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COVID-19 as a Catalyst for Digital Competence in Post-Yugoslav Higher Education

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The COVID-19 pandemic significantly accelerated digital transformation in education. Traditional face-to-face learning was rapidly replaced by e-learning, highlighting the urgent need for digital competence among educators and students. The present study examines how the pandemic acted as a catalyst for the development of digital competencies within the educational sectors in post-Yugoslav states. It explores the challenges and opportunities presented by e-learning during the pandemic period and considers its long-term implications. Online surveys with 424 educators and 1,549 students were conducted in Bosnia and Herzegovina, Croatia, North Macedonia, Montenegro and Slovenia to assess their experiences with digital learning tools and platforms. In addition, statistical data on e-learning adoption rates and technological advancements in education were analysed. The findings indicate a notable increase in digital competence among both educators and students, while also revealing persistent gaps in digital readiness. The most significant improvements were observed in digitally less-developed countries, where reliance on free-of-charge software played a crucial role. Looking ahead, it is essential to integrate digital competency training into educational curricula to ensure sustainable and effective use of technology in education. The study underscores the importance of institutional investment in digital training and infrastructure to support long-term digital learning strategies. It also offers insights into how a crisis can accelerate digital transformation in education, highlighting both the benefits and challenges of e-learning adoption.

Keywords: COVID-19, e-learning, digital competence, education, digital transformation, online learning, digital literacy

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Covid-19 kot katalizator digitalne kompetentnosti v visokošolskem izobraževanju držav nekdanje Jugoslavije

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Pandemija covida-19 je znatno pospešila digitalno preobrazbo v izobraževanju. Tradicionalno učenje iz oči v oči je bilo hitro nadomeščeno z e-učenjem, kar je poudarilo nujno potrebo po digitalnih kompetencah izobraževalcev in študentov. Ta članek kaže, kako je pandemija delovala kot katalizator za razvoj digitalnih kompetenc v izobraževanju v državah nekdanje Jugoslavije. Raziskuje izzive in priložnosti, ki jih je prinesel prehod na e-učenje med pandemijo, ter ocenjuje dolgoročne posledice tega prehoda. Da bi izmerili izkušnje z digitalnimi učnimi orodji in platformami, smo v Bosni in Hercegovini, na Hrvaškem, v Severni Makedoniji, Črni gori in v Sloveniji prek spleta anketirali 424 izobraževalcev in 1.549 študentov. Analizirali smo tudi statistične podatke o stopnji sprejetosti e-učenja in tehnološkem napredku v izobraževanju. Podatki kažejo na opazno povečanje digitalnih kompetenc med izobraževalci in študenti, hkrati pa razkrivajo vztrajne vrzeli v digitalni kompetentnosti. Največje izboljšave so bile opazne v digitalno manj razvitih državah, v katerih je imela ključno vlogo uporaba brezplačne programske opreme. Za zagotovitev trajnostne in učinkovite rabe tehnologij v izobraževanju bo treba v izobraževalne programe vključiti tudi usposabljanje na področju digitalne kompetentnosti. Študija poudarja pomen institucionalnih vlaganj v digitalno usposabljanje in infrastrukturo za podporo dolgoročnih strategij digitalnega učenja ter prikazuje prednosti in omejitve hitre digitalne transformacije v kriznem obdobju.

Ključne besede: covid-19, e-izobraževanje, digitalna kompetentnost, izobraževanje, digitalna transformacija, spletno učenje, digitalna pismenost

Introduction

The COVID-19 pandemic profoundly impacted education systems worldwide, necessitating an unprecedented shift towards digital learning. This transition affected all levels of education, from higher education institutions to primary schools. Studies have shown that parents experienced both positive contributions, such as increased autonomy in their children's learning, and significant challenges, including the need for guidance and support in the online learning environment (Drvodelić & Domović, 2022). In Slovenia, parents, particularly those with adolescents, faced difficulties in coordinating their work with supporting their children's motivation during remote schooling (Levpušček & Uršič, 2021). Universities and other higher education institutions were compelled to transition rapidly from traditional face-to-face instruction to fully online or hybrid learning models. While this shift presented numerous challenges, it also served as a powerful catalyst for the development of digital competencies among both educators and students (Pérez-Escoda et al., 2021; Vishnu et al., 2022). The rapid move to online learning presented unique challenges and opportunities across various disciplines; for example, architectural education had to adapt to virtual formats (Unver & Sungur, 2022), requiring innovative solutions to maintain effective teaching. Furthermore, research has highlighted the importance of students' self-regulation and positivity in navigating emergency remote teaching in higher education (Jurišević et al., 2021). Even physical education explored new models, with studies identifying effective approaches like flipped learning to maintain student engagement (Petrušič & Štemberger, 2021).

Studies across multiple countries revealed varying levels of digital competence among students and faculty, with socioeconomic factors influencing these skills (Tejedor et al., 2020). While most students demonstrated basic digital competencies, weaknesses were identified in areas such as digital content creation and cybersecurity (Martínez-Garcés & Garcés-Fuenmayor, 2020). The pandemic underscored the need for universities to enhance digital literacy, improve communication and adapt teaching methodologies to new technological demands (Tejedor et al., 2020; Cook et al., 2023). Furthermore, research highlighted the importance of integrating digital tools and social networks to support students in developing essential digital skills (Rodríguez-Moreno et al., 2021).

