Responses to the Challenges of Fast Digital Conversion, in the Light of International Research Results - A Comparative Look at Virtual Spaces

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Abstract: In order to assure effectiveness, digital instruction prioritizes digital devices and systems over traditional technological and methodological solutions. In the current digital age and the way of life defined by digital culture, digital skills and competences become highly appreciated. Also, innovative methodological solutions, promoting the long term maintenance of attention and motivation, become key factors in remote learning or digitally scheduled education. Furthermore, the emergence of additional digital gaps, triggers newer digital paradigm shifts, gaining special importance during such exigencies, as a pandemic. An effective response or potential remedy, to this situation, is offered by digital pedagogy. Digital pedagogy faced substantial challenges during the first wave of the COVID-19 pandemic, imposing demanding tasks on all participants, within the education sector. Our study introduces the results of a quantitative, multivariable, empirical inquiry, entailing a comparative analysis of data obtained from a survey of the pedagogue attitudes and digital tool systems for three selected countries.

Keywords: COVID-19; Virtual Learning Environments; digital tools and systems; digital competences

1 Introduction

Several factors including the availability of the trained labour force or the adaptation skills of the members of society can determine the economic development of a country. Identifying a correlation between the available human capital and the quality of education reveals that quality improvement can lead to better labour market perspectives. [1-7]. Hanushek and Kimko [5] were able to quantify quality in the context of internationally comparable test results. Consequently, while a quality increase equal to one unit of standard deviation results in a growth rate of 1 percentage point, the achievement of the same result requires nine years of schooling on average if the given intervention is only quantity-oriented [4]. The efficiency of a country's education system and its growth potential are determined by the increasing personal knowledge of teachers as teacher quality represents a variable with a direct impact on students' academic progress. Paper [3] asserts that the proficiency of teachers is determined by knowledge, expertise and routine, which increases, with experience. We believe that in the present digital instruction framework the extent and quality of teachers' digital competence is of vital importance in addition to their ability to cope with the new challenges, meet the respective demands, support their students and transmit the given knowledge.

The dynamic development of telematics, computer technology and the information and communication technologies resulted in the emergence of the knowledge and information-centred society [8]. The main beneficiaries of these trends are those who are motivated toward knowledge acquisition and capable of self-directed learning. The learning process enriched with the three dimensional augmented reality giving rise to an alternative spatial awareness provides a special experience for students. Such approaches utilize the latest ICT-based and Cognitive Infocommunications methodologies including the virtual classroom and VR systems (google class, classcraft), interactive digital educational materials or human-computer interaction based methods [9], for example.

Several authors, among them Lajos Besenyei emphasized that the information society leads "to the emergence of a fully different social co-existence system." [10] The symbol of our age is the computer which became fully integrated into everyday life. The network contributed to the "constriction of space and the elimination of distance as the virtual world spans over the Earth and connections can be established in seconds between people living at the farthest points of our planet." Consequently, unprecedented learning formats and options appeared [10]. Specific devices notwithstanding and with general consequences in mind, we can

declare that the prevalence of info-communication technology in education generated a substantial impact on the formation of human relationship networks. Accordingly, the learning, problem solving, decision making and mutual support options facilitated by increasingly diverse networks have undergone substantial change. The radical transformation of social networks, enabled citizens to expand their previously, close-knit, communities, achieve more variety in their connections and obtain more efficient forms of information acquisition. The online framework or world resulted in unprecedented communication potential and information gathering capacity enabling people or users to appear, act, communicate, or develop new methods of keeping touch independently or as part of a community [11]. Due to the prevalence of internet-based communication and medialization education faces several challenges in the present and in the future. The tripartite Prussian instruction paradigm emphasizing reading, writing, and arithmetic introduced in the eighteenth century is superseded by the 4C (Collaboration, Curiosity, Complexity and Creativity) model. As László Z. Karvalics argues, "influenced by the postmodern scepticism toward the fragmentation of knowledge brought on by the lack of transparency in the given disciplines and the mistrust toward practical activities requiring specialized skills a general lack of credibility can be discerned." [12]. Finding or providing information via links, the ability to search in digitally recorded texts, and the easy way to copy lead to radical changes in established academic practice facilitating editing open texts and plagiarism, at the same time.

The theoretical basis behind educational networks, includes the concept of connectivism, representing a cross-section between informatics, pedagogy, and network research promoted by George Siemens [13]. The theory holds that internet-based communication and media supported information exchange play a central role in the informal network context. Such information exchange is part of lifelong learning schemes and it differs from its previous counterparts as among others it can be embedded into free time activities and motivation continues to be one of its crucial requirements. As Sándor Forgó asserted "connectivism should be considered an integrated approach while focusing on the key components of instruction including competence, content, motivation, flexibility, and the evaluation of learner progress." [14]

The full integration of info-communication methods [15] [16] like mathability [17] [18] or other HMI based interfaces [19] [20] into everyday practice has led to increasing medialization of and the prevalence of digital technology in education [21] to detect learning problems [22] [23] or improve student's skills like problem solving [24]. The use of ICT in the education process boosted by the emergence of the worldwide web led to several tendencies and trends including the prevalence of digital data recording, the penetration of computers in the private sphere, followed by the world of work and learning, and eventually everyday life. Some of these factors have already reached the plateau of productivity. Based on the

above, the results of the study related to digital education in the comparison of Serbia, Slovakia and Hungary are presented in this article.

