Generic and digital competences for employability — results of a Croatian national graduates survey

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Abstract

Mastery of generic competences is widely recognized as important for a successful transition from higher education to the world of work, especially in today's networked, digitalized, and globalized environment. This study analyses data of 7201 respondents to the Croatian national graduate survey 2017 on students who graduated in the academic year 2015/2016 in different fields of education (Medicine and Biomedical Sciences, Biotechnical Sciences, Social Sciences, Humanities, Natural Sciences, Technical Sciences and Arts). The goal of this study is to identify graduates' perspectives on gaps between the generic and digital competences acquired during higher education studies and those required in the first workplace. It addresses three research questions: (1) Which generic and digital competences do graduates consider relevant for employability?, (2) Which groups of competences show a similar pattern of competence gap, from the graduate's perspective?, and (3) How do graduates' perceptions of gaps in competence levels vary among fields of education? Research results reveal disparities in graduates' perceptions about achieved competence levels and labour market requirements. The study identifies differences among graduates from different fields of education. Results may be useful to educators in all fields of education as guidelines for the introduction of generic and digital competences development in higher education.

Keywords Generic competences · Employability · National student survey · Graduate skills · Factor analysis

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Introduction

Generic competences are nowadays a relevant topic in both educational and scientific discourse. They are usually defined as competences that are transferable across different domains and contexts. In the literature, they are also called generic, key, or transferable skills/competences. Even though the term competence is usually understood as a broader term that comprises both knowledge and skills, this paper uses the terms generic competences and generic skills interchangeably, reflecting the term as used in the referenced literature.

Businesses are becoming more knowledge-intensive, facilitated by the development of information and communication technology (ICT). Consequently, meeting the increased demand for a workforce with a new set of skills in the context of digitization is becoming a strategic issue at the policy level. Relevant initiatives all recognize that the unknown and changing nature of future jobs will, in addition to professional skills, require a certain level of digital competence and core generic skills, including leadership, communication, problem-solving, teamwork skills, and critical thinking (European Commission, 2016a; OECD, 2016, 2018). The European Skills Agenda, which emphasizes the need for both transversal and digital skills, was recently announced, and includes 12 actions targeted at reskilling and upskilling individuals and businesses with relevant skills (European Commission, 2020b).

Frey and Osborne (2013) believe that this global shift will require employees with creative and social skills. Therefore, changes in society and the labour market put certain pressure on higher education institutions (HEIs) to produce employable graduates with relevant knowledge and skills, including generic competences, complemented with digital competences. Possession of digital competences moved higher on the education agenda with the appearance of the COVID-19 pandemic, which unexpectedly shifted educational processes into an online environment overnight. In response, the European Commission (EU) launched the Digital Education Action Plan (2021–2027) (European Commission, 2020a), which focused on fostering the development of a high-performing digital education ecosystem, while also enhancing digital skills and competences for digital transformation. Accordingly, theories in higher education (HE) are increasingly advocating a shift from 'traditional' to 'modern' education, in which students are at the centre of the educational process, and education processes are supported by different digital tools, with the final aim of 'producing' so-called T-shaped individuals capable of both depth and breadth of knowledge.

Generic competences are a component of many well-known employability models and theories, in addition to being a part of 'future education' (Dacre Pool & Sewell, 2007; Knight & Yorke, 2002; McQuaid & Lindsay, 2005). Recent graduate employability research confirms a close connection between graduates' generic skills and their employability potential (Jackson, 2017; Jayasingam et al., 2018; Moore & Morton, 2017).

There is no doubt that generic competences development is an integral part of HE and important for employability. However, gaps between the acquisition of generic and digital competences in different fields of education and their need in the workplaces have received less attention. The goal of this study is to identify patterns in graduates' perceptions of gaps between competences acquired during higher education and those required in the first workplace. The research is based on data from the Croatian national graduate survey 2017 of recent graduates in different fields of education (Medicine and Biomedical Sciences, Biotechnical Sciences, Social Sciences, Humanities, Natural Sciences, Technical Sciences

and Arts). The survey included 25 generic and 10 digital competences. Specific objectives are to (1) identify which generic and digital competences are the most relevant for employment from the perspective of graduates, (2) identify groups of competences with similar patterns of competence gaps from the graduate's perspective, and (3) identify variations in perceived gaps in competence levels by competence group and field of education.

The paper is organized as follows. The 'Literature review' presents insights from research on the most important generic and digital competencies for employment, and previous research on competence gaps/mismatch. Further, 'Materials and methods' detail study participants, data collection, and statistical analyses. 'Results' are structured in three sub-sections corresponding to the research questions. Finally, 'Discussion' places research results in the context of current research, considering research limitations, and 'Conclusions' highlight research relevance for researchers and practitioners.

Literature review

Generic and digital competences most important for employment

Different definitions and names of generic competences can be found in the literature (Badcock et al., 2010), and terms like 'soft', 'transversal', 'employability', 'basic', and 'core' are used interchangeably. The same can be said about lists of generic competences — to the best of the authors' knowledge, no such widely accepted and used list of generic competences exists. There are, however, some well-known lists of generic competences used in research in different countries and within different study disciplines — e.g. the list of 31 generic competences from the Tuning project (Tuning Educational structures in Europe, 2008) or the list of 22 generic competences used in Higher Education as a Generator of Strategic Competences project (HEGESCO, 2007). Additionally, there are lists developed for studying generic competences in particular fields of education, such as the list of 20 competences and associated behaviours applicable to business students (Jackson & Chapman, 2012) or the competence list applied to the field of Master of Engineering (MEng) (Peng et al., 2016).