Overall, these studies emphasise the critical role of digital competencies in higher education and the necessity for continued development and institutional support in this area (Zhao et al., 2021). The pandemic not only accelerated digital transformation but also highlighted disparities in digital readiness,

reinforcing the urgent need for long-term strategies to bridge the digital divide and enhance digital education frameworks.

As elsewhere, these global trends were acutely felt in the post-Yugoslav states, where the rapid transition to e-learning revealed specific regional challenges and opportunities, exposing significant disparities in digital infrastructure, institutional preparedness and pedagogical adaptability. While some higher education institutions successfully integrated existing digital tools, others encountered substantial challenges, including limited technological proficiency, inadequate resources and resistance to change. This accelerated digital transformation has underscored the need to re-evaluate digital literacy and competencies as fundamental pillars of contemporary academic environments.

The adoption of e-learning across post-Yugoslav countries presents diverse challenges and opportunities. In Bosnia and Herzegovina, institutional readiness, the effectiveness of quality assurance systems and student motivation have emerged as critical factors influencing the implementation of e-learning (Nurovic & Poturak, 2023). Slovenia has leveraged e-learning to enhance economic development and employability, demonstrating its broader societal benefits (Carey & Blatnik, 2005). In Serbia, the success of e-learning initiatives has been assessed using key performance indicators such as academic achievement and student satisfaction (Raspopovic et al., 2014). Meanwhile, Croatia has recognised the strategic importance of e-learning implementation, emphasising its functional advantages in higher education (Divjak & Begičević, 2006). Given the evolving landscape of digital education, it is imperative for higher education institutions in the post-Yugoslav region to prioritise sustained investment in digital infrastructure, faculty training and student support services. Addressing these challenges through targeted policy interventions and strategic planning will be essential in ensuring the long-term success and inclusivity of e-learning initiatives in the region.

The present paper examines how the COVID-19 crisis influenced the development of digital competencies in higher education institutions across post-Yugoslav countries. Specifically, it explores the key challenges and opportunities arising from the rapid adoption of e-learning, the role of institutional policies and the long-term implications for digital education in the region. By analysing these factors, the study aims to contribute to the broader discourse on digital transformation in academia and inform future strategies for enhancing digital readiness in higher education.

Research question:

- Was the COVID-19 pandemic associated with a reduction in the digital competences gap between countries?

Theoretical Background

What Can We Learn From the COVID-19 Era in the Field of Online Studies?

The COVID-19 pandemic prompted a dramatic shift in global education systems, forcing educational institutions to rapidly pivot to online learning as a response to public health concerns and social distancing measures. This transition, while swift and necessary, revealed both significant challenges and emerging opportunities in the landscape of education (Chakraborty et al., 2021; Dhawan, 2020). While many students expressed a preference for traditional, in-person classrooms, they also recognised the necessity and benefits of online education in such unprecedented circumstances (Chakraborty et al., 2021). This shift emphasised the crucial role of online teaching strategies and highlighted the need for educators to adapt to digital tools, with a particular focus on enhancing digital pedagogy skills (Jena, 2020; Jiang et al., 2022).

During this period, a wide array of instructional modalities emerged, with institutions employing both synchronous and asynchronous formats. Technologies such as video conferencing platforms, particularly Zoom, became integral to delivering lectures, engaging students and facilitating discussions, allowing a semblance of classroom interactivity in virtual environments (Camargo et al., 2020). Despite initial hesitation from both educators and students regarding the efficacy of online learning, educational institutions gradually adapted their teaching methodologies, refining pedagogical approaches and exploring new avenues for virtual engagement. As a result, the demand for educational technology solutions surged, fostering the rapid growth of EdTech startups aimed at addressing the specific needs of this new educational paradigm (Dhawan, 2020).

However, this rapid transition was not without its challenges. Students reported experiencing significant stress due to increased screen time, the blurring of boundaries between work and personal life, and difficulties with maintaining focus and motivation in a remote learning environment. In addition, concerns about physical health and the negative effects of prolonged isolation were prevalent (Chakraborty et al., 2021; Ishmuhametov & Kuzmenko, 2021). These issues underscored the need for a holistic approach to online education, one that considers not only the technological and pedagogical aspects but also the well-being of students as they navigated this new learning environment.

Despite these challenges, the experience of navigating the shift to online learning has provided valuable lessons for the future of education. Insights gained during this period have underscored the importance of preparedness

for digital transformation, highlighting the need for robust infrastructure, professional development of educators, and the creation of supportive learning environments that promote student engagement and well-being (Telli & Altun, 2021; Valova & Mladenova, 2022). As education systems continue to evolve, the experiences gained during the pandemic will inform ongoing efforts to enhance online education practices and ensure their sustainability in an increasingly digital world. The lessons learned from this era are thus instrumental in shaping the future trajectory of education, as institutions seek to integrate the most effective aspects of online learning into their long-term educational strategies.

