeholders", in García-Peñalvo, F. J. (Ed.), Proceedings of the 6th International Conference on Technological Ecosystems for Enhancing Multiculturality (TEEM 2018), Salamanca, Spain, October 24-26, 2018, pp. 781-787.
19. Spante, M., Hashemi, S. S., Lundin, M., Algers, A. (2018), "Digital competence and digital literacy in higher education research: Systematic review of concept use", Cogent Education, Vol. 5, No. 1, pp. 1-21.
20. Torres-Coronas, T., Vidal-Blasco, M.-A. (2015), "Students and employers perception about the development of digital skills in higher education", Revista de Educación, No. 367, pp. 63-89.

About the authors

Dragana Draganac, PhD, is an Assistant Professor at the Department of Accounting and Corporate Finance at the University of Belgrade, Faculty of Economics and Business. She obtained her PhD in 2019 with the doctoral thesis "Rational Price Bubbles in Traditional and Behavioral Finance: An Experimental Study". In the 2018-2019 academic year, Dragana was a visiting researcher at the Massachusetts Institute of Technology and Harvard University under the Fulbright Non-Degree Research Program for Doctoral Students. The main research fields are Corporate Finance, Behavioral Economics and Behavioral Finance, and Experimental Economics and Experimental Finance. At the undergraduate academic studies level, she teaches the following courses: Corporate Finance, Principles of Corporate Finance and Principles of Behavioral Finance. At the undergraduate international programme in cooperation with the University of London, LSE, she is engaged in a course called Principles of Corporate Finance. At the master's academic studies level, she teaches courses in Corporate Financial Management and Behavioral Finance. In contrast, at international master programmes, she is involved in teaching Corporate Finance and Behavioral Economics and Finance. She is a member of the Society for Experimental Finance (SEF), Economic Science Association (ESA) and Fulbright & Friends Association. The author can be contacted at **dragana.draganac@ekof.bg.ac.rs**.

Danica Jović, PhD, graduated and obtained a magister's and PhD degrees from the University of Belgrade, Faculty of Economics and Business. She is employed at the University of Belgrade, Faculty of Economics and Business, at the Department of Accounting and Corporate Finance. The main fields of interest and research are Accounting and Financial Reporting of Entities in the Public and Private Sectors, Consolidation of Financial Statements, and Financial Analysis. Courses taught: Financial Accounting, Public Sector Accounting (undergraduate studies); Consolidated Financial Statements: Advanced Issues (master academic studies); and Principles of Accounting and Core Management Concepts (LSE Business and Management program). She is a coordinator of the CEEPUS program for the University of Belgrade, Faculty of Economics and Business, certified accountant and member of the Association of Accountants and Auditors of Serbia, the Scientific Society of Economists of Serbia, and the Society of Economists of Belgrade. The author can be contacted at **danica.jovic@ekof.bg.ac.rs**.

Ana Novak, PhD, is an Associate Professor of Accounting at the Faculty of Economics and Business, University of Zagreb, Croatia. She received PhD in Accounting from the Faculty of Economics and Business, University of Zagreb. She is the (co)author of several scientific and professional papers. She is a member of the Association of Accountants and Financial Experts and the Internal Audit Section (national). Her main research interests are accounting, accounting information systems, financial reporting, and accounting education. The author can be contacted at **anovak@efzg.hr.**