Table 1 provides the generic competence list used in the Croatian national graduate survey 2017. A comparison with a selection of lists from the literature indicates that all 25 competencies are, directly or indirectly, present in some other list (HEGESCO, 2007; Jackson & Chapman, 2012; Peng et al., 2016; Tuning Educational structures in Europe, 2008).

On the other hand, the Croatian national graduate survey 2017 did not include *The use of information and communication technologies (ICT)* as a generic competence, even though it can be found in most competence lists. A reason for that is the growing importance of specific digital competences for different professions and the fact that, in some professions (e.g. ICT-related and engineering), digital competences are not considered generic, but core professional skills. Therefore, digital competences were analysed in more depth, according to the shortened and modified list from the DigComp framework (European Commission, 2016b), as shown in Table 2.

The question '*Which competences are most relevant for employment*?' does not have a unique answer. It is probably impossible to identify the most relevant employability skills in general because research results are inconsistent even within a single field of education. For instance, results of studies on desirable generic skills of ICT graduates from the perspective of employers in Australia (Hamilton et al., 2015), Spain (Llorens et al.,

Table 1 List of generic competences used in Croatian national graduate survey 2017

G1	Mastery/practical knowledge of your field and discipline
G2	Ability to apply knowledge in practical situations
G3	Knowledge in other fields
G4	Analytical thinking that includes mathematical skills
G5	Ability to rapidly acquire new knowledge and skills
G6	Knowledge about research methods
G7	Ability to identify and resolve problems
G8	Ability to perform well under pressure
G9	Ability to adapt to and act in new situations
G10	Spirit of enterprise, ability to take initiative
G11	Capacity to generate new ideas (creativity and innovativeness)
G12	Ability to manage projects
G13	Ability to use time effectively
G14	Ability to work in a team
G15	Ability to motivate people and move toward common goals
G16	Ability to develop and argue your ideas/attitude
G17	Ability to argument and make reasoned decisions
G18	Ability to be critical and self-critical
G19	Ability to work autonomously
G20	Taking responsibility and assessing the quality of one's work
G21	Ability to communicate both orally and through the written word in the mother tongue
G22	Ability to write and speak in a foreign language
G23	Ability to understand professional literature in a foreign language
G24	Professional knowledge of other countries in a part of a profession (economy, society, legislature …)
G25	Ability to work with people from other cultural environments or orientation

Table 2 List of basic digital competences (source DigComp framework (European Commission 2016b))

D1	Browsing and searching data and digital content
D2	Critically evaluate credibility and reliability of data and their sources
D3	Communicate and collaborate through digital technologies
D4	To be aware of behavioural norms in a digital environment and respect them
D5	Developing, editing and exchanging different forms of digital content
D6	To understand and respect copyright and licencing in a digital environment
D7	Planning and developing a sequence of program code
D8	Protecting personal data and privacy in a digital environment
D9	Solving technical problems in a digital environment and when using digital devices (i.e. computers)
D10	Work on the development of one's digital competences

2019), and Croatia (Pažur Aničić & Bušelić, 2021) differ. When analysing generic competences within a field of education, certain similarities and patterns can still be found. Some competences (e.g. already mentioned the use of ICT) can be generic for students in one

field of education, and core professional skills for students in another field. Thus, generic competences perceived most important for employment will be analysed within fields of education.

Generic and digital competence gaps

Researchers often group competences with similar characteristics to simplify research and communication on competence acquisition and requirements in different contexts.

However, classifications, either theoretical or empirical, are rarely based on competence gaps. Authors searched the Web of Science Core Collection and Scopus databases using the query 'TITLE-ABS-KEY (((generic* OR digital OR employ* OR graduat*) W/4 (competenc* OR skill*)) W/4 (match* OR gap* OR mismatch) AND ((factor OR principal) W/3 analys*))'. The search resulted in 13 papers in Scopus and 16 papers in WoS, out of which 13 were duplicates. Only few of those papers put focus on competence gaps.

'Competence gap' is usually defined as a difference between the level of competence acquired during studies and the level of competence required in the workplace (demand). The gap can be observed from the perspective of different stakeholders — students (Nghia, 2018), graduates (Ayodele et al., 2021; Nghia, 2018), employers (Ayodele et al., 2021; Collet et al., 2015), and others, including e.g. academic staff and public sector (Guàrdia et al., 2021). However, in some papers, gaps assessment is not based on two measures (the level of competence acquired during the studies and the level of competence required in the workplace), but on self-assessment of the gaps. For instance, Garcia-Vandewalle Garcia et al. (2021) and Guzman-Simon et al. (2017) used a student self-assessment scale in researching digital competence gaps among students in education, while Teng et al. (2019) refer to the 'graduate skill gap' by comparing undergraduate perceptions of soft employability skills development in Malaysia and China. Other measures of competence gaps can be found in the literature as well. Thus, Guàrdia et al. (2021) assessed the 'skills gap' as a % of stakeholders who agreed that the skill was valuable in the labour market (responses 'Moderately important' or 'Very important'), and (dis)agreed with the statement that the skill is acquired in higher education (responses 'Disagree' or 'Strongly disagree').