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2 Methodology

At the end of March 2020, two weeks after the nationwide conversion to digital instruction, we launched an online questionnaire-based survey, focusing on the initial experiences of pedagogues related to digital instruction and their respective role, competences and attitudes in three countries, Hungary, Slovakia and Serbia. The data for the inquiry was obtained via simple and random sampling. The samples were compiled by the snowball approach as the potential respondents were contacted and informed on social media and through personal connections concerning the objectives of the research program and the guarantee of anonymity. Therefore the sample cannot be considered representative. Following the three week period allotted for the completion of the questionnaires the results were systemised, purified, and coded. The survey resulted in 3390, 141, and 193 valid responses from Hungary, Serbia, and Slovakia respectively. The data were processed via difference statistical approach using SPSS 23 software. We resorted to the triangulation method, in order to explore and compare the ICT use habits and pedagogical attitudes. This method based on difference statistics facilitates a multifaceted inquiry of the current situation, the digital competences of educators, the willingness of pedagogues to apply ICT devices on their own, and the methods and experiences related to ICT use. Since our research efforts focused on a heretofore unexplored field, due to the lack of relevant research results and experiences, we were not able to arrive at any unequivocal conclusions. Consequently, we tested null-hypotheses. The individual variables were assessed by the Likert scale considering the former ordinal variables. We relied on two statistical analysis methods. During the processing of two partial samples (male/female, participated in training/didn't participate in training) we used the Mann-Whitney probe, while in cases when more than two sample components (highest educational level) had to be compared we resorted to the Kruskal-Wallis test. Due to spatial and length related requirements and for the sake of clarity the statistical test results (ranking scores, p, U, Chi square values, average figures) are not included in the text, but we list them in separate tables related to the given hypotheses. In order to observe the extent and content-based restrictions of the study we provide a detailed description of only the most informative results of our research effort.

3 Results and Discussion

The next charts illustrate the country-specific distribution of pedagogues completing the questionnaire according to the respective background variables. The majority of respondents in all three countries were women in (Serbia 60%, Slovakia 77.5% and Hungary 82.4%) respectively.

We have assessed the educational background and qualification of the respondents. While there are significant differences concerning the size of the sample, it was revealed that the Hungarian participants had the lowest level of qualification as the number of those with MA/MSc degree and PhD lags behind that of their counterparts from the other two countries (Figure 1).

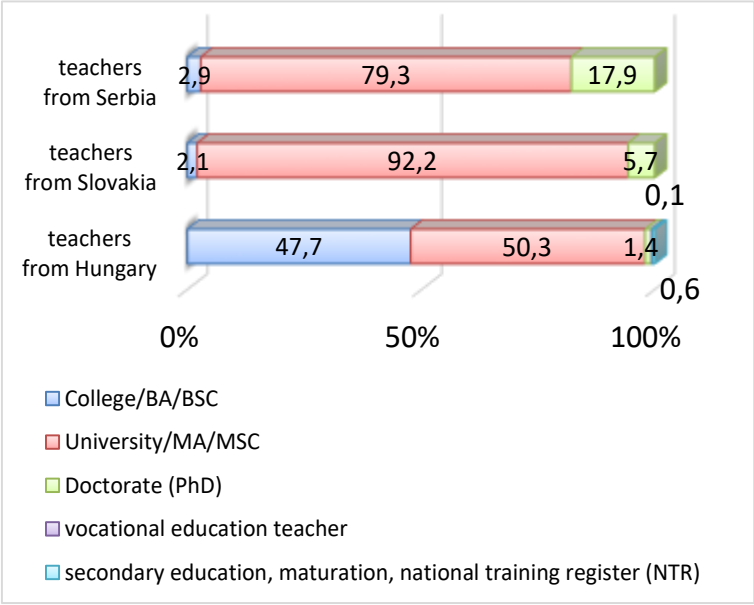

Figure 1
Highest education level of respondents

Prior to launching the research project we hypothesized that familiarity with digital pedagogy could generate a significant impact on ICT use. Consequently, we assessed what percentage of the respondents received digital training during their studies and how many respondents took part in such training outside the framework of their studies. While only a small portion (20.7%), of Serbian colleagues, received digital training during their studies, it is encouraging that more than half of them felt it was needed and made up for this deficiency in an extracurricular fashion. In the same vein, although half (46.6%) of Slovakian teachers participated in digital pedagogy training during their studies, the high rate of extracurricular participation in such programs demonstrates the priority

assigned to digital instruction. Similar results can be seen in case of Hungary as more than half (50.3%) of the respondents participated in digital training during their studies, but they took part in such programs in an extracurricular format as well.