Interactivity of Online Teaching

Interactivity plays a pivotal role in fostering student satisfaction, persistence and success within online learning environments (Durrington et al., 2006; Croxton, 2014). The absence of face-to-face interactions in virtual classrooms requires educators to strategically design courses that emphasise engagement through various forms of interaction. Research suggests that effective online courses should provide ample opportunities for student-instructor, student-student and student-content interactions in order to create a dynamic and supportive learning atmosphere (Mabrito, 2005; Ngoc, 2022). These interactions are essential for building a sense of community, promoting deeper learning and ensuring that students remain motivated and connected to their peers and instructors.

One of the most important strategies to enhance interactivity in online education is timely and constructive feedback. According to Barboza and da Silva (2016), feedback that is both prompt and specific helps students understand their strengths and areas for improvement, motivating them to engage more actively in their learning process. Blending synchronous and asynchronous activities is another effective strategy to foster interaction. Malik (2010) suggests that while synchronous activities such as live webinars and discussions enable real-time engagement and immediate feedback, asynchronous activities provide students with the flexibility to reflect and engage at their own pace. The combination of both formats ensures that students can benefit from the immediacy of live interactions as well as the thoughtful, reflective nature of asynchronous learning.

Collaborative projects and presentations further enhance interactivity by encouraging students to work together, share ideas and learn from one another. These activities not only deepen students' understanding of course material but also help develop essential teamwork and communication skills (Ngoc,

2022). In order to maximise these opportunities, instructors can take an active role in designing creative activities, actively encouraging student participation and fostering an online environment that is conducive to interaction. Developing strong online teaching competencies, including the ability to engage students through innovative approaches, is vital for instructors to effectively navigate the digital space (Muirhead, 2001; Barboza & da Silva, 2016).

The relationship between interactivity and student outcomes is well supported by research. Durrington et al. (2006) found that interactive online environments contribute to more positive student attitudes and improved performance levels. When students feel engaged and supported through regular interactions with instructors and peers, they are more likely to persist in their studies and achieve academic success. Despite these benefits, maintaining high-quality interactions in distance education remains a significant challenge, particularly given the inherent limitations of online learning, such as technology access, time zones and varying levels of student engagement. Continued research is therefore necessary in order to identify and refine the most effective strategies for fostering interactivity in online education. Additionally, the professional development of instructors is crucial to ensure they are equipped with the skills and knowledge necessary to design and facilitate interactive learning experiences (Muirhead, 2001; Sunal et al., 2006). As online education continues to evolve, ongoing efforts to improve interactivity will be instrumental in enhancing the overall quality and effectiveness of digital learning environments.

What Students Want From Online Teaching

Students' preferences in online learning are strongly influenced by their need for flexibility and personalised learning experiences. They value the ability to study at their own pace and schedule, which helps them balance academic and personal responsibilities (Choy et al., 2002; Van Wart et al., 2020). Personalised and interactive approaches further enhance motivation and foster a sense of belonging in the learning community (Shearer et al., 2020). Interactive media, such as simulations and videos, make learning more engaging and help students apply theoretical knowledge to real-world contexts (Utomo et al., 2021). The integration of such tools bridges the gap between traditional and digital learning by offering practical, hands-on experiences. Learning management systems (LMS) provide essential functions – easy access to materials, progress tracking and online discussions – that support organisation and communication (Palmer & Holt, 2010). Yet, technological tools alone are not enough; timely instructor support and feedback remain crucial for a positive learning experience (Choy et al., 2002).

Research emphasises that teaching presence, cognitive presence and social comfort significantly affect student engagement and success (Van Wart et al., 2020). When these elements are present, learners are more likely to persist and achieve their goals. However, preferences differ: some students prefer collaboration, while others thrive in independent, self-paced study. Differences also appear in preferences for flexible versus fixed schedules and practical versus theoretical learning (Koper, 2015). This diversity highlights the need for adaptable and responsive course design. Overall, students expect online learning to be flexible, interactive, well supported and tailored to individual needs. Institutions must therefore continue to innovate and refine their strategies in order to ensure engaging and effective online learning experiences that promote satisfaction, motivation and success.

What Lecturers Want From Online Teaching

Research on online teaching during the COVID-19 pandemic reveals both significant challenges and emerging opportunities for educators. The abrupt shift to online learning posed numerous difficulties, particularly for educators unprepared for the technological demands and changes in pedagogy. These challenges included technical issues, struggles with maintaining student engagement, and the difficulty of replicating the interactive and collaborative nature of in-person classrooms (Šribar, 2020; Krecenbaher Mernik & Ploj Virtič, 2021). Despite these obstacles, the transition also fostered innovation in teaching methods, with many educators adopting new tools and strategies such as gamification and problem-based learning to enhance the online learning experience (Petek et al., 2021; Šeďová et al., 2021).

The move to online teaching also encouraged greater student autonomy, as learners were given more control over the pace and schedule of their studies. This shift helped students develop important digital skills, which will be crucial in future learning environments. However, certain practical skills, particularly those that require hands-on or physical engagement, proved challenging to teach effectively in a remote setting (Bobnar, 2002; Jereb & Urh, 2022). Despite these challenges, many educators recognised the value of online learning and expressed interest in continuing to integrate digital tools into their teaching practices in the future (Dadić Fruk, 2023). However, scepticism remained among some educators about the effectiveness of online learning compared to traditional face-to-face instruction (Gabrilo & Rodek, 2009).