For this paper, previous research on grouping competences according to the similarity of competence gaps is particularly relevant. Even though factor analysis and principal components analysis are used in generic skills research, they are rarely applied to identify groups of competences based on competence gaps. E.g. Ayodele et al. (2021) applied factor analysis to determine factors influencing the soft skill gaps, while Guàrdia et al. (2021) used principal components analysis (PCA) to group skills based on respondents' assessment of the skills, not on the gaps. Only two papers identified in the databases applied factor analysis on competence gaps (Collet et al., 2015; Martinez-Cerda & Torrent-Sellens, 2016). Collet et al. (2015) identified 10 groups of competences gaps: (1) knowledge, (2) enterprise leadership, (3) business function, (4) technical management, (5) team worker, (6) interprofessional collaboration, (7) leadership antecedence, (8) progress, (9) improve, and (10) create, based on employers' perceptions of skill gaps in graduates employed in a knowledge-intensive industry. Martinez-Cerda and Torrent-Sellens (2016) analyse the survey on employment outcomes of graduates from Catalan universities with 14 indicators for matching skills and jobs (including generic and ICT skills). They detected five groups of matching skills: management, theoretical-practical, instrumental, academic, and communication.

Another relevant aspect for research on competences is the field of education, as different job positions require different competences. However, generic competences are often referred to as transversal competences, indicating their presumed transferability across sectors. Therefore, research on generic competences is expected to enable comparison among different fields of education, which is poorly represented in the existing literature. Often, research is focused on only one sector, such as real estate (Ayodele et al., 2021), teacher education (Garcia-Vandewalle Garcia et al., 2021; Guzman-Simon et al., 2017), knowledge-intensive industry (Collet et al., 2015), or includes several universities (Martinez-Cerda & Torrent-Sellens, 2016; Nghia, 2018). Badcock et al. (2010) compared the Art, Science, and Engineering students and found differences in the acquisition of generic skills among the three groups, but not among the gaps. They suggested that further comparison of discipline-specific priorities would be valuable in the context of the development of generic skills within educational programmes.

Finally, some authors reported on competences with evident gaps. E.g. Ayodele et al. (2021) analyse gaps in generic skills in the real estate sector from both employers' and graduates' points of view. Employers rated the expected and the observed graduates' soft skills, while graduates expressed their perception of the expected soft skills and self-assessed their actual skills. The employers identified skill gaps in responsibility, business negotiation, logical thinking, marketing skills, and dispute resolution as the most prominent. From the graduates' point of view, business negotiation, listening, ICT, marketing, and leadership skills were the most pronounced skill gaps. Nghia (2018) compared skill gaps in the final year students and graduates from Vietnam. Graduates evaluated levels of 35 skills (organized into six groups) at which work could be performed effectively, and then both graduates and final-year students were asked to rate their levels of these 35 skills. As a result, the gap was found for all six groups of competences: career development skills, learning and personal development skills, interpersonal and communication skills, intellectual skills, literacy skills, and information skills. In the majority of these papers on competence gaps, the list of generic competences included ICT competences.

It is difficult to compare the results of different studies. They do not use the same generic competence lists or the methods, nor do they include the same stakeholders who provide the competence assessments. Moreover, comparisons of the perceived levels of generic competences developed during HE with the levels required in the first workplace, among recent HE graduates from different fields of education, are rare. This study contributes to the understanding of generic and digital competence gaps from graduates' perspectives. Factor analysis was applied to data on recent graduates' perceived competence gaps from the Croatian national graduate survey 2017, using an approach similar to Collet et al. (2015).

Materials and methods

Participants

Data for this study were collected during 2017 as part of the Agency for Science and Higher Education's national survey on the employability of 2015/2016 graduates. Upon graduation, the students were asked if they agreed to participate in the survey, and 12,759, out of the total of 32,895 graduates (Croatian Bureau of Statistics, 2017), were later invited to participate in the survey. Out of 7201 respondents who initiated filling up the

questionnaire, 2851 provided complete responses to the part of the survey on generic and digital competences. Graduates in Interdisciplinary Sciences ($N=34$) were excluded from further analysis, due to their small number and heterogeneity. The final sample size was 2817. The sample comprised more female (58.7%) than male participants (41.3%). This is consistent with the data from the Croatian Bureau of Statistics according to which there were 60.0% female, and 40.0% male graduates from HEIs in Croatia in 2016 (Croatian Bureau of Statistics, 2017).

Questionnaire

The survey comprised a combination of closed and open-ended questions within eight groups of questions: A. participant data, B. study programme, C. engagement during studies, D. transition from education to the labour market, E. the first job after graduation, F. support for early career development within HEI, G. generic and transferable competences, and H. basic digital competences. The focus of this study is on the last two parts. Generic and transferable competences comprised a list of 25 competences presented in Table 1. Digital competences comprised a list of 10 basic competences provided in Table 2.

For each competence, graduates responded to two 5-points Likert-type items 'What was your acquired level of competence during your studies?' and 'What is the level of competence needed in your current workplace?', with responses ranging from 1 (none at all) to 5 (to a great extent).

Data analysis

The data analysis comprised (1) analysis of graduates' perception of the importance of generic and digital competences in the current workplace, (2) analysis of groups of competences with similar competence gaps, and (3) analysis of variation in competence gap scores among the fields of education. Data analyses were conducted using R in RStudio with packages psych, tidyverse, and fmsb (R Core Team, 2021; RStudio Team, 2021; Minato, 2022; Revelle, 2022; Wickham et al., 2019).

The most important generic and digital competences were identified by comparing descriptive statistics (mean, standard deviation, and median) of the perceived level of competences required in graduates' current jobs.

Common patterns of competence gaps were identified using exploratory factor analysis. The suitability of data for factor analysis was assessed using Keiser-Meier-Olkin's measure of sampling adequacy and Bartlett's test of sphericity. The number of factors to extract was determined using the parallel analysis, and factors extracted using principal axes factor analysis were rotated to a simple structure using oblimin rotation (Mulaik, 2010).