Assessing the availability of digital devices for the pedagogues in the participating countries was a crucial component of the research program. The respective rates were favourable in all three countries (Figure 2). The highest access level was shown in Slovakia, while the lowest scores were in Serbia.

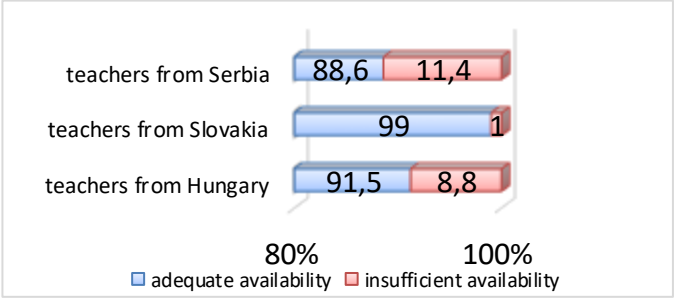

Figure 2
Digital equipment availability

The results of the specific statistical analyses are summarized below in the form of tables (Table 1-13).

Table 1
The distribution of ICT use and attitudes according to the participating countries

		Hungary %	Hungarian average	Slovakian %	Slovakian average	Serbian %	Serbian average
Possession of basic ICT skills	1	1.1	4.53	4.1	4.86	2.1	5.22
	2	5.2		1.0		2.9	
	3	17.6		10.9		9.3	
	4	20.1		17.1		5.7	
	5	28.1		22.3		16.4	
	6	28.0		44.6		63.6	
Confident application of ICT during teaching	1	2.3	4.27	3.6	4.87	0	5.07
	2	6.8		2.6		5.7	
	3	20.1		5.2		8.6	
	4	23.6		20.2		11.4	
	5	26.9		29.0		21.4	
	6	20.3		39.4		52.9	
ICT use for preparing digital education materials	1	5.5	4.04	3.1	4.68	2.1	5.11
	2	11.7		4.7		2.9	
	3	19.2		10.9		8.6	
	4	20.3		18.7		12.9	
	5	22.4		28.0		15.0	
	6	20.7		34.7		58.6	

Supporting the learning process through digital communication options	1	1.8	4.67	3.1	5.04	0	5.23
	2	6.0		1.6		5.7	
	3	12.1		7.3		5.0	
	4	17.4		13.0		9.3	
	5	28.6		26.9		20.7	
	6	34.1		48.2		59.3	
ICT use for monitoring and evaluation	1	8.2	3.93	6.7	4.43	1.4	4.91
	2	12.9		5.2		7.9	
	3	17.3		11.9		8.6	
	4	19.8		20.7		11.4	
	5	23.3		25.4		22.1	
	6	18.6		30.1		48.6	
Simultaneous use of several ICT services	1	8.4	4.10	4.1	4.54	5.0	4.89
	2	11.3		6.7		5.7	
	3	14.5		9.8		9.3	
	4	17.3		23.8		10.7	
	5	24.3		21.2		13.6	
	6	24.2		34.2		55.7	
Only uses reliable systems	1	1.6	4.88	2.1	4.979	2.9	4.97
	2	4.3		3.1		4.3	
	3	9.9		6.2		7.1	
	4	13.7		16.6		12.9	
	5	29.9		27.5		24.3	
	6	40.7		44.6		48.6	

The ICT use habits were assessed on a six step Likert scale with 1 indicating total rejection and 6 standing for absolute acceptance. The table reveals that the highest scores and average values were discerned in case of Serbian teachers. This result is especially noteworthy as the rate of participation in digital training either during one's studies or in an extracurricular manner was the lowest with Serbian respondents, not to mention that the availability of digital devices was the lowest in their case. The lowest overall scores, however, were by Hungarian participants.

Table 2

Correlation of ICT use among Hungarian pedagogues

Hungarian– Mann-Whitney-probe: Correlation between sex and teachers' ICT use						
Dependent variable	Independent variable: sex	MR	U	p	average	group median
Possession of basic ICT skills	Male	1997.64	836832	<0.000	4.85	5.11
	Female	1652.75			4.44	4.54
Confident application of ICT during teaching	Male	2062.58	786176.5	<0.000	4.69	4.91
	Female	1633.85			4.15	4.21
ICT use for preparing digital education materials	Male	1993.92	839734.5	<0.000	4.43	4.67
	Female	1653.83			3.93	4.01
Supporting the learning process through digital communication options	Male	1812.38	981336	<0.000	4.76	5.07
	Female	1706.67			4.65	4.88

ICT use for monitoring and evaluation	Male	1946.02	877092	<0.000	4.26	4.49
	Female	1667.77			3.83	3.95
Simultaneous use of several ICT services	Male	1898.41	914228.5	<0.000	4.35	4.71
	Female	1681.63			4.03	4.24
Only uses reliable systems	Male	1738.78	1038743.5	0.782	4.91	5.16
	Female	1728.09			4.87	5.16

