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ICT in higher education: a logistic perspective from the pandemic period

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Abstract

A period of pandemics and distance learning has forced teachers to plunge headlong into the technological challenges of education. Today, it is possible to look back on this time as an educational milestone that, although forced, contributed to a much-needed leap into the digital age in higher education. Information and communication technologies (ICT) have contributed to a significant paradigm shift in learning and the roles of teachers and students in education today. ICT tools in the educational process have become indispensable, whether for on-site teaching, an exclusively online system, or a hybrid scheme. Therefore, this study aims to establish how modern technology has enabled a unity of resources in the education process and to identify how the pandemic conditions have affected the logistics process for didactics, particularly related to providing a unity of the right resources in the correct place. Moreover, the authors indicate the benefits of the described changes in the didactic process for teachers and students in the post-pandemic period.

Introduction

A precondition for any purposefully organized human activity is the need for resources. This activity may concern an unlimited number of areas, of different types and scales. Traditionally, logistics is identified with economic activity. In every large enterprise, there is a department named logistics or a unit similarly responsible for the implementation of logistical tasks such as transport, storage, purchasing, distribution, etc. (Chaberek, 2020). Micro and small enterprises usually do not establish a separate logistics department; nevertheless, the abovementioned tasks are also performed. However, logistics cannot be limited to supporting only business activity. In fact, equally important areas have been indicated in the literature, distinguishing business, military, and social areas of logistics applications, which creates the so-called logistics triad (Szołtysek & Twaróg, 2013). Therefore, the application of logistics in military activities, as well as in the activities of a city, a region, or public utility entities (such as a hospital, a school, or a university), may be equally well considered.

It is worth emphasizing here that regardless of the area of application, the objective of the logistics process is always the same, i.e., to provide **the right resources**, in the correct quantity, to the **right place**, at the right time, and at a cost necessary for the main process. This postulate in the literature is referred to

as the 5R principle (Naim et al., 2000). The logistics process is, therefore, permanently linked to the core business, as shown in Figure 1.

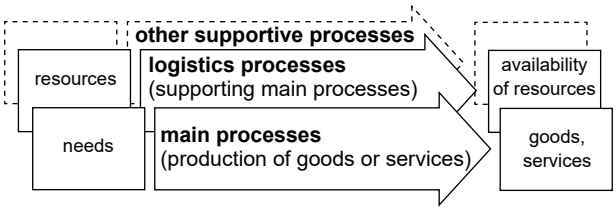


Figure 1. Coexistence of main and supportive processes in an organization (Reszka, 2021)

In the traditional view of economics, resources are located among the three main production factors: land, capital, and labor. Nowadays, in the so-called knowledge-based economy, intangible resources (among which are the foremost information resources) are gaining increasingly more importance.

The educational process mentioned in the title of this article, which is the main process at the university, requires a unity of the time and place of the resources. Previously, that is, before the pandemic, teaching required students and the lecturer to be in the same lecture room at the same time with the appropriate equipment. However, the pandemic period has necessitated a different view of this process and, consequently, of the logistics process that supports it. Unity of place, understood as lecturing, i.e., a meeting between a lecturer and students in the same lecture room, has been replaced by a meeting in the same communication channel, e.g., in the same MS Teams or Zoom meeting.

The pandemic and online classes also had an impact on resources. Of course, the fundamental resources for the classes, i.e., lecturers and students, remained unchanged. However, there was a need to use appropriate software, which in turn required appropriate hardware resources for both lecturers and students, as well as a sufficiently fast and stable Internet connection. The change in the necessary resources also affected the costs. The costs of physical logistics processes, e.g., the cost of travel to the university, and the cost of renting a dormitory room for students living in locations far from the university, have been significantly reduced or even eliminated. There were, however, costs for equipping a suitable computer or other electronic devices, software, and a fee for the use of an Internet connection.

It is also worth emphasizing here that the change in the method by which lectures have been delivered (as described above) would not have been possible if the development of information communication technologies had not reached an appropriate level. However, before the pandemic, there was never a need for a complete and unexpected transfer from on-site to online teaching on such a scale. As a consequence, unprecedented problems arose in the context of the logistics of the didactic process, which are worth examining to close the gap in the research.

In view of the above, this study aims to investigate how the pandemic conditions have affected the logistics process for didactics, particularly those related to providing a unity of the correct resources in the right place. Moreover, the authors intend to indicate the benefits of the described changes in the didactic process for teachers and students in the post-pandemic period.

To fulfill our goal, the authors searched for answers to the following research questions: How has modern technology enabled a unity of resources in the education process? What were the difficulties in the transition from on-site to online education? What were the difficulties dependent on?