For each competence gaps group identified by factor analysis, its score was computed as the mean of competence gaps in the group. Variability of these scores among the fields of education was visualized using radial plots.

Results

Table 3 summarizes data on participants' demographics. The sample comprised more female (58.7%) than male participants (41.3%). As expected, most respondents (80.5%) were between 24 and 29 years old. Differences in age distribution between male and female

Table 3 Participants' demographic characteristics

		Gender		Total (%)
		Male (*N*, % by age group)	Female (*N*, % by age group)	
Age group	20–23 years	76 (6.5)	137 (8.3)	213 (7.6)
	24–29	948 (81.6)	1320 (79.8)	2268 (80.5)
	30–39	113 (9.7)	143 (8.6)	256 (9.1)
	40–55	25 (2.2)	54 (3.3)	79 (2.8)
	56+	0 (0.0)	1 (0.1)	1 (0.0)
	Total	1162 (41.2)	1655 (58.8)	2817

graduates were not statistically significant ($\chi^2 = 7.2$, df $= 3$, $p = 0.066$). For comparison, in the population of all 2016 graduates, 76.0% were between 22 and 27 years old (Croatian Bureau of Statistics, 2017).

The majority of respondents graduated in Social Sciences (49.4%) or Technical Sciences (29.7%) (Table 4). Comparable statistics on graduates in the population are not available; however, in 2016, 43.5% of students were enrolled in a study programme in Social Sciences, and 26.3% in Technical Sciences (Agency for Science & Higher Education, 2021). Thus, the age and field of education structure of our sample matches well the population structure (Croatian Bureau of Statistics, 2017).

The most important generic and digital competencies for employment

Table 5 shows descriptive statistics by field of education for the three generic and digital competences with the highest perceived level of competence required in the workplace. It is interesting that for all fields of education, the top three generic competences come from a set of only five generic competences:

- *G7 Ability to identify and resolve problems* — Natural Sciences, Technical Sciences
- *G9 Ability to adapt to and act in new situations* — Biomedicine and Health Sciences, Biotechnical, Social Sciences, Humanities and Arts

Table 4 Distribution of participants by gender and field of education

		Gender		Total
		Male *N* (%)	Female *N* (%)	
Field of education	Biomedicine and Health Sciences	40 (3.4)	132 (8.0)	172 (6.1)
	Biotechnical Sciences	31 (2.7)	60 (3.6)	91 (3.2)
	Social Sciences	365 (31.4)	1026 (62.0)	1391 (49.4)
	Humanities	31 (5.8)	96 (5.8)	127 (4.5)
	Natural Sciences	51 (6.4)	106 (6.4)	157 (5.6)
	Technical Sciences	625 (53.8)	211 (12.8)	836 (29.7)
	Arts	19 (1.6)	24 (1.5)	43 (1.5)
	Total	1162	1655	2817

Table 5 Descriptive statistics of required competence levels by field of education and competence group, featuring three generic and digital competences with the highest mean score

	Range of $\bar{x}$'s	Competence*	$\bar{x}$	σ	Me
All students					
Generic competences	2.82–4.12	G19	4.12	0.99	4
		G20	4.10	0.99	4
		G9	4.07	1.10	4
Digital competences	2.58–4.14	D1	4.14	1.08	5
		D3	4.08	1.10	4
		D2	3.94	1.12	4
Biomedicine and Health Sciences					
Generic competences	2.94–4.23	G20	4.23	0.93	5
		G19	4.23	1.00	5
		G9	4.20	0.95	5
Digital competences	2.28–3.76	D1	3.76	1.15	4
		D3	3.72	1.14	4
		D2	3.66	1.19	4
Biotechnical Sciences					
Generic competences	2.77–4.10	G19	4.10	1.04	4
		G20	3.95	1.13	4
		G9	3.82	1.17	4
Digital competences	2.44–3.71	D1	3.71	1.36	4
		D3	3.57	1.37	4
		D2	3.53	1.34	4
Social Sciences					
Generic competences	2.77–4.11	G21	4.11	1.11	5
		G19	4.07	1.02	4
		G9	4.07	1.01	4
Digital competences	2.34–4.11	D1	4.11	1.09	4
		D3	4.07	1.11	4
		D4	3.92	1.13	4
Humanities					
Generic competences	2.81–4.40	G19	4.40	0.95	5
		G9	4.39	1.01	5
		G21	4.39	1.03	5
Digital competences	2.81–4.17	D1	4.17	1.12	5
		D2	4.06	1.22	5
		D3	4.05	1.16	4
Natural Sciences					
Generic competences	2.81–4.33	G19	4.33	0.92	5
		G20	4.28	0.93	5
		G7	4.23	0.97	5
Digital competences	3.12–4.49	D1	4.49	0.87	5
		D3	4.34	0.92	5
		D2	4.29	0.95	5

Table 5 (continued)

	Range of $\bar{x}$'s	Competence*	$\bar{x}$	σ	Me
Technical Sciences					
Generic competences	2.77–4.10	G7	4.10	1.01	4
		G19	4.10	0.94	4
		G20	4.09	0.93	4
Digital competences	3.06–4.25	D1	4.25	1.01	5
		D3	4.18	1.03	5
		D2	4.03	1.07	4
Arts					
Generic competences	2.47–4.26	G20	4.26	1.00	5
		G9	4.23	0.97	4
		G19	4.19	1.12	5
Digital competences	1.93–3.98	D3	3.98	1.18	4
		D1	3.84	1.17	4
		D4	3.74	1.22	4