Table 3

Correlation of ICT use among Slovakian pedagogues

Slovakian– Mann-Whitney-probe: Correlation between sex and teachers' ICT use						
Dependent variable	Independent variable: sex	MR	U	p	average	group median
Possession of basic ICT skills	Male	106.25	2388.5	0.261	5.00	5.40
	Female	95.02			4.83	5.12
Confident application of ICT during teaching	Male	91.43	2513.5	0.501	4.65	4.94
	Female	98.19			4.91	5.14
ICT use for preparing digital education materials	Male	93.03	2568	0.636	4.50	4.83
	Female	97.85			4.72	4.96
Supporting the learning process through digital communication options	Male	85.66	2317.5	0.161	4.62	5.13
	Female	99.42			5.13	5.34
ICT use for monitoring and evaluation	Male	92.71	2557	0.612	4.24	4.60
	Female	97.92			4.47	4.70
Simultaneous use of several ICT services	Male	92.91	2564	0.627	4.44	4.65
	Female	97.87			4.56	4.80
Only uses reliable systems	Male	74.46	1936.5	0.006	4.382	4.688
	Female	101.82			5.107	5.311

Table 4

Correlation of ICT use among Serbian pedagogues

Serbian – Mann-Whitney-probe: Correlation between sex and teachers' ICT use						
Dependent variable	Independent variable: sex	MR	U	p	average	group median
Possession of basic ICT skills	Male	71.25	2310.000000	0.835	5.25	5.57
	Female	70.00			5.20	5.53
Confident application of ICT during teaching	Male	74.93	2104.000000	0.250	5.20	5.48
	Female	67.55			4.99	5.28
ICT use for preparing digital education materials	Male	73.50	2184.000000	0.422	5.20	5.51
	Female	68.50			5.06	5.38

Supporting the learning process through digital communication options	Male	70.27	2339.000000	0.950	5.21	5.49
	Female	70.65			5.24	5.49
ICT use for monitoring and evaluation	Male	70.02	2325.000000	0.902	4.86	5.29
	Female	70.82			4.94	5.26
Simultaneous use of several ICT services	Male	73.54	2181.500000	0.424	4.96	5.45
	Female	68.47			4.85	5.30
Only uses reliable systems	Male	70.07	2328.000000	0.913	4.93	5.30
	Female	70.79			5.00	5.29

We relied on the Mann-Whitney proble to identify significant divergences between answers provided by women and men regarding ICT use. (scores indicating significance are highlighted with blue) It is noteworthy that in case of Hungarian teachers we could discern significant divergence between the sexes with the exception of the question concerning the use of the reliable systems. Regardless of significance men received higher scores. Only one significant digression could be revealed among pedagogues from Slovakia as women achieved higher scores despite the self-professed higher ICT skills by men. The significant digression, favouring women, was identified in case of the use of reliable systems. Responses by Serbian teachers are more diverse as the scores differ according to sex in some questions, while no significant digression could be identified.

Table 5

ICT use in light of digital training among Hungarian teachers

Hungarian– Mann-Whitney-probe: Correlation between digital training received during studies and teachers' ICT use						
Dependent variable	Independent variable: digital training during studies	MR	U	p	average	group median
Possession of basic ICT skills	no	1559.50	1202440	<0.000	4.30	4.38
	yes	1899.34			4.76	4.94
Confident application of ICT during teaching	no	1535.38	1160974.5	<0.000	4.00	4.03
	yes	1923.16			4.53	4.64
ICT use for preparing digital education materials	no	1527.45	1147355	<0.000	3.73	3.75
	yes	1930.98			4.36	4.51
Supporting the learning process through digital communication options	no	1604.51	1279817.5	<0.000	4.49	4.71
	yes	1854.90			4.85	5.10

ICT use for monitoring and evaluation	no	1563.49	1209302.5	<0.000	3.66	3.72
	yes	1895.40			4.20	4.38
Simultaneous use of several ICT services	no	1569.93	1220363	<0.000	3.82	4.04
	yes	1889.04			4.38	4.61
Only uses reliable systems	no	1675.59	1401991	0.001	4.79	5.10
	yes	1784.72			4.96	5.21

Table 6

ICT use in light of digital training among Slovakian teachers

Slovakian– Mann-Whitney probe: Correlation between digital training received during studies and teachers' ICT use						
Dependent variable	Independent variable: digital training during studies	MR	U	p	average	group median
Possession of basic ICT skills	no	86.27	3529.500000	0.003	4.63	4.86
	yes	109.28			5.12	5.41
Confident application of ICT during teaching	no	90.82	3998.500000	0.084	4.74	4.98
	yes	104.07			5.01	5.25
ICT use for preparing digital education materials	no	89.93	3907.000000	0.051	4.52	4.72
	yes	105.09			4.86	5.15
Supporting the learning process through digital communication options	no	99.03	4426.000000	0.562	5.09	5.34
	yes	94.68			4.98	5.27
ICT use for monitoring and evaluation	no	90.76	3992.500000	0.088	4.25	4.53
	yes	104.14			4.63	4.88
Simultaneous use of several ICT services	no	89.21	3833.000000	0.032	4.32	4.53
	yes	105.91			4.79	5.02
Only uses reliable systems	no	97.67	4566.500000	0.851	5.00	5.247
	yes	96.24			4.956	5.21