Literature review

With the predominance of ICT in almost every aspect of our lives, it is not surprising that university teachers are examining its proper application in the educational process. The use of different ICT software and platforms greatly impacts how learning occurs in many disciplines and contexts, including online and hybrid learning (Naciri et al., 2020). Following an exploration of its potential and an overview of the current research, it becomes clear that many factors influence the implementation of ICT solutions within the educational context (Tezci, 2011a). This includes the availability and accessibility of ICT software and equipment, and the assistance from authorities (in terms of technical support) to facilitate various climates and cultures (Al-Ruz & Khasawneh, 2011; Tezci, 2011b; Lin, Wang & Lin, 2012). However, regardless of the reasons and the extent to which ICT solutions have been used in the educational process in the past, the pandemic has forced higher education institutions to adopt selected ICT solutions (Armstrong-Mensah et al., 2020; Alshaboul et al., 2021; Filho et al., 2021). Situations in which university authorities, and teachers themselves, did not have much experience in the use of particular tools often occurred previously (Hodges et al., 2020; Hébert, Wood & Reena, 2022).

It is undoubtedly the case that a great deal of the academic staff understands the importance of technology in teaching and learning, especially given the

impact that switching to remote learning has had on the sector, precipitated by the COVID-19 pandemic of 2020 (Zhou & Milecka-Forest, 2021). Yet, teachers are required to be more creative in adapting and customizing their own teaching materials and strategies (Li et al., 2021; Tomczyk & Walker, 2021). However, such an approach requires the knowledge of ICT solutions that are available on the market, as well as the skills to apply them (Dębicka et al., 2022).

Methodology of survey

A survey of university teachers in six European countries – i.e., Croatia, Romania, Poland, Slovenia, Finland, and Italy – was used to determine changes in the level of use of ICT in the educational process.

The themes of the questionnaire focused on the identification of problems and good practices related to preparedness for online teaching (the situation before the pandemic), challenges in a shift to online teaching (for spring-summer semester 2020 and spring semester 2021), and plans and perspectives. The questionnaire was compiled in English using a Webropol survey and reporting tool. The respondents could answer the open questions in English or their own language. The survey was opened on 25 May 2021 and closed on 25 October 2021. The link to the questionnaire was sent to academic teachers in the InCompEdu partner universities, which are: the University of Gdańsk in Poland, the University of Rijeka in Croatia, the University of Primorska in Slovenia, the University of Alba Julia in Romania, the University of Roma Tora Vergata in Italy, University of Turku in Finland, and to teachers in universities and research institutes in the project partners' countries. In total, 525 replies were received (Table 1).

Table 1. Number of replies per country (Pöntynen et al., 2022)

Country	No.	In %
Croatia	102	19%
Finland	75	14%
Italy	57	11%
Poland	144	27%
Romania	67	13%
Slovenia	80	15%

Most respondents (21%) were affiliated with economic faculties, followed by engineering and humanities (both 14%). In addition to the options on the questionnaire, architecture, landscape architecture, geography, mathematics, economics and finance, healthcare sciences, psychology, organizational psychology, national philology and language learning, philology, computer science, logistics, arts, dentistry, chemistry, and chemical technology, veterinary, open university, and in-service training were mentioned (Table 2).

Table 2. Faculties in which the interview participants teach

Faculty	Croatia	Finland	Italy	Poland	Romania	Slovenia	Total
Arts	2%	5%	0%	3%	0%	10%	3%
Economics/commerce	18%	11%	13%	27%	40%	11%	21%
Education	20%	11%	2%	4%	5%	7%	8%
Engineering	14%	4%	29%	14%	17%	11%	14%
Humanities	15%	16%	4%	17%	9%	16%	14%
Information technology	7%	12%	2%	7%	6%	7%	7%
Law	1%	0%	13%	4%	8%	1%	4%
Management studies	6%	3%	5%	15%	8%	8%	9%
Medicine	12%	15%	16%	0%	0%	22%	9%
Music	3%	0%	0%	0%	0%	1%	1%
Natural sciences	9%	14%	4%	9%	0%	18%	9%
Philosophy	1%	0%	0%	1%	0%	1%	1%
Science	4%	5%	27%	7%	6%	10%	9%
Social sciences	6%	11%	2%	10%	9%	8%	8%
Sports	5%	1%	0%	0%	6%	1%	2%
Political sciences	0%	3%	2%	1%	0%	1%	1%
Technology	6%	7%	0%	5%	3%	10%	5%
Theology	1%	0%	0%	0%	2%	1%	1%
Other	1%	3%	2%	7%	2%	12%	5%

Research and data analysis

The pandemic has significantly influenced two of the five goals of logistics, that is, correct resources and places. Both of these goals were closely related to the use of ICT tools, since they created the possibility of organizing the learning process via the Internet (the right place), as well as supporting didactics (correct resources) – from posting teaching materials online to organizing classes, distributing assessments, and documenting the course of study (educational assessment).