*Gx and Dx represent generic competences enumerated in Table 1 and digital competences enumerated in Table 2, respectively

- *G19 Ability to work autonomously* — in all fields of education
- *G20 Taking responsibility and assessing the quality of one's work* — all fields of education except Social Sciences and Humanities
- *G21 Ability to communicate both orally and through the written word in the mother tongue* — Social Sciences and Humanities

When it comes to digital competences, the top three competences for all fields of education come from a set of only four competences:

- *D1 Browsing and searching data and digital content* — all fields of education
- *D2 Critically evaluate credibility and reliability of data and their sources* — all fields of education except Social Sciences and Arts
- *D3 Communicate and collaborate through digital technologies* — all fields of education
- *D4 To be aware of behavioural norms in a digital environment and respect them* — Social Sciences and Arts

Factor analysis

To identify common patterns in competence gaps, an exploratory factor analysis was conducted. The Kaiser–Meyer–Olkin's (KMO) measure of sampling adequacy was 0.97, indicating that analysed competence gaps were highly appropriate for factor analysis. Bartlett's test of sphericity was highly significant ($\chi^2 = 64{,}363$, df $= 595$, $p < 0.001$) also confirming that competence gaps were not independent.

The parallel analysis suggested eight factors. The extracted factors were transformed into a simple structure using oblimin rotation. Competence gaps in *G3 Knowledge in other fields* and *G13 Ability to use time effectively* had loadings below 0.3 on all factors and were excluded from further analysis. Competence gaps in *G5 Ability to rapidly acquire new knowledge and skills*, *G15 Ability to motivate people and move toward common goals*, and *D5 Developing, editing and exchanging different forms of digital content* had loadings above 0.3 on two factors. After removing these competence gaps, a simple factor structure was obtained. The eighth factor had Cronbach's alpha equal to 0.57; therefore, competence gaps loading on this factor (*G6 Knowledge about research methods* and *G4 Analytical thinking that includes mathematical skills*) were also removed from the analysis, due to low factor reliability. After removing these competence gaps, the overall sampling adequacy KMO was 0.96, and item level sampling adequacies ranged between 0.90 and 0.99. Bartlett's test of sphericity was still highly significant ($\chi^2 = 50{,}080$, df $= 378$, $p < 0.001$). The parallel analysis suggested seven factors, which accounted for 62% of the variance.

Table 6 presents the results of the common factor analysis. Communalities of competence gaps ranged between 0.37 and 0.76. Communalities below 0.5 were achieved by G21 (0.37), G14 (0.43), D7 (0.43), G25 (0.46), and D6 (0.48). Correlations between the rotated factors ranged between 0.28 and 0.78. The highest correlations were between gaps in general digital competences and technical digital competences (0.776), followed by critical thinking and reasoning and intercultural competences (0.648), critical thinking and reasoning and entrepreneurial spirit and leadership (0.596), and general digital competences and intercultural competences (0.592). All other correlations were below 0.55. Cronbach's alphas were all above 0.8, reflecting high reliability. The lowest corrected item-total correlation was 0.59. Interpretations of extracted factors are as follows:

(1) *Critical thinking and reasoning* include gaps in competences related to developing and arguing own ideas/attitudes, making reasoned decisions, and the ability to be critical and self-critical. These competences are also reflected in the ability to assess the quality of one's work, to work autonomously, and to take responsibility. This group includes three of the five generic competences with the highest perceived levels required in the workplace.

(2) *General digital competences* are related to the use of digital technology in everyday life. They are necessary for effective communication using digital tools and services, finding and evaluating online sources of data and information, and respecting behavioural norms in the digital environment, not strictly related to a workplace. This group includes all four digital competences with the highest perceived levels required in the workplace.

(3) *Technical digital competences* include a higher level of digital skills, such as solving technical problems and working on the development of one's digital competences, as well as programming, data security, and privacy in a digital environment.

(4) *Intercultural competences* are related to communication in foreign languages and relevant professional knowledge of other countries, including working with people from other cultures.

(5) *Practical knowledge and its application* relate to core professional skills and the ability to apply theoretical knowledge in a real situation.

(6) *Adaptability* includes competences required for working under pressure, adapting to new situations and rapid acquisition of new knowledge to solve complex real-world

Table 6 Results of the common factor analysis of competence gaps after oblimin rotation. Cronbach's alpha and percent of variance accounted are reported for each factor. For each competence gap, its mean, standard deviation, factor loading, communality, and corrected item-total correlation are reported for each factor. Mean competence gap group score and standard deviation are reported for each factor