For lecturers, the transition to online teaching during the pandemic presented additional hurdles. They faced technical difficulties, limited student interaction and the urgent need to adapt their pedagogical approaches. In many

cases, lecturers struggled with technology integration, highlighting the need for professional development to enhance their online teaching skills (Davidovitch & Wadmany, 2021; Mesuwini & Mokoena, 2024). Successful online teaching, as identified by researchers, was not simply about using technology but was instead viewed as a social and interactive process. Lecturers assumed multiple roles – pedagogical, managerial, social and technological – in order to create a supportive and engaging online learning environment (Khoo et al., 2010). The personal attitudes, epistemological positioning and cultural values of lecturers played a significant role in shaping their online teaching practices (Coker, 2018).

Despite the challenges, some lecturers noted indirect benefits of online teaching, such as increased flexibility and new opportunities for collaboration and innovation (Mokoena-De Beer & Moloko, 2022). In order to improve online teaching in the future, recommendations included ongoing professional development, addressing technical issues and taking into account students' diverse learning styles to create more inclusive and effective digital learning environments (Singh-Pillay & Naidoo, 2020). Ultimately, the transition to online teaching during the COVID-19 pandemic underscored the need for universities to reassess their approach to education. The post-pandemic era presents an opportunity for institutions to rethink how to integrate digital tools and online teaching strategies in ways that enhance learning outcomes and cater to the evolving needs of both students and educators (Davidovitch & Wadmany, 2021).

Technology Accessibility and Inequalities in Online Learning

The digital divide continues to be one of the biggest barriers to online education. Limited access to reliable internet, suitable devices and digital literacy prevents many students from fully participating in remote learning, reinforcing existing socioeconomic inequalities (Anthony & Keating, 2013; Agung et al., 2020). These challenges are especially acute for students from weaker academic backgrounds, low-income households or marginalised communities, who often face lower engagement and success rates in fully online courses (Baum & McPherson, 2019).

Institutions have responded with initiatives such as device loan programmes, cloud-based learning tools and training in digital skills for both staff and students (Iyer & Chapman, 2021). However, persistent issues – such as poor infrastructure, unreliable electricity or high ICT costs – continue to affect many regions, particularly in developing countries (Omidinia et al., 2011; Adarkwah, 2021). Addressing these issues requires long-term investment, professional development and culturally responsive approaches that adapt technology to local contexts (Rambe & Mawere, 2011).

Due to low family income and limited institutional funding, educators and students in some regions may struggle to afford software licences or subscriptions for software-as-a-service (SaaS) platforms, such as Zoom or MS Teams. In the present research, we were interested in whether access to free-of-charge[3] software helped mitigate the digital divide in certain countries.

Inequalities in home learning conditions also exacerbate disparities. Students without quiet or private study spaces, or those living in overcrowded housing, often struggle more to focus on and participate in online learning (Gu, 2022; Renick & Reich, 2023). Gender plays a role as well: female students, particularly those with caregiving responsibilities, frequently face additional challenges in balancing academic and domestic duties (Waismel-Manor et al., 2021).

Privacy concerns linked to camera use have further highlighted inequalities. Many students feel uncomfortable exposing their home environments during video calls, especially when these settings reflect socioeconomic disadvantage (Cuerdo-Vilches & Navas-Martín, 2021). This reduces engagement and creates added stress.

Overall, while online learning has expanded access, it also risks deepening educational divides if systemic barriers are not addressed. Ensuring equitable access to technology, supporting diverse learning environments and providing targeted assistance for vulnerable groups are essential for creating more inclusive digital education systems (Quach & Chen, 2021).

The research question will be addressed by testing the following hypotheses:

H1: Respondents from different countries of the former Yugoslavia share similar experiences and perceptions with e-learning.

H2: The COVID-19 pandemic was associated with a reduction in the digital divide between countries in higher education.

H3: Free-of-charge software has been crucial in accelerating digital competences in higher education in less developed countries.

3 The authors use the term "free-of-charge software" because the expression "free software" refers specifically to software that respects user freedoms, which does not apply to most of the free-of-charge solutions reported in this survey, such as Google, WhatsApp, Skype and Facebook (Stallman et al., 2006).

Method

Participants

Data were collected with a web survey, which was conducted in 2021–22 immediately after the first wave of the pandemic and covered students and lecturers in five countries of the former Yugoslavia: Slovenia, Croatia, Montenegro, Bosnia and Herzegovina and North Macedonia. Selected higher education institutions in all five countries were contacted via a letter describing the project and asking them to distribute the invitation to their students and lecturers. The letter also included participant information sheets and invitation letters for both students and lecturers, outlining the purpose of the research, its voluntary nature, data anonymisation protocols and participants' rights (e.g., the right to withdraw at any time).

In all of the listed countries, students and lecturers were invited to participate through an initial invitation letter followed by three reminders. The first letter was sent at the end of May 2021, with two subsequent reminders sent at seven-day intervals. A final reminder was distributed after the academic holidays in December 2021.

This procedure resulted in a cross-sectional survey based on a non-probability sample. The invitations were distributed through institutional representatives rather than directly to staff or student registers, which may have introduced self-selection bias and differences in participation across institutions and countries. As a result, the sample cannot be considered representative and reliable participation rates cannot be calculated.