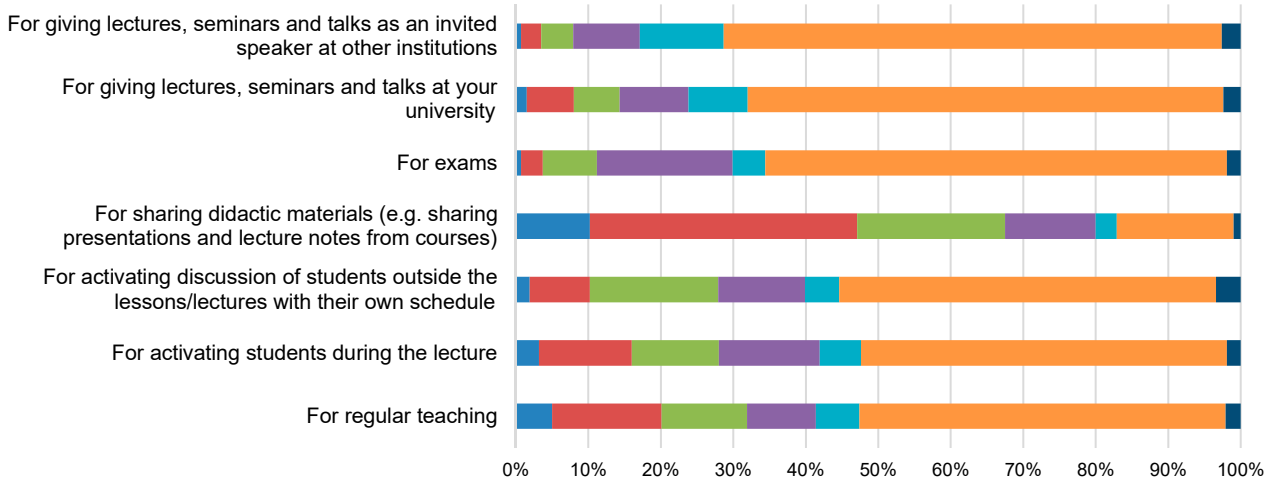
In the case of remote or hybrid learning, a close link also emerges between these goals since the correct resources and the right place in material terms (i.e., ICT tools and platforms) need to be supported by the right resources in terms of teachers' knowledge and skills. In both cases, the key to making the best use of the technology for educational purposes is the availability of necessary ICT resources and the teachers' skills and experience with the tools adopted for teaching.

The challenges of the transition to distance learning have exposed existing weaknesses in these areas while contributing in the long run to the strengthening of teachers' competencies and greater use of ICT tools, even in the post-pandemic period.

The new situation at the beginning of 2019 forced teachers to use software and tools they were previously unfamiliar with. The study shows that, before the pandemic period, the use of both software and online platforms by academic teachers was low. More than 65% of respondents have never used ICT tools for presenting lectures, and more than half of the teachers surveyed had never used ICT support for regular teaching or for activating discussions with students during the lectures (Figure 2).

The need for a unity of place and resources to conduct online lessons has forced academics to use platforms offering meeting organizations. Platforms for online teaching activities allow teachers to create online lessons, boards for students to share their thoughts and work, and collaborative learning spaces. They provide teachers with the ability to communicate easily with students.

University teachers have been asked about the difficulties connecting with various aspects of online teaching in the spring-summer semester of 2020 (the beginning of the pandemic). Here, we wanted to create a scale of difficulties in online teaching and, thus, we have followed up the questionnaire



	For regular teaching	For activating students during the lecture	For activating discussion of students outside the lessons/lectures with their own schedule	For sharing didactic materials (e.g. sharing presentations and lecture notes from courses)	For exams	For giving lectures, seminars and talks at your university	For giving lectures, seminars and talks as an invited speaker at other institutions
Daily	5.0%	3.2%	1.9%	10.2%	0.7%	1.5%	0.7%
Weekly	15.1%	12.8%	8.3%	36.9%	3.0%	6.5%	2.8%
Monthly	11.8%	12.0%	17.7%	20.4%	7.5%	6.3%	4.4%
Once a semester	9.5%	13.9%	12.0%	12.5%	18.7%	9.5%	9.2%
Once a year	6.0%	5.7%	4.7%	2.9%	4.5%	8.2%	11.6%
Never	50.5%	50.5%	52.0%	16.1%	63.7%	65.6%	68.8%
I cannot say	2.1%	1.9%	3.4%	1.0%	1.9%	2.4%	2.6%

Figure 2. Frequency of using online teaching tools and collaboration platforms before COVID-19

with a reliability analysis for the scale. Cronbach's alpha is a measurement of the internal consistency, or reliability, of a group of survey items. This statistic helps assess whether a collection of items consistently measures the same feature. Cronbach's alpha assesses the level of agreement on a standardized 0 to 1 scale. Higher values indicate greater agreement among items.

High Cronbach's alpha levels suggest that response values for each participant across a set of questions are consistent. When participants provide a high reaction to one of the items, they are more likely to give a high response to the others. This consistency shows that the measurements are accurate, and the items could measure the same property. Low numbers, on the other hand, suggest that the group of items does not reliably measure the same construct (Table 3).

For this statistic, data originated from survey responses, assessment tools, and test scores. Data can be continuous; however, it is more commonly represented by Likert and binary values. Analysts commonly use 0.7 as a benchmark figure for Cronbach's alpha. At this level and higher, the items are sufficiently consistent and indicate that the measure is dependable. Values approaching 0.7 are often minimally acceptable but not excellent. We observe an overall Cronbach's alpha of 0.88 for the scale and very similar values for the appropriate individual variables, thus proving the reliability of the scale. A similar approach has been assumed for the questions about the difficulties in online teaching in semester 2021 (Table 4).