CA	% var	Factor	$\bar{x}$	σ	Factor loading	h^2	CITC
0.89	13%	**1 Critical thinking and reasoning**	−0.37	1.00			
		G16 Developing and arguing own ideas/attitude	−0.39	1.4	0.80	0.72	0.81
		G17 Ability to argument and make reasoned decisions	−0.47	1.3	0.80	0.76	0.84
		G18 Ability to be critical and self-critical	−0.25	1.2	0.66	0.59	0.75
		G20 Taking responsibility and assessing the quality of one's work	−0.51	1.2	0.57	0.61	0.77
		G19 Ability to work autonomously	−0.40	1.2	0.54	0.51	0.70
		G14 Ability to work in a team	−0.32	1.3	0.39	0.43	0.64
		G21 Ability to communicate both orally and through the written word in the mother tongue	−0.25	1.3	0.39	0.37	0.59
0.90	12%	**2 General digital competences**	−0.24	1.12			
		D1 Browsing and searching data and digital content	−0.21	1.3	0.84	0.69	0.81
		D3 Communicate and collaborate through digital technologies	−0.34	1.3	0.82	0.76	0.87
		D2 Critically evaluate credibility and reliability of data and their sources	−0.24	1.3	0.81	0.70	0.82
		D4 To be aware of behavioural norms in a digital environment and respect them	−0.32	1.3	0.68	0.70	0.84
		D6 To understand and respect copyright and licencing in a digital environment	−0.06	1.4	0.34	0.48	0.65
0.86	10%	**3 Technical digital competences**	−0.36	1.09			
		D9 Solving technical problems in a digital environment and when using digital devices (i.e. computers)	−0.50	1.3	0.84	0.71	0.82
		D10 Work on the development of one's digital competences	−0.40	1.4	0.71	0.70	0.82
		D8 Protecting personal data and privacy in a digital environment	−0.45	1.4	0.67	0.62	0.76
		D7 Planning and developing a sequence of program code	−0.10	1.2	0.64	0.43	0.64
0.83	9%	**4 Intercultural competences**	−0.30	1.17			
		G23 Ability to understand professional literature in a foreign language	−0.11	1.5	0.77	0.66	0.77
		G22 Ability to write and speak in a foreign language	−0.41	1.4	0.76	0.62	0.77
		G24 Professional knowledge of other countries in a part of a profession	−0.27	1.3	0.72	0.54	0.72
		G25 Ability to work with people from other cultural environments or orientation	−0.41	1.4	0.59	0.46	0.66
0.81	6%	**5 Practical knowledge and its application**	−0.33	1.33			

Table 6 (continued)

CA	% var	Factor	$\bar{x}$	σ	Factor loading	h^2	CITC
		G1 Mastery/practical knowledge of your field and discipline	− 0.09	1.4	0.85	0.70	0.76
		G2 Ability to apply knowledge in practical situations	− 0.58	1.5	0.77	0.68	0.76
0.82	6%	**6 Adaptability**	− 0.64	1.16			
		G8 Ability to perform well under pressure	− 0.60	1.5	0.70	0.60	0.73
		G9 Ability to adapt to and act in new situations	− 0.77	1.3	0.65	0.74	0.81
		G7 Ability to identify and resolve problems	− 0.55	1.3	0.33	0.59	0.70
0.83	5%	**7 Entrepreneurial spirit and leadership**	− 0.49	1.24			
		G10 Spirit of enterprise, ability to take initiative	− 0.58	1.4	0.57	0.67	0.78
		G12 Ability to manage projects	− 0.45	1.5	0.47	0.59	0.74
		G11 Capacity to generate new ideas (creativity and innovativeness)	− 0.45	1.4	0.46	0.66	0.77

CA, Cronbach's alpha; h^2, communalities; *CITC*, corrected item-total correlation

problems. This group contains two of the five generic competences with the highest
perceived levels required in the workplace.

(7) *Entrepreneurial spirit and leadership* are related to the ability to take initiative, manage
projects, and generate new ideas that can lead to the achievement of set goals.

The average perceived competence gap is negative for all competences included in the
factor analysis, indicating a perceived general lack of acquired competences. For each of
these competence groups, a competence gap group score was computed as the mean com-
petence gap. Mean competence gap group scores were also all negative.

Competence gaps by field of education

Variation in competence gaps across fields of education was analysed by comparing com-
petence gap group scores. Figure 1 shows radial plots of mean scores by competence group
for each field of education (red line). The black line traces the score of zero, indicating no
competence gap, and the blue line represents the overall mean score for all fields of educa-
tion. Red lines closer to the centre of the plot indicate larger competence gaps, while those
closer to the edge than the black line indicate no lack of competence for the competence
group.

Overall mean scores for all competence groups were negative, indicating a perceived
competence gap in all competence groups. Graduates in Natural Sciences perceived the
competence gaps in intercultural competences and entrepreneurial spirit and leadership as
the most prominent, while the gaps in practical knowledge and its application and adapt-
ability were present, but smaller than the overall average. On the other hand, graduates in
Biomedicine and Health Sciences perceived the gaps in adaptability and practical knowl-
edge and its application as the most remarkable. These graduates also perceived a gap in
critical thinking larger than average, but they perceived no gap in general digital compe-
tences. Graduates in Biotechnical Sciences perceived gaps less than the overall average for
all competence groups. They perceived competence gaps in entrepreneurial spirit and lead-
ership and adaptability, but no gaps in general and technical digital competences, practical
knowledge and its application, and intercultural competences. Perceived gaps for graduates
in Technical Sciences were only slightly larger than overall averages, as expected because
Social Sciences and Technical Sciences had the highest representation in the data, exert-
ing the largest influence on the means. Still, graduates in Technical Sciences perceived
the gaps in intercultural competences, and practical knowledge and its application as the
most pronounced. Graduates in Social Sciences were the largest group in the data. Their
mean scores were therefore also close to the overall means, with larger perceived gaps in
adaptability and practical knowledge and its applications, and technical digital compe-
tences, and less than average gaps in intercultural competences and entrepreneurial spirit
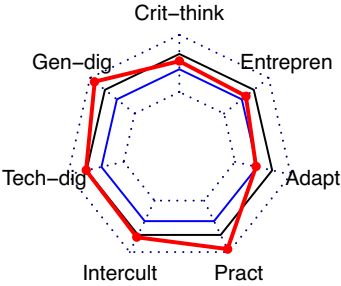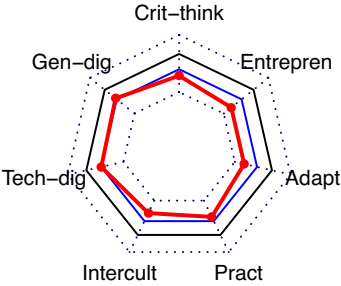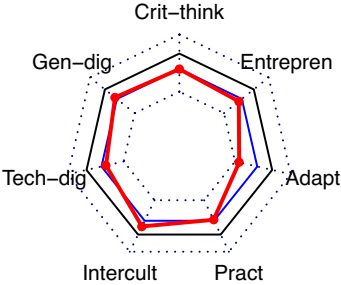
Natural Sciences
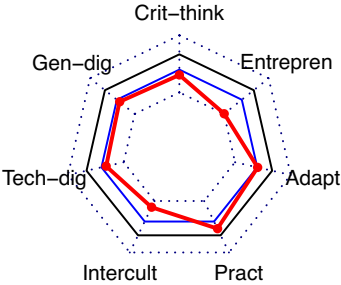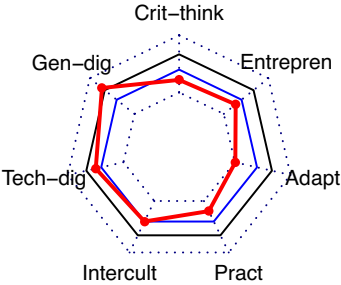
Crit–think
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Biomedicine and Health Sciences