Nevertheless, despite somewhat lower participation in North Macedonia, the overall number and diversity of responses were sufficient to provide meaningful insights into the dynamics of change in digital competencies across the participating institutions and the five selected countries.

At least half of the survey was completed by 1,549 students (78.5%) and 424 (21.5%) lecturers, with the majority of the participants (77.7% of the students and 72.9% of the lecturers) completing the survey in full. As shown in Table 1, with the exception of representatives from North Macedonia and Montenegro, the proportions of participants roughly correspond – unintentionally but expectedly – to the proportions of the populations of the respective countries.

Table 1
Demographic composition of the sample

Country	Survey		Population	
	Number	Share of total	Millions of citizens	Share of total
Slovenia	326	16.5%	2.12	18.3%
Croatia	826	41.9%	3.86	33.4%
BiH	483	24.5%	3.19	27.6%
Montenegro	259	13.1%	0.6	5.2%
North Macedonia	79	4.0%	1.8	15.6%
Total	1973	100.0 %	11.57	100.0%

Source: World Bank Group, 2025.

Instrument

The instrument was developed during the COVID-19 pandemic and is adapted to the rapid dynamics of change in e-learning at that time, while also incorporating innovations in the measurement of digital competences related to e-learning and taking into account current platforms for online work, communication and learning (Raspor, 2021). The core module is summarised by Liaw (2008) and supplemented with a series of questions that measure each dimension of the original instrument in more detail (Raspor, 2021).

In addition to the key socio-demographic and experiential dimensions, eight e-learning dimensions were also measured in detail:

1. perceived self-efficacy (SE) in e-learning,
2. perceived satisfaction with e-learning (SAT),
3. perceived usefulness of e-learning (USEFUL),
4. behavioural intention to continue e-learning (INTENT),
5. e-learning system quality evaluation (SYSQUAL),
6. the importance of interactive learning activities (INTACT),
7. e-learning effectiveness (EFFECT), and
8. the importance of multimedia instruction (MM).

By comparing the averages of these dimensions, we will test the first hypothesis, according to which people in different countries of the former Yugoslavia should pursue the same goals in e-learning.

Subsequently, we will test the second hypothesis, that the digital divide in terms of digital competences between countries should decrease during the

COVID-19 pandemic, by comparing the shares of users of different e-learning technologies. The gap between countries can be measured by comparing the use of different assistive technologies before and during the COVID-19 pandemic in each country, which is made possible by multiple-choice questions (multiple-response categorical variable) containing the names of the most frequently used platforms. The respondents chose between the offered platforms, which are grouped together in the analysis according to the purpose of use:

1. No experience;
2. General communication tools: Skype, Viber, Facebook;
3. Platforms for education and distance learning: Moodle, Arnes, Blackboard, Microsoft Teams, BigBlueButton;
4. Tools for online meetings and video conferencing: Zoom, MiTeam, GoToMeeting, Cisco WebEx, Slack;
5. Other (open-ended response type, researchers manually categorised responses).

The third hypothesis will be tested by comparing the use of platforms according to their price.

Data were collected using an online survey built in the 1KlikAnketa (1KA) survey tool and an interface adapted to desktop and laptop computers, as well as mobile phones and tablets.

Instrument Validation

The basic module of the study comes from a country with a cultural model completely different from the one prevailing in Slovenia and the countries of the former Yugoslavia (Hofstede, 2001). In the initial stage, we therefore validated the validity of the instrument. The reliability of the scales was assessed using Cronbach α and exploratory analysis (PCA) of the individual dimensions was also performed. All of the analyses were performed using the SPSS Statistics software package version 27.0.1.0.

The results are excellent: for both groups (lecturers and students, Table 2) and all five countries (Table 3), all of the scales show high reliability ($\alpha > 0.7$) and PCA detected a single component (NC) with high explained model variance (% var) for all dimensions.

Table 2
Validation of the instrument for both groups of respondents

Dimension	Cronbach α		Explained variance [%]	
	Students	Lecturers	Students	Lecturers
SE	0.9	0.9	77.7	78.1
SAT	0.9	0.9	84.1	78.0
USEFUL	0.9	0.9	86.4	89.4
INTENT	0.8	0.8	77.2	72.3
SYSQUAL	0.9	0.7	76.2	72.8
INTACT	0.8	0.8	74.7	76.7
EFFECT	0.9	1.0	90.2	91.4
MM	0.9	0.9	84.2	85.1

Table 3
Instrument validation by participating countries

Dimension	Cronbach α					Explained variance [%]				
	SLO	CRO	BiH	MNE	NMK	SLO	CRO	BiH	MNE	NMK
SE	0.9	0.9	0.8	0.9	0.9	81.4	78.3	76.1	76.5	77.5
SAT	0.9	0.9	0.9	0.9	0.9	81.7	82.2	85.5	84.9	78.9
USEFUL	0.9	0.9	0.9	0.9	0.9	90.0	86.4	86.8	86.1	87.4
INTENT	0.8	0.8	0.8	0.8	0.8	77.4	75.5	73.7	77.5	68.7
SYSQUAL	0.9	0.9	0.9	0.9	0.8	76.2	75.8	76.3	72.3	68.6
INTACT	0.9	0.8	0.9	0.8	0.8	77.0	74.0	76.8	74.6	75.6
EFFECT	0.9	0.9	1.0	1.0	0.9	90.2	90.1	91.4	91.2	90.0
MM	0.9	0.9	0.9	0.9	0.9	84.7	83.8	84.8	86.6	82.2

We find that the instrument works adequately in both groups analysed and in all five participating countries.