Cronbach's alphas for these measurements are even higher than the acceptable threshold. This indicates the reliability of the scale for both periods of inquiry. To establish the variability patterns, we followed up with an exploratory factor analysis (Table 5).

Exploratory factor analysis (EFA) is a popular statistical tool in the social sciences. According to Costello and Osborne (Costello & Osborne, 2005), around 1700 research articles used EFA in some way. More than half of the researchers said they employed principle components analysis with varimax rotation to evaluate the data. The following is a list of the criteria used to determine whether or not a certain piece of equipment should be kept (i.e., all factors with eigenvalues greater than one).

Some options in many software systems have several names, and critical alternatives are frequently not presented properly. The optimal way also depends on the study plan, the nature of the data, and the issues that need to be answered. The major axis approach, extended least squares, maximum likelihood, alpha factoring, and picture factoring are a few techniques for extracting factors from factor analyses. Experts disagree on the relative advantages and

Table 3. Results of the Cronbach's alpha test for difficulties in online teaching in spring-summer semester 2020

Variable	Summary for scale: Mean = 26.6789 Std.Dv. = 7.75213 Valid N:489 Cronbach alpha: .877603 Standardized alpha: .877886 Average inter-item corr.: .400478				
	Mean if deleted	Var. if deleted	StDv. if deleted	Itm-Totl Correl.	Alpha if deleted
Past1_Online teaching methods and techniques	24.26380	51.27396	7.160584	0.547658	0.869395
Past2_Communication with students (e.g., keep in contact with them)	24.33129	50.52420	7.108037	0.542763	0.869864
Past3_Engagement of students during lessons (e.g., motivation, activation, and making students reactive and mentally focused)	24.84458	51.81634	7.198357	0.524247	0.870823
Past4_Scheduling with other professional activities remotely (e.g., research)	23.92434	48.99427	6.999591	0.643269	0.862963
Past5_Communication with colleagues related to teaching	23.71370	50.89145	7.133824	0.580196	0.867386
Past6_Lack of scheduling with in-presence activities	23.75051	49.63510	7.045218	0.564370	0.868636
Past7_Increased workload due to the organization of online teaching	24.70348	50.16361	7.082627	0.603254	0.865810
Past8_Fatigue from prolonged activities on screen	24.66053	49.55756	7.039713	0.638955	0.863413
Past9_Ergonomics in remote working	24.48875	50.17625	7.083520	0.608480	0.865492
Past10_Remote working premises/circumstances (e.g., restricted or no workspace)	23.98569	49.37608	7.026811	0.609588	0.865316
Past11_Work-home interference	24.12270	49.46961	7.033463	0.580238	0.867467

Table 4. Results of the Cronbach's alpha test for difficulties in online teaching in spring semester 2021

Variable	Summary for scale: Mean = 30.8696 Std.Dv. = 8.65537 Valid N:460 Cronbach alpha: .918804 Standardized alpha: .919107 Average inter-item corr.: .516043				
	Mean if deleted	Var. if deleted	StDv. if deleted	Itm-Totl Correl.	Alpha if deleted
Current1_Online teaching methods and techniques	27.93913	63.50064	7.968729	0.666103	0.912154
Current2_Communication with students (e.g., keep in contact with them)	28.09565	62.80390	7.924891	0.650692	0.912820
Current3_Engagement of students during lessons (e.g., motivation, activation, and making students reactive and mentally focused)	28.53478	63.34444	7.958922	0.614176	0.914587
Current4_Scheduling with other professional activities remotely (e.g., research)	27.87609	61.68247	7.853819	0.722387	0.909313
Current5_Communication with colleagues related to teaching	27.63696	63.99211	7.999507	0.658988	0.912562
Current6_Lack of scheduling with in-presence activities	27.66957	62.52124	7.907038	0.694626	0.910730
Current7_Increased workload due to the organization of online teaching	28.35870	61.17786	7.821628	0.701789	0.910332
Current8_Fatigue from prolonged activities on screen	28.52826	60.84921	7.800590	0.700479	0.910457
Current9_Ergonomics in remote working	28.32609	61.40672	7.836244	0.710440	0.909868
Current10_Remote working premises/circumstances (e.g., restricted or no workspace)	27.80217	61.68043	7.853689	0.704680	0.910165
Current11_Work-home interference	27.92826	62.12746	7.882098	0.663483	0.912252

Table 5. Results of the exploratory factor analysis

Variable	Factor Loadings (Unrotated) Extraction: Principal factors (Centroid) (Marked loadings are > .550000)
	Factor 1
Past1_Online teaching methods and techniques	0.587215
Past2_Communication with students (e.g., keep in contact with them)	0.609334
Past3_Engagement of students during lessons (e.g., motivation, activation, and making students reactive and mentally focused)	0.590486
Past4_Scheduling with other professional activities remotely (e.g., research)	0.689766
Past5_Communication with colleagues related to teaching	0.635655
Past6_Lack of scheduling with in-presence activities	0.624020
Past7_Increased workload due to the organization of online teaching	0.663593
Past8_Fatigue from prolonged activities on screen	0.721119
Past9_Ergonomics in remote working	0.662126
Past10_Remote working premises/circumstances (e.g., restricted or no workspace)	0.676770
Past11_Work-home interference	0.646322
Expl.Var	4.608548
Prp.Totl	0.418959

disadvantages of various strategies. The researcher must next decide how many elements to rotate after extraction. Overextraction and underextraction of components maintained for rotation may have an adverse effect on the findings. The majority of statistical software packages, by default, preserve all factors with eigenvalues greater than 1.0.