Crit–think
Gen–dig
Entrepren
Tech–dig
Adapt
Intercult
Pract

Biotechnical Sciences

Crit–think
Gen–dig
Entrepren
Tech–dig
Adapt
Intercult
Pract

Technical Sciences

Crit–think
Gen–dig
Entrepren
Tech–dig
Adapt
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Social Sciences

Crit–think
Gen–dig
Entrepren
Tech–dig
Adapt
Intercult
Pract

Humanities

Crit–think
Gen–dig
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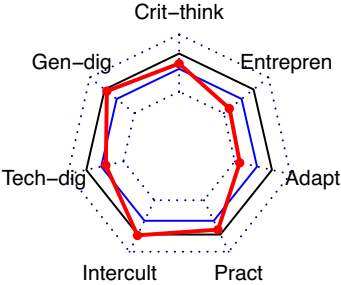
Crit–think
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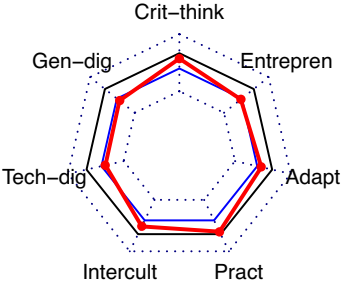
and leadership. Graduates in Humanities did not perceive any gaps in intercultural competences, general digital competences, and practical knowledge and its application, but had perceived above-average gaps in adaptability, entrepreneurial spirit and leadership, and technical digital skills. Graduates in Arts were the smallest group, and their mean scores should be interpreted with a grain of salt because the standard error of the mean is the largest. The largest perceived gap for these graduates was in general digital competences, and they perceived practically no gap in critical thinking and practical knowledge and its application.

Discussion

The present study analyses competence gaps from the perspective of recent graduates up to 1 year following graduation. The study is based on data from a Croatian national graduate survey and comprises both generic and digital competences.

The study explores the most important generic and digital competences in today's workplace, as identified by recent graduates. Interestingly, the *ability to work autonomously* was placed among the top three competences by students in all fields of education. As stated in World Economic Forum-Centre for the New Economy and Society White Paper (2019), the 4th industrial revolution poses challenges to the current learning and employment ecosystem and requires continuous reskilling and upskilling of the workforce. In that environment, the ability to learn and work autonomously can be crucial for one's career development and progress. This relates to *adapting to new situations* and *taking responsibility for the quality of one's work*, both of which were recognized as important for most fields of education. Additionally, graduates also identified basic digital skills, including *browsing digital content and its evaluation*, as well as *communication through digital technologies* as important for all fields of education. These results emphasize the importance of recent EU endeavours for developing digital skills among students and the workforce (European Commission, 2020a, b).

The most important contribution of this study is in seven identified groups of competence gaps using factor analysis. Although research on competence groups are evident in the literature, there is no reason to believe that competence gaps group the same way as competences. To the best authors' knowledge, only two studies (Collet et al., 2015; Martinez-Cerda & Torrent-Sellens, 2016) analyse competence gap groups using factor analysis. Collet et al. (2015) research competence gaps from employers' perspective in knowledge-intensive industry. Their competence list includes 61 items that put emphasis on business and leadership skills. Martinez-Cerda and Torrent-Sellens (2016) research design is more similar to our research as their sample includes graduates from several HEIs and they use more similar competence list. However, ICT skills are represented as one item. The contribution of our research is evident in following: (1) two competence lists are studied — generic competence list and generic digital competence list, (2) research is performed on a national level, including large sample of graduates from all fields of education, and (3) factor analysis is performed on competence gaps, with seven groups identified.