Research Design

The study adopts a cross-sectional survey research design, based on the methodology developed by Raspor (2021), which enables comparative analysis of perceptions, attitudes and experiences with e-learning across different population groups and contexts. The research focuses on higher education institutions in five post-Yugoslav countries – Slovenia, Croatia, Bosnia and Herzegovina, Montenegro and North Macedonia – during the COVID-19 pandemic.

The primary aim of the research design was to investigate the development of digital competencies among students and lecturers during the sudden shift to online learning. The design allowed an analysis of individual-level responses related to stress, preparedness, satisfaction and engagement with digital tools, while also enabling comparisons between countries with different levels of digital infrastructure and e-learning readiness.

The participants were recruited through institutional contacts at universities, higher education institutions and vocational colleges. The survey was conducted online using the 1KA platform and was active between May 2021 and May 2022. The questionnaire included both demographic questions and items targeting eight dimensions of e-learning: perceived self-efficacy, satisfaction, usefulness, behavioural intention to continue e-learning, system quality evaluation, importance of interactivity, perceived effectiveness and multimedia importance. These dimensions were measured using 7-point Likert scales and were validated for reliability and internal consistency across countries and groups (students and lecturers), with Cronbach's alpha coefficients exceeding 0.76 for all dimensions.

Due to the non-probabilistic nature of sampling, the study does not aim for generalisability but provides meaningful insights into trends and variations in digital competence development across different national contexts. Data analysis was performed using SPSS, including descriptive statistics, ANOVA and chi-square tests to examine intergroup differences and test the study's hypotheses.

Ethical approval for the study was obtained from the Ethics Committee of the Faculty of Organisational Sciences, University of Maribor, and all of the participants gave informed consent prior to participation. The anonymous and voluntary nature of the study was emphasised in all communication.

Results

Differences in Experiences and Perceptions With e-Learning

By comparing the averages of the eight dimensions of the core module, we tested whether there are statistically significant differences between countries in terms of experiences with and perceptions of e-learning. The comparison of means was carried out using analysis of variance (ANOVA), first checking for homogeneity of variances due to differences in the number of participants between countries (Table 4)

Table 4

Levene test on homogeneity of variances between countries

	Levene Statistic	*df1*	*df2*	Sig.
SE	0.5	4	1790.0	.723
SAT	5.1	4	1660.6	.000
USEFUL	7.0	4	1643.0	.000
INTENT	0.7	4	1666.3	.594
SYSQUAL	4.7	4	1523.9	.001
INTACT	0.8	4	1532.4	.530
EFFECT	2.2	4	1525.7	.064
MM	2.6	4	1522.4	.034

Note. All values are based on median with adjusted degrees of freedom.

As shown in Table 4, SAT, USEFUL, SYSQUAL and MM do not meet the homogeneity of variances condition and were therefore analysed using the more robust Welch method.

For SE, INTENT, INTACT and EFFECT, it was found that the differences in the mean scores of each dimension between countries are statistically significant but very small, as the country can explain at most 2.8% of the variance (in the case of intentions for further e-learning). The data are shown in Table 5.

Table 5

Analysis of variance across countries

	Sum of Squares	*df*	Mean Square	*F*	Sig.	η^2
SE						
Between Groups	22.8	4	5.7	2.6	.037	0.006
Within Groups	4029.4	1810	2.2			
Total	4052.2	1814				
INTENT						
Between Groups	125.1	4	31.3	12.1	.000	0.028
Within Groups	4320.2	1673	2.6			
Total	4445.3	1677				
INTACT						
Between Groups	52.7	4	13.2	5.1	.000	0.013
Within Groups	3979.2	1542	2.6			
Total	4031.9	1546				

	Sum of Squares	*df*	Mean Square	*F*	Sig.	η^2
EFFECT						
Between Groups	39.0	4	9.7	3.0	.019	0.008
Within Groups	5035.4	1532	3.3			
Total	5074.3	1536				

There are no statistically significant differences between countries for the importance of multimedia in e-learning (MM). For the other three dimensions (SAT, USEFUL and SYSQUAL), the differences are statistically significant but small, with less than 2.5% of the variance explained by country (Table 6).

Table 6

Analysis of variance for selected variables using the Welch method

		Statistic[a]	*df1*	*df2*	Sig.	η^2
SAT	Welch	6.6	4	366.7	.000	0.013
USEFUL	Welch	10.7	4	359.8	.000	0.021
SYSQUAL	Welch	11.3	4	350.0	.000	0.025
MM	Welch	0.6	4	336.5	.670	0.001

Note. [a]Asymptotically F distributed. Robust Tests of Equality of Means.