The rotational technique is the next choice. Rotation serves to make the data structure clearer and simpler. Rotation cannot enhance the analysis' essential properties, such as the amount of variation retrieved from the components. There are numerous options, just as there are with extraction procedures. Varimax, quartimax, and equamax often use orthogonal rotational techniques, while direct oblimin, quartimin, and promax regularly employ oblique ones. When factors are rotated orthogonally, they become uncorrelated; when they are rotated obliquely, they

Table 6. Results of the exploratory factor analysis

Variable	Factor Loadings (Unrotated) Extraction: Principal factors (Centroid) (Marked loadings are > .550000)
	Factor 1
Current1_Online teaching methods and techniques	–0.686943
Current2_Communication with students (e.g., keep in contact with them)	–0.666055
Current3_Engagement of students during lessons (e.g., motivation, activation, and making students reactive and mentally focused)	–0.632076
Current4_Scheduling with other professional activities remotely (e.g., research)	–0.753569
Current5_Communication with colleagues related to teaching	–0.690131
Current6_Lack of scheduling with in-presence activities	–0.730504
Current7_Increased workload due to the organization of online teaching	–0.737694
Current8_Fatigue from prolonged activities on screen	–0.739903
Current9_Ergonomics in remote working	–0.749251
Current10_Remote working premises/circumstances (e.g., restricted or no workspace)	–0.745198
Current11_Work-home interference	–0.704781
Expl.Var	5.597884
Prp.Totl	0.508899

become linked. Conventional wisdom advocates orthogonal rotation because it yields data that is easier to comprehend, although this is a shaky justification. This is because behavior is rarely reduced into neatly packaged parts that act independently of one another; we typically expect some relationships across elements in the social sciences. As a result, if the parts are linked, orthogonal rotation results in the loss of critical information, whereas oblique rotation should yield a more accurate (and likely repeatable) solution. Results from orthogonal and oblique rotation are virtually comparable if the variables are totally uncorrelated.

Given the structure of the data, we assume a centroid method of extraction. Due to only one factor being extracted, we apply no rotation. This indicates that all of the difficulties that arise provide a comparable variability pattern – if the teacher experiences difficulties of one type, he is likely to experience difficulties of another type. We follow up with a similar approach for the difficulties in the spring semester 2021 (Table 6).

The outcomes align with the results relating to past difficulties. We save the factor scores and aggregate the scale of difficulties in single variables: dif_2020, indicating the scale of current variables (the higher the values, the higher the difficulties), and dif_2021 (due to inverse representation of the data – the higher the values, the lower the difficulties). We follow up with a standard Pearson correlation analysis (Table 7).

Table 7. Results of the Pearson correlation analysis

Variable	Correlations Marked correlations are significant at $p < .05000$ N = 437 (Casewise deletion of missing data)			
	Means	Std.Dev.	dif_2020	dif_2021
dif_2020	0.020541	0.964376	1.000000	–0.628237
dif_2021	–0.009948	0.963622	–0.628237	1.000000

The results indicate a significant correlation between the difficulties in 2020 and 2021 – the more likely someone was to have difficulties in the spring semester of 2020, the more likely they had them in the spring semester of 2021, or at least perceive reality in such a way.

We follow up with an analysis of covariance. ANOVA with covariance (ANCOVA) is a general linear model that combines ANOVA with regression. ANCOVA tests whether the means of a dependent variable (DV) are the same across levels of a categorical independent variable (IV), also known as a treatment, while statistically controlling for the effects of other continuous variables that are not of primary interest, known as covariates (CV) or nuisance variables. Mathematically, ANCOVA decomposes the variance in the DV into variance explained by the CV, variance explained by the categorical IV, and residual variance. Intuitively, ANCOVA can be thought of as 'adjusting' the DV by the group means of the CV. In this case, the difficulties in the spring semester of 2021 are the dependent variable, while the difficulties in the spring semester of 2020 are the covariate and the qualitative factors include age, gender, using online teaching before the pandemic, academic position, and the country of origin (Table 8).