Table 7

ICT use in light of digital training among Serbian teachers

Serbian– Mann-Whitney probe: Correlation between digital training received during studies and teachers' ICT use						
Dependent variable	Independent variable digital training during studies	MR	U	p	average	group median
Possession of basic ICT skills	no	68.13	1346.500000	0.115	5.14	5.49
	yes	79.57			5.52	5.72

Confident application of ICT during teaching	no	67.26	1249.500000	0.043	4.96	5.29
	yes	82.91			5.48	5.63
ICT use for preparing digital education materials	no	67.32	1256.500000	0.042	5.01	5.35
	yes	82.67			5.52	5.71
Supporting the learning process through digital communication options	no	67.66	1294.000000	0.067	5.13	5.43
	yes	81.38			5.62	5.69
ICT use for monitoring and evaluation	no	68.18	1352.000000	0.156	4.81	5.22
	yes	79.38			5.28	5.45
Simultaneous use of several ICT services	no	67.60	1287.500000	0.068	4.77	5.28
	yes	81.60			5.38	5.61
Only uses reliable systems	no	68.51	1388.500000	0.223	4.91	5.24
	yes	78.12			5.21	5.48

We relied on the Mann-Whitney probe to explore ICT use habits or in an indirect fashion we inquired about the efficiency of digital instruction, namely, whether receiving training in digital pedagogy during one's studies can have an impact on the effectiveness of teaching. Responses provided by Hungarian pedagogues receiving such training reveal a higher score and a significant divergence in case of all questions. Regarding the Slovakian responses, higher scores were given in case of two questions (Supporting the learning process through digital communication options, Only uses reliable systems) by those teachers, who did not take part in digital training. Consequently, two significant digressions can be identified regarding ICT skills and the ability to use several services simultaneously. Similarly to their Hungarian counterparts those Serbian teachers posted higher scores, who received digital training during their studies. Significant digressions were discerned regarding confident ICT use and the preparation of digital educational materials.

Table 8

ICT use in light of extracurricular digital training among Hungarian pedagogues

Hungarian– Mann-Whitney-probe: Correlation between participation in digital pedagogy training and teachers' ICT use						
Dependent variable	Independent variable: extracurricular digital training	MR	U	p	average	group median
Possession of basic ICT skills	no	1567.59	1201416.5	<0.000	4.29	4.41
	yes	1833.09			4.68	4.82
Confident application of	no	1570.22	1204926	<0.000	4.04	4.10
	yes	1831.44			4.41	4.50

ICT during teaching						
ICT use for preparing digital education materials	no	1560.69	1192192	<0.000	3.77	3.81
	yes	1837.44			4.22	4.34
Supporting the learning process through digital communication options	no	1657.611776	1321772.5	<0.000	4.55	4.81
	yes				4.75	5.00
ICT use for monitoring and evaluation	no	1614.75	1264465.5	<0.000	3.73	3.84
	yes	1803.40			4.05	4.21
Simultaneous use of several ICT services	no	1594.64	1237578	<0.000	3.86	4.05
	yes	1816.06			4.25	4.49
Only uses reliable systems	no	1683.06	1355803	0.020	4.77	5.12
	yes	1760.37			4.95	5.18

Table 9

ICT use in light of digital training among Slovakian pedagogues

Slovakian– Mann-Whitney-probe: Correlation between participation in extracurricular digital pedagogy training and teachers' ICT use						
Dependent variable	Independent variable: extracurricular digital training	MR	U	p	average	group median
Possession of basic ICT skills	no	91.62	2793.000000	0.476	4.79	5.04
	yes	98.36			4.88	4.91
Confident application of ICT during teaching	no	87.23	2622.000000	0.199	4.69	4.87
	yes	99.47			4.91	5.17
ICT use for preparing digital education materials	no	89.00	2691.000000	0.299	4.51	4.63
	yes	99.03			4.72	5.02
Supporting the learning process through digital communication options	no	96.28	2975.000000	0.923	4.97	5.31
	yes	97.18			5.05	5.31
ICT use for monitoring and evaluation	no	99.81	2893.500000	0.718	4.51	4.80
	yes	96.29			4.41	4.65
Simultaneous use of several ICT services	no	91.65	2794.500000	0.489	4.38	4.63
	yes	98.35			4.58	4.81
Only uses reliable systems	no	100.96	2848.500000	0.598	5.154	5.281
	yes	96.00			4.935	5.215

Table 10
ICT use in light of extracurricular digital training among Serbian pedagogues