It can be concluded that the participants in all of the studied countries share similar experiences and perceptions with e-learning, as the differences are negligible. **Hypothesis H1 "Residents of different countries of the former Yugoslavia experiences and perceptions with e-learning" can be confirmed.**

Reducing the Digital Competence Gap Between Countries During the COVID-19 Pandemic

The respondents, both lecturers and students across all years of study, assessed their digital skills before and during the pandemic, which enabled us to capture perceived changes in digital competence. Although the cross-sectional design does not allow us to establish temporal causality with statistical certainty, the comparative scope of the study (encompassing multiple groups across several countries) adds robustness to the findings. The design provides meaningful insights into the dynamics of the digital divide across the studied countries during this period. Therefore, by comparing the experience of using platforms suitable for electronic communication and e-learning before and during the COVID-19 pandemic, we will examine the extent to which differences between the countries have changed.

The proportions are compared using two tables, and the Pearson chi-square test of independence is used to assess whether the differences are statistically significant. Table 7 shows the proportions of participants with any experience of e-learning platforms by country before and during the pandemic.

Table 7

Comparison of the shares of participants with experience of using e-learning platforms before and during the COVID-19 pandemic by individual country

Country	Share of participants with experience		Increase in %
	Before	During	
Slovenia	86.2%	93.3%	7.1
Croatia	78.5%	92.6%	14.1
BiH	74.5%	92.8%	18.3
Montenegro	78.8%	90.0%	11.2
North Macedonia	73.4%	91.1%	17.4

The differences in the proportion of participants with any experience of e-learning platforms before the COVID-19 pandemic are larger between countries (between 73.4% and 86.2%) than during the pandemic (between 90% and 93.3%). Pearson's test of independence confirmed the findings with statistically significant differences between the countries before the COVID-19 pandemic ($\chi^2 = 17.217$; $p = 0.002$) and no statistically significant differences during the pandemic ($\chi^2 = 2.823$; $p = 0.588$). Given these results, we can confirm hypothesis 2, albeit in a statistically more cautious formulation: the COVID-19 pandemic *is associated with a reduction of* the digital divide between countries in higher education.

Using Free-Of-Charge Software to Reduce the Gap Between Countries

In the open-ended responses to the questions about the platforms used, many free-of-charge tools were mentioned, especially those offered by Google, which suggests that in some countries, such solutions may have contributed to narrowing the information gap.

In order to test this assumption, we classified all of the referenced platforms (those offered as an option and those contributed by the respondents) into free-of-charge and paid, and created a new binary variable "PayWare" with

a default value of 0. For individuals who reported using any paid software (MS Teams, Zoom, Adobe Connect, etc.), the value was set to 1. This approach allows us to identify cases where no paid software was reported, which likely indicates that such software was not provided by the respondent's institution. Although this categorisation might seem somewhat simplistic, it nevertheless enables us to statistically examine whether free-of-charge solutions contributed to reducing the digital divide between the countries involved.

Similarly to the analysis on the reduction of the digital competence gap, we used Pearson's chi-square test of independence, as we compared two nominal variables: country and use of free tools. The proportion of participants using paid software is shown in Table 8.

Table 8

Comparison of the share of use of paid software between countries

Country	Use of paid software
Slovenia	98.2%
Croatia	97.3%
BiH	84.5%
Montenegro	96.1%
North Macedonia	77.2%

The results of the Pearson chi-square test of independence ($\chi^2 = 131.184$; $p < 0.001$) confirm a strong correlation between the country and the use of free-of-charge software. Comparing the data with the results of the analysis of progress in digital competences (Table 7), we can also **confirm H3:** the countries with the largest leaps in digital competences (North Macedonia and BiH, with 17.4 and 18.3 percentage points of leap, respectively) used paid software to the least extent, while the countries with the smallest leaps (Montenegro and Slovenia, with 11.2 and 7.1 percentage points of leap, respectively) used paid software to the greatest extent. In short, free-of-charge software was crucial in accelerating digital competences in higher education in less developed countries.

Discussion

Countries that once shared a common education system entered the pandemic with varying levels of digital competence, reflecting the different paths they had taken since the breakup of their former state. While some had already invested in digital education before the crisis, others only began adopting digital

solutions more intensively when faced with the challenges of remote learning during the COVID-19 pandemic. Furthermore, our research suggests that in countries with lower levels of digital literacy, progress may not necessarily have resulted from government investments in e-learning but rather from the determination of lecturers and students themselves. The findings of the study, which highlight the accelerated development of digital competencies in higher education, are consistent with broader trends observed across different educational levels and disciplines. Research on parents' experiences with distance learning indicates that increased parental involvement and support played a crucial role in students' adaptation to online learning (Drvodelić & Domović, 2022), which indirectly contributed to the development of students' digital competence. However, challenges such as the need for parental guidance and support, as well as difficulties in coordinating work and home responsibilities (Levpušček & Uršič, 2021), underscore the importance of a holistic approach to online learning that considers the needs of both students and their families.

In particular, in countries that were less prepared for online education, students and lecturers often relied on free-of-charge software to accelerate their transition to digital learning. At first glance, this appeared to narrow the digital divide and create a more uniform experience and perception of e-learning among both students and lecturers, as all of the countries gained experience in online education and digital teaching methods. The transition to online learning also varied significantly across different disciplines. While some fields, like architecture, faced unique challenges in adapting practical skills to a virtual environment (Unver & Sungur, 2022), others, like physical education, identified effective online teaching models to maintain student engagement (Petrušič & Štemberger, 2021). These disciplinary differences highlight the need for tailored online learning strategies that address the specific needs and contexts of different fields of study.