Table 8. Results of the analysis of covariance

Effect	Univariate Tests of Significance for Current_dif Sigma-restricted parameterization Effective hypothesis decomposition; Std. Error of Estimate: 0.7390				
	SS	Degr. of Freedom	MS	F	p
Intercept	0.3612	1	0.3612	0.6614	0.416570
dif_2020	105.8665	1	105.8665	193.8577	0.000000
Age	0.9572	5	0.1914	0.3505	0.881836
Gender	1.8191	3	0.6064	1.1103	0.344694
Prepandemic_online_teaching	2.4294	5	0.4859	0.8897	0.487875
Position	1.0093	2	0.5046	0.9241	0.397749
Which country do you teach in?	8.3093	6	1.3849	2.5359	0.020213
Error	216.2572	396	0.5461		

Interestingly, apart from the continuous predictor, the only statistically significant variable is the country of origin, which means that the scale of difficulties in teaching in the spring semester of 2021 (if adjusted for the challenges in teaching in the spring semester of 2020) varies significantly only between countries. This might indicate that different good practices have been adopted in certain countries, which turned out to be more efficient than in other countries. To confirm, we follow up with the formal verifications of the homogeneity of variances (p-value for Cochran C at 0.38) and covariances (p-value for the M Box test at 0.07). To conclude, we perform a posthoc Bonferroni test for the difficulties in different countries (Table 9).

For comparison, we estimate a GLM for difficulties in teaching in the spring semester of 2020, in which the country of origin is the key factor in identifying the initial difficulties. The highest value was for Finland and the lowest for Croatia and Romania. Apart from the teachers running didactic in more than one country (variable = 7), the variances are homogenous (Figure 3).

The diagnosed problems were, in the authors' opinion, due to the lack of experience in the use of platforms and systems. The survey results showed that the use of online software to work with students was very low before the pandemic period. Respondents listed only five types of software but only Moodle was more widely used (48%), while the others were marginally utilized, including files and chats in Teams (9%), breakout rooms in Zoom (5%), and Google Workspace (7%). Despite the broad range of available online software, it seems that only a few chose to attempt new solutions during the pandemic. Instead, our participants preferred to use familiar platforms such as Moodle (55%), breakout rooms in Zoom (42%), or file sharing and chat in MS Teams (73%) (Figure 4). Moreover, almost half of the respondents declared that they want to use MS Teams (46%) and Moodle (45%) in their work with students after the pandemic (Figure 4). However, there was some information, but not much more than 6%, about the intention to use other platforms such as Lectora, Elucidat, Easy Generator, Symbaloo, and GOMO Learning Suite.

Many teachers reported problems with students' activation during the pandemic but few of them had the necessary experience, and used the IT support tools in this area, before the pandemic (Figure 5). Among the programs used were Google Docs (34%), Kahoot (29%), Mentimeter (13%), and Google Slide (13%). While these applications were still in use during pandemic online classes, other applications

Table 9. Results of the posthoc Bonferroni test

Cell No.	Bonferroni test; variable dif_2021 Probabilities for Post Hoc Tests Error: Between MSE = .54610, df = 396.00							
	Which country do you teach in?	{1} .17781	{2} –.4617	{3} –.3246	{4} –.0087	{5} .50402	{6} –.0893	{7} .14035
1	Croatia {1}		0.000012	0.008691	1.000000	0.223655	0.654350	1.000000
2	Finland {2}	0.000012		1.000000	0.003374	0.000000	0.118889	1.000000
3	Italy {3}	0.008691	1.000000		0.413626	0.000002	1.000000	1.000000
4	Poland {4}	1.000000	0.003374	0.413626		0.000527	1.000000	1.000000
5	Romania {5}	0.223655	0.000000	0.000002	0.000527		0.000303	1.000000
6	Slovenia {6}	0.654350	0.118889	1.000000	1.000000	0.000303		1.000000
7	Other {7}	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	