Serbian– Mann-Whitney-probe: Correlation between participation in extracurricular digital pedagogy training and teachers' ICT use						
Dependent variable	Independent variable extracurricular digital training	MR	U	p	average	group median
Possession of basic ICT skills	no	67.09	2210.500000	0.294	5.17	5.47
	yes	73.29			5.26	5.61
Confident application of ICT during teaching	no	67.96	2265.500000	0.465	5.05	5.28
	yes	72.58			5.09	5.43
ICT use for preparing digital education materials	no	68.04	2270.500000	0.466	5.02	5.38
	yes	72.51			5.19	5.48
Supporting the learning process through digital communication options	no	71.13	2386.000000	0.852	5.21	5.52
	yes	69.99			5.25	5.47
ICT use for monitoring and evaluation	no	67.68	2248.000000	0.426	4.79	5.19
	yes	72.81			5.00	5.33
Simultaneous use of several ICT services	no	68.48	2298.500000	0.557	4.79	5.29
	yes	72.15			4.97	5.41
Only uses reliable systems	no	68.10	2274.500000	0.497	4.83	5.23
	yes	72.46			5.09	5.34

Similarly to the previous test, this inquiry aimed to assess the impact of extracurricular digital training on the dependent variables. The responses by Hungarian teachers were similar to that of the training undertaken during one's studies as the participants gave significantly higher scores to all questions. Respondents from Slovakia, who did not participate in digital training beyond their studies provided higher ranking scores in connection with two questions (ICT use for monitoring and evaluation, Only uses reliable systems). While high scores were assigned to the other questions, none of the respective divergences can be considered significant. Serbian pedagogues participating in digital training regularly provided higher evaluations to the questions, but significant divergence could not be discerned in this category either.

Table 11

ICT use in light of the highest level of education by Hungarian pedagogues

Hungarian– Kruskal-Wallis-probe: Correlation between highest qualification and teachers' ICT use						
Dependent variable	Independent variable: highest qualification	MR	Chi-square	p	average	group median
Possession of basic ICT skills	College/BA/BSC	1613.28	52.078	<0.000	4.38	4.47
	University/MA/MSC	1836.67			4.67	4.85
	PhD	2004.07			4.81	5.18
	Vocational education teacher	521.50			3.00	3.00
	secondary education/maturation/NTR	1639.78			4.35	4.50
Confident application of ICT during teaching	College/BA/BSC	1629.90	38.595	<0.000	4.14	4.20
	University/MA/MSC	1817.17			4.38	4.49
	PhD	2006.04			4.60	4.82
	Vocational education teacher	663.50			3.00	3.00
	secondary education/maturation/NTR	1944.65			4.50	4.78
ICT use for preparing digital educational materials	College/BA/BSC	1570.92	88.385	<0.000	3.80	3.85
	University/MA/MSC	1869.63			4.25	4.42
	PhD	2053.48			4.54	4.68
	Vocational education teacher	931.50			3.00	3.00
	secondary education/maturation/NTR	2111.68			4.60	5.00
Supporting the learning process through digital communication options	College/BA/BSC	1626.47	38.465	<0.000	4.53	4.74
	University/MA/MSC	1823.11			4.80	5.07
	PhD	1878.85			4.88	5.13
	Vocational education teacher	1133.25			4.00	4.00
	secondary education/maturation/NTR	1968.83			5.00	5.21
ICT use for monitoring and evaluation	College/BA/BSC	1621.04	44.120	<0.000	3.76	3.84
	University/MA/MSC	1821.56			4.07	4.27
	PhD	2042.24			4.40	4.71
	Vocational education teacher	1348.25			3.50	3.50
	secondary education/maturation/NTR	2139.48			4.55	4.80
Simultaneous use of several ICT services	College/BA/BSC	1556.15	108.887	<0.000	3.82	3.97
	University/MA/MSC	1880.37			4.34	4.64
	PhD	2257.26			4.92	5.26
	Vocational education teacher	935.50			3.00	3.00
	secondary education/maturation/NTR	1907.43			4.35	4.75
Only uses reliable systems	College/BA/BSC	1689.89	10.024	0.040	4.81	5.12
	University/MA/MSC	1761.13			4.93	5.19
	PhD	1965.36			5.19	5.39
	Vocational education teacher	956.25			4.00	4.00
	secondary education/maturation/NTR	1933.88			5.05	5.40