However, this rapid shift should not be seen purely as technical progress or as proof that an external trigger can equalise digitalisation levels and education quality. Differences in digital competence are largely rooted in systemic factors, such as long-term education policies, investments in technology and teacher training. While access to digital tools has improved, this does not necessarily mean a lasting equalisation of educational quality. The more important question is whether the digital practices adopted during the pandemic have been permanently integrated into education systems or whether they were merely a short-term adaptation to an emergency. Countries that have used the crisis as an opportunity for systemic change will likely see long-term benefits, while for others, digitalisation may remain a superficial adjustment without

meaningful transformation. As the focus shifts from short-term solutions back to long-term education strategies, the apparent narrowing of the digital divide may prove temporary, with pre-existing disparities once again becoming evident. Furthermore, student characteristics such as self-regulation and positivity emerged as critical factors influencing the online learning experience (Jurišević et al., 2021). These findings underscore the importance of promoting students' self-regulation skills and positive attitudes towards online learning in order to enhance their success and well-being in digital learning environments.

Conclusion

While the present research cannot conclude whether it was *due to* pandemic, it has confirmed that the digital divide in higher education in the Balkans was reduced *during* the pandemic. Hence, the main research question "*Was the COVID-19 pandemic associated with a reduction in the digital competences gap in between countries?*" can be answered in the affirmative.

If the students and lecturers who woke up in a world of long-lasting maintenance wanted to be able to study successfully at least to some extent, they had to switch, willingly or unwillingly, to online delivery of their studies practically overnight. From this perspective, it is natural to conclude that the changes were mostly *due* to the pandemic.

All of the countries involved in the present research emerged from the pandemic highly competent, with over 90% experience of the relevant technologies. However, they entered the period differently prepared, as educators and students had different levels of experience with the use of relevant technologies; for example, while in the most developed country, Slovenia, the proportion of participants with relevant experience rose from 86.2% to 93.3% (a difference of 7.1 percentage points), in the least developed country, North Macedonia, it rose by 17.4 percentage points from 73.4% to 91.1%. The same is true for the other countries. It is impossible to predict whether these changes are permanent or whether students and lecturers will eventually revert to their pre-pandemic routines, thereby reducing their digital competences; only longitudinal research can clarify this. The authors argue that digital policies in higher education could play a crucial role in fostering high and lasting digital skills.

Despite the pursuit of the same objectives in all of the countries studied, the transition has not been easy, especially in the countries that entered the period less prepared. Different countries have therefore used different means to achieve the targets, not only to make studying easier but also to improve digital literacy.

In this respect, previously less-developed countries have been significantly more successful, partly by using free-of-charge software to achieve high levels of digital literacy.

Finally, the discussion on inequalities and disparities in online learning should acknowledge the role of socioeconomic factors and family circumstances in shaping students' access to resources and support. The challenges faced by parents in supporting their children's online learning highlight the need for equitable access to technology, support services and learning environments in order to ensure that all students can benefit from the opportunities of online education. This is where digital policies might again play a crucial role. In addition, free-of-charge and open-source software solutions could offer educators ways to support students from diverse socioeconomic backgrounds, while at the same time safeguarding their well-being and privacy.

Like all surveys, the present one has some methodological limitations that prevent the results from being necessarily generalisable. The survey was only carried out in a selected, non-probability sample of educational institutions, so the results cannot be generalised to all higher education institutions in the region. The instrument worked well in both populations (students, lecturers) and in all five countries studied, and the response to the survey was solid. However, as we did not have access to a register of all students and teachers, we cannot calculate the participation rate or the reliability of the results obtained. Nevertheless, the results should not be disregarded because of this, as the literature shows that findings from cross-site, adequately conducted, non-representative online surveys can in some cases be comparable to findings from surveys conducted on representative samples (Ellis et al., 2023). Additionally, the data from the present study cannot prove that the COVID-19 pandemic was the sole trigger of change, but we can hypothesise that this is the case, as the constraints of infection prevention measures would have prevented education without the shift to digital platforms. In this sense, although the COVID-19 pandemic cannot perhaps be seen as the only element of the transition to e-learning, it can certainly be regarded as an essential element.

Further research is needed to evaluate digitalisation and the digital divide in higher education in the countries studied. The lessons learned from the pandemic offer a crucial opportunity to build more resilient and inclusive digital education systems in the post-Yugoslav states, but this will require sustained effort and a long-term vision.

Ethical Statement

This research was conducted in accordance with relevant ethical guidelines and regulations. The study involving surveys with educators and students was approved by the Research Ethics Committee of the Faculty of Organisational Sciences, University of Maribor, under the approval numbers 514-7/2021/1/902-DJ and 514-7/2021/2/902-DJ. The participants were informed about the purpose of the research, the voluntary nature of their participation, their right to withdraw at any time without penalty, and the confidentiality and anonymity of their responses. All of the data collected were anonymised and stored securely to protect the privacy of the participants. We confirm that all of the data were handled responsibly and ethically throughout the research process.

Data Availability Statement

Datasets, generated in this study, were deposited at the Repository of the University of Ljubljana (available at: https://repozitorij.uni-lj.si/IzpisGradiva.php?id=181954&lang=slv).

Disclosure Statement

The authors have no conflict of interest to declare.

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