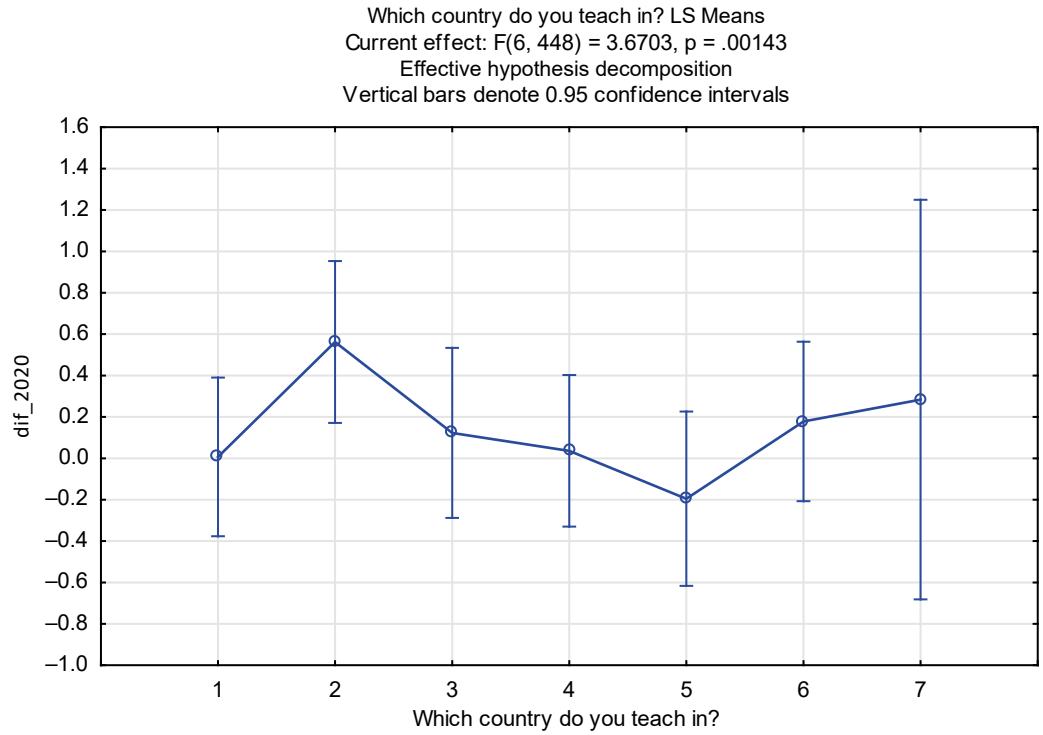


Figure 3. GLM for the difficulties in teaching in the spring semester 2020

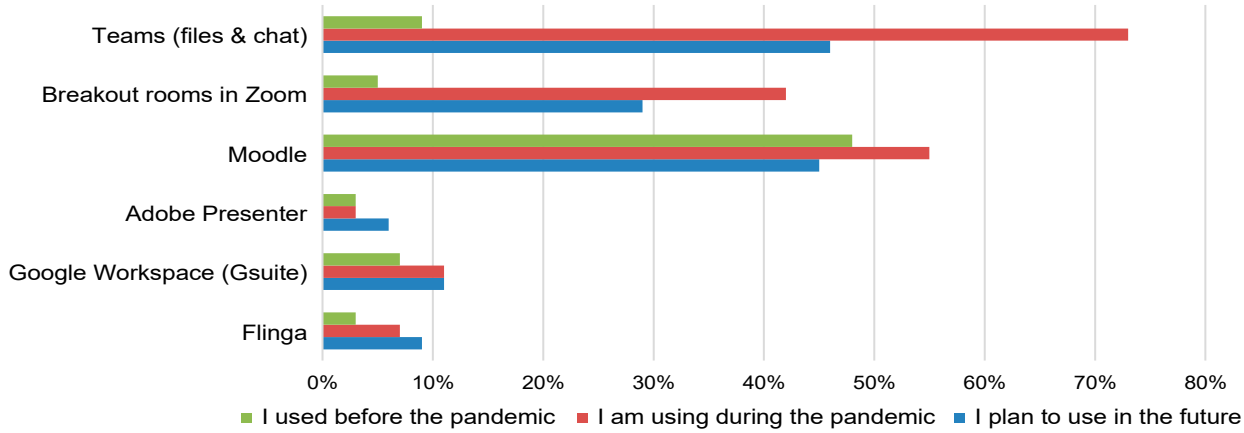


Figure 4. Platforms for online teaching activities

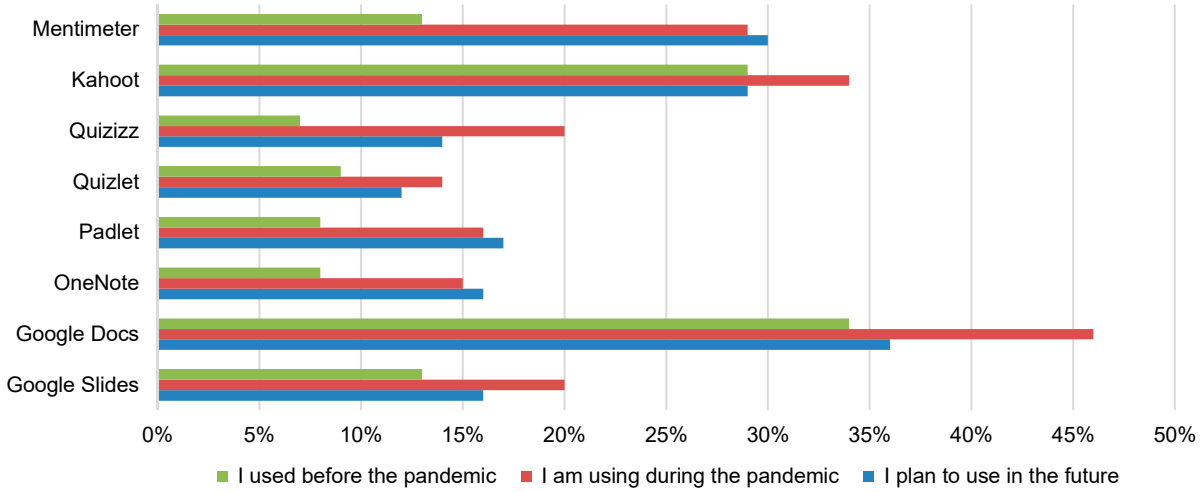
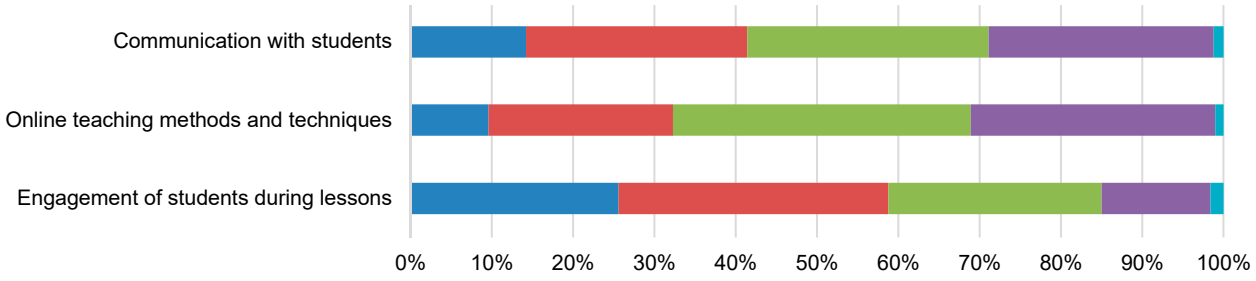