Table 12

ICT use in light of the highest level of education by Slovakian pedagogues

Slovakian– Kruskal-Wallis-probe: Correlation between highest qualification and teachers' ICT use						
Dependent variable	Independent variable:	MR	Chi-square	p	average	group median
Possession of basic ICT skills	College/BA/BSC	124.88	1.947475	0.378	5.50	5.50
	University/MA/MSC	95.55			4.83	5.14
	PhD (doctorate)	110.32			5.09	5.44
Confident application of ICT in teaching	College/BA/BSC	76.13	0.636918	0.727	4.50	4.50
	University/MA/MSC	97.36			4.88	5.12
	PhD (doctorate)	98.77			4.82	5.14
ICT use in preparing digital education materials	College/BA/BSC	85.00	0.521178	0.771	4.50	4.50
	University/MA/MSC	96.71			4.68	4.93
	PhD (doctorate)	106.14			4.73	5.25
Supporting the learning process through digital communication options	College/BA/BSC	114.38	1.377140	0.502	5.25	5.25
	University/MA/MSC	95.73			5.03	5.28
	PhD (doctorate)	111.23			5.00	5.33
ICT use for monitoring and evaluation	College/BA/BSC	107.63	0.470725	0.790	4.75	4.97
	University/MA/MSC	97.33			4.44	4.70
	PhD (doctorate)	87.86			4.18	4.50
Simultaneous use of several ICT services	College/BA/BSC	94.75	0.421697	0.810	4.25	5.00
	University/MA/MSC	96.42			4.53	4.74
	PhD (doctorate)	107.23			4.82	5.13
Only uses reliable systems	College/BA/BSC	133.13	3.382616	0.184	5.75	5.75
	University/MA/MSC	97.38			4.989	5.234
	PhD (doctorate)	77.68			4.545	4.80

Table 13

ICT use in light of the highest level of education by Serbian pedagogues

Serbian – Kruskal-Wallis-probe: Correlation between highest qualification and teachers' ICT use						
Dependent variable	Independent variable: Highest qualification	MR	Chi-square	p	average	group median
Possession of basic ICT skills	College/BA/BSC	52.00	1.635904	0.441	4.00	4.00
	University/MA/MSC	70.07			5.21	5.53
	PhD (doctorate)	75.38			5.48	5.64
Confident application of ICT in teaching	College/BA/BSC	78.75	1.240407	0.538	5.00	5.00
	University/MA/MSC	68.72			5.03	5.31
	PhD (doctorate)	77.10			5.28	5.25
ICT use for preparing digital educational materials	College/BA/BSC	78.00	0.359129	0.836	5.25	5.25
	University/MA/MSC	69.65			5.10	5.41
	PhD (doctorate)	73.06			5.16	5.52
Supporting the learning process through digital communication options	College/BA/BSC	75.38	0.536582	0.765	5.00	5.00
	University/MA/MSC	71.35			5.24	5.51
	PhD (doctorate)	65.96			5.20	5.41
ICT use for monitoring and evaluation	College/BA/BSC	88.25	0.969223	0.616	5.50	5.50
	University/MA/MSC	69.59			4.88	5.24
	PhD (doctorate)	71.72			4.92	5.35

Simultaneous use of several ICT services	College/BA/BSC	79.00	0.591387	0.744	5.00	5.00
	University/MA/MSC	69.34			4.86	5.31
	PhD (doctorate)	74.30			5.00	5.50
Only uses reliable systems	College/BA/BSC	55.25	0.727308	0.695	4.75	4.67
	University/MA/MSC	70.58			4.95	5.30
	PhD (doctorate)	72.58			5.08	5.35

The Kruskal-Wallis probe was applied to identify whether the highest level of qualification has any impact on ICT use. The analysis of Hungarian respondents' answers reveals a pattern according to which the higher the level of qualification, the better the given educator considers their own habits, skills, and efficiency of ICT use. In case of all dependent variables significant divergences were discerned. Responses from Slovakia and Serbia do not show such uniformity as no significant divergence can be discerned in the samples. Thus, we can conclude that ICT use is not dependent on educational qualification and the high p values suggest that any differences in the answers are merely coincidental.

Conclusions and Future Work

In March 2020 it was revealed that the Hungarian education system was not prepared to meet the requirements of 21st Century education. Teachers had merely, one weekend, to change from the delivery based, frontal instruction and monitoring paradigm, to become inclusive and adaptive organisers of the learning process. Educators were also expected to promote student motivation in a playful and enjoyable manner. The real division between the two approaches, was not familarity with, or previous user experience, concerning digital devices, or the possession of digital literacy, but, the maintenance of a flexible pedagogical perspective. The substantial challenge imposed by the digital transformation process, was convoyed with several potential setbacks, including the limited control of student activities, via the digital surfaces and the reduced attention span of students, despite the application of innovative and interactive solutions. While previous experiences gained from distance learning provided an adequate foundation for achieving the respective goals, the VUCA effect imposed heavy demand on everyone. The present research confirmed that, apart from using such platforms, such as, the Edupage or Big Blue Button, the digital device system of the three countries under inquiry is virtually identical. The ICT habits and device use perceived in case of the large sample groups showed a wide variety of solutions depending on the available digital skills and infrastructure. The examination of numerous background variables revealed significant divergence only in two aspects: Confident ICT use and the preparation of digital educational materials. Although participation in digital training programs along with the educational level can have a major impact, in light of the $p<0.05$ reliability, significant divergences were not revealed.