Some similarities with previous research in identified competence gap group can be recognized. The factor *Practical knowledge and its application* and *Entrepreneurial spirit and leadership* can be found in very similar forms in both Collet et al. (2015) and Martinez-Cerda and Torrent-Sellens (2016), who indicated a persistent gap in knowledge and leadership competences, regardless of the field of education or points of view

of different stakeholders. Factor *Critical thinking and reasoning* comprises a set of competences that are found in different competence groups in the research literature, e.g. Knowledge in Collet et al. (2015) and Management, Academic and Communication in Martinez-Cerda and Torrent-Sellens (2016). The latter example is consistent with the relatively high correlation between our critical thinking and reasoning and both intercultural competences (related to communication), and entrepreneurial spirit and leadership (related to management). Interestingly, competences gaps in group *intercultural competence* and *adaptability* are grouped to some extent together within *interprofessional collaboration* (Collet et al., 2015). The new results is that gaps in digital competences formed two separate, though correlated factors — *general digital competences* and *technical digital competences*. This could not have been identified by previous research that used less items for ICT skills. E.g. in Martinez-Cerda and Torrent-Sellens (2016), the single ICT skills item is grouped with languages and documentation as an instrumental skill group. Their grouping of languages and documentation is consistent with our finding of a relatively high correlation between intercultural competences and general digital competences. The present research indicates that more emphasis should be put on digital skills gaps.

Some parallels with previous research can also be found in competence gap groups by field of education. E.g. the subject-specific skills gaps, similar to our *practical knowledge and its application*, are evident in 35% of respondents from Guàrdia et al. (2021), while the study by Ayodele et al. (2021) indicated skill gaps in leadership, from students' point of view. Our *critical thinking and reasoning* are similar to logical thinking and dispute resolutions, which are recognized by employers as skills with influenced gap (Ayodele et al., 2021). In our study, the perceived level of required competences for *critical thinking and reasoning* was high, and the mean gap score was negative for all fields of education. This finding indicates the importance of developing critical thinking among students in all fields of education. Because globalization and digitalization are expected to have a huge impact on future jobs (World Economic Forum Centre for the New Economy and Society Insight Report, 2018), competences categorized as 'digital' and 'intercultural' will play a significant role in all sectors. In our research, the gap for intercultural competences varied across fields of education. It was the most pronounced in Technical and Natural Sciences, and non-existent in Humanities and Biotechnical Sciences. Guàrdia et al. (2021) found that 43% of respondents recognized gaps in cross-cultural and diversity competence. Therefore, HEIs should find ways to support students' development of those skills, such as online education, including collaboration with other universities, as is already the case in software engineering (Billingsley et al., 2019; Bosnić et al., 2019). Finally, the distinction between generic and technical digital competences revealed the dependence of more complex (technical) ICT skills on the study area, which corroborates of our decision to analyse digital competencies separately from the generic ones. Previous research shows that including ICT skills among generic skills often results in detecting a gap, which might not really exist for the digital competences (Ayodele et al., 2021; Guàrdia et al., 2021).

Analysis of competence gaps across fields of education identified particular educational needs of graduates in certain disciplines. For instance, graduates in medicine and biomedicine face very responsible and stressful situations in their workplace that are difficult to imitate during their studies. Graduates in Biomedical and Health Sciences reported the largest gaps in *practical knowledge and its application*, *adaptability*, and *entrepreneurial spirit and leadership*. In addition to more internship and work-integrated learning, they could also benefit from courses on dealing with stressful situations and taking responsibility for their work. Activities that would help students to adapt to

and act in new situations would also benefit graduates in Social Sciences, Humanities, and Technical Sciences, while students in all fields should be encouraged to develop entrepreneurial skills.

Conclusion

Contribution of this study is in identified patterns of competence gaps across fields of education, in particular two subgroups of ICT competence gaps — *general digital competences* and *technical digital competences*. The study's findings contribute to understanding of the pattern of mismatches between required and acquired competencies in higher education, as well as their variation across fields of education. Considering challenges and developments occurring in today's world, such as globalization and digital transformation, HEIs should find ways to transform and adapt their processes to equip students with competences relevant to the labour market. The results of this research can serve as a good starting point to improve students' generic and digital competences in different fields of education.

Several limitations of this study can be recognized. The size of the sample is this study's strength, but the sample collected from a single country is its limitation. However, one should also consider that Croatian higher education is aligned with European Higher Education through participation in the Bologna process and adoption of the European Qualification Framework. Therefore, we believe that these empirical results can be generalized across the national border. Another limitation is that graduate perceptions are always subjective to some extent. Inclusion of the employers and HE teachers' perspectives may provide more balanced view on graduates' generic and digital competence gap.

Future research may address the recognized limitations by conducting replication studies across different countries and fields of education. Longitudinal study in the same country would also provide valuable results and insight into trends in competence gap patterns. Finally, combining perspectives of all stakeholders, employers, graduates, and teachers would have the potential to make significant strides in bridging the identified gaps.

Author contribution Conceptualization: JGM, KPA, DŠ.
 Data curation: JGM.
 Formal analysis and visualization: JGM.
 Funding acquisition: KPA.
 Methodology: JGM, KPA, DŠ.
 Supervision: DŠ.
 Writing — original draft preparation: KPA, JGM.
 Writing — review and editing: JGM, KPA, DŠ.

Availability of data and material The study uses secondary data, and the authors are not authorized to share the individual data. The data might be available on request from the Croatian Agency for Science and Higher Education.

Code availability Analyses were performed using statistical environment R. R scripts are available from the authors on request.

Declarations

Ethics approval The study uses anonymized secondary data from the national study on graduate employability. Therefore, the approval from the ethics committee is not required.

Consent to participate This study uses secondary data collected by the Croatian Agency for Science and Higher Education within project *Improving the assurance system and improving the quality of higher education (SKAZVO).* The authors were not responsible for data collection, but they received formal approval from Croatian Agency for Science and Higher Education to use the anonymized data for this study.

Competing interests The authors declare no competing interests.

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