Modern education methods prioritise fast identification and retrieval of authentic and credible information, over passive reception of knowledge, while problem solving, replaces following the teacher's instructions. Proven by the results of

final examinations administered on-line, such skills and aptitudes have to be continuously developed. In addition, Educators must pay attention to such concerns, in the future.

References

[1] B. Orosz, et. al.: Digital education in digital cooperative environments. Journal of Applied Technical and Educational Sciences, Vol. 9, No. 4, 2019, pp. 55-69

[2] A. Buda: Educators in the digital age. Trend research in schools in a big city. Budapest, Hungary: Thought Publisher 2020

[3] B. Csapó: The role of teacher knowledge in the development of the education system, NEW PEDAGOGICAL REVIEW, Vol 3, No. 4, 2007, pp. 1-9

[4] T. Sebestyén: (2005): Human capital and education. Which quality do we measure? Labor Review, april, 2005, pp 28-32

[5] Eric A. Hanushek, Dennis D. Kimko: Schooling, Labor-Force Quality, and the Growth of Nations, American Economic Review, Vol. 90, No. 5, 2000, pp. 1184-1208

[6] Rivkin, S. G., E. A. Hanushek, J. F. Kain: Teachers, schools, and academic achievement, Econometrica, 2005

[7] Nagy et al.: Development opportunities of digital and labor market competences in higher education, In: L., Gómez Chova; A., López Martínez; I., Candel Torres (ed.) ICERI2018 Proceedings: 11th International Conference of Education, Research and Innovation, Seville, International Academy of Technology, Education and Development (IATED), 2018 10 600 p. pp. 10590-10594

[8] A. Kovari: Synergy of digital society and digital education. Civil Szemle, Vol. 17, No. 1, 2020, pp. 69-72

[9] A. Kovari, J. Katona, C. Costescu: Quantitative Analysis of Relationship Between Visual Attention and Eye-Hand Coordination. Acta Polytechnica Hungarica, Vol. 17, No. 2, 2020, pp 77-95

[10] L. Besenyei: The revolution of generation change, OPUS ET EDUCATIO, Vol. 3, No. 4, doi:http://dx.doi.org/10.3311/ope.19 , 2016, pp. 371-378

[11] P. Molnár: Networking and learning in network environments, Budapest, Eötvös Loránd University, 2013, http://www.tankonyvtar.hu/hu/tartalom/tamop412A/2011-0073_halozatosodas_tanulas_halozati_kornyezetben/index.html

[12] L. Z. Karvalics: Information, society, history, Budapest, Typotex, 2003, 178 p.

[13] G. Siemens: Connectivism: A Learning Theory for the Digital Age. 2 International Journal of Instructional Technology and Distance Learning, 2004, http://www.itdl.org/journal/jan_05/article01.htm

[14] S. Forgó: New Media competence perspectives – instructor competences required for teaching the New Media, In Nádasi András (ed.): Agria Média 2011 – X. Information Technology and Educational Technology Conference and Exhibition. Eger, Líceum, 2011, pp. 216-217

[15] P. Baranyi, A. Csapo, Gy. Sallai: Cognitive Infocommunications (CogInfoCom), Springer International Publishing Switzerland, 2015, p. 219

[16] P. Baranyi, A. Csapó: Definition and synergies of cognitive infocommunications. Acta Polytechnica Hungarica, Vol. 9, No. 1, 2012, pp. 67-83

[17] A. Kovari, M. Rajcsányi-Molnár: Mathability and Creative Problem Solving in the MaTech Math Competition. Acta Polytechnica Hungarica, Vol. 17, No. 2, 2020, pp. 147-161

[18] E. Kocsó, M. Cserné Pekkel, L. Bognár, P. Horváth: Teaching Mathematics at the Correspondence Courses of the University of Dunaújváros. Journal of Applied Technical and Educational Sciences, Vol. 10, No. 4, 2020, pp 87-104

[19] A. Skobrák: Direct hand-movement control in virtual space: a potential interface for virtual lab purposes. Transactions on IT and Engineering Education, Vol. 2, No. 1, 2019, pp 30-45

[20] G. Sziládi G.: Applications of human-computer interfaces and related psychological-educational aspects. Computers & Learning, Vol. 2, No. 1, 2019, pp. 1-14

[21] R. Demeter et al: Importance of digital simulation in the competence development of engineers defining the society of the future, Civil Szemle, Vol. 17, No. 2, 2020, pp. 89-101

[22] C. Costescu, A. M. Rosan: Development an assessment protocol to identify the characteristics of ASD using eye-tracking for special education purpose. Journal of Applied Technical and Educational Sciences, Vol. 9, No. 4, 2019, pp. 70-87

[23] S. Maravic Cisar, R. Pinter: Analysis of students' dropout rate at Subotica Tech. Journal of Applied Technical and Educational Sciences, Vol. 9, No. 4, 2019, pp. 43-54

[24] A. Kovari: Study of Algorithmic Problem-Solving and Executive Function. Acta Polytechnica Hungarica, Vol. 17, No. 9, 2020, pp. 241-256