Figure 5. Online tools for students' activation during the lessons



	Engagement of students during lessons	Online teaching methods and techniques	Communication with students
Significantly challenging	25.6%	9.6%	14.2%
Moderately challenging	33.2%	22.7%	27.2%
Slightly challenging	26.2%	36.6%	29.7%
Not at all challenging	13.4%	30.1%	27.7%
Does not apply to me	1.6%	1.0%	1.2%

Figure 6. Current challenges in online teaching

such as Kahoot (34%), Quizizz (20%), or Jambord (17%) have also been applied. Some of them have been well-received by teachers who still intend to use these tools after the end of the pandemic, including Google Docs (36%), Mentimeter (30%), Kahoot (29%), Padlet (17%), and Quizzis (14%).

Respondents declared a significant increase in their competence and skills in using ICT tools in the teaching process after the 18-month pandemic, with 45% indicating an improvement and 35% a significant improvement. However, according to respondents, knowledge of the functionality of ICT tools does not directly translate into improved online didactics. Challenges remain for the methods and techniques of online classes and ways of engaging students (Figure 6).

Discussion and conclusion

The pandemic has fundamentally shaken-up established teaching patterns in higher education. Previously, the teaching standard was on-site education with a unity of place and time of teachers and students in the traditional sense. Maintaining the continuity of the didactic process required a shift from classrooms to online environments, preserving the unity of place but with a virtual dimension. Such a rapid change has forced educators to quickly seek and test technologies and tools that best meet their needs for accessibility, ease, and efficiency of tools to support online teaching.

Teachers used ready-to-use platforms. Access to them was mostly provided by university authorities. Often, basic training was also granted by university authorities. Teaching online, however, was not unproblematic, which primarily related to the lack of adequate motivation and involvement of students. The next step for online teaching during the pandemic period was to seek ways to motivate and engage students. While it is a fact that activation tools are often part of the platforms that teachers at this stage were already using, there was also a noticeable desire to explore new tools, which are available from various sources, and test their functionality and attractiveness for students.

The results of the factor analysis indicate a common cause behind the variability in difficulties in online teaching, both in the spring-summer semester of 2020 and the spring semester of 2021. While the past difficulties in 2020 are definitely correlated with the ones in 2021, the strength varies among countries. This leads to the conclusion that to battle these difficulties, one should look for holistic solutions, not just ones focusing on individual subcategories of difficulties. On the other hand, the differences between countries indicate where to look for good practices and how to adapt them appropriately.

However, these conclusions are based on an analysis of the results of a study conducted in six European countries, that is, Poland, Finland, Romania, Slovenia, Croatia, and Italy. With the increasing mobility of both academics and students in mind, it is worth continuing the study by expanding it to other countries.

The advantages of the described tools appear to be significant for both sides of the didactic process, that is, teachers and students. They have led to increased use of ICT tools in education, including in the post-pandemic period, which promotes the activation and motivation of students. However, there is a risk of abandoning the use of these tools in on-site education. It is, therefore, worth continuing further research into the possibilities of using ICT tools in

any form of education, considering the benefits of the developed ways of their application.

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The InCompEdu project tackles the common challenges in the sudden switch to online teaching at the HEI in the EU, due to COVID-19, by identifying and sharing the good practices, knowledge, and experience gained at the partner universities and beyond. The challenges include both mastering new digital skills and the methodologies of creating and conducting online courses. The project consortium involves six academic partners from six different countries: Croatia, Finland, Italy, Poland, Romania, and Slovenia. It is led by the University of Gdansk, Poland.

References

1. Al-ruz, J.A. & Khasawneh, S. (2011) Jordanian preservice teachers' and technology integration: A human resource development approach. *Educational Technology & Society* 14(4), pp. 77–87.
2. Alshaboul, Y., Hamaidi, D., Arouri, Y. & Alshaboul, A. (2021) COVID-19 enforced shift to distance education: Readiness and challenges. *Journal of Education and E-Learning Research* 8(3), pp. 349–359.
3. Armstrong-Mensah, E., Ramsey-White, K., Yankey, B. & Self-Brown, S. (2020) COVID-19 and distance learning: Effects on Georgia State University School of Public Health Students. *Front Public Health* 8, 576227.
4. Chaberek, M. (2020) *Logistics order in management* (in Polish). Gdańsk: Gdańsk University Press.
5. Costello, A. & Osborne, J (2005) Best practices in exploratory factor analysis: four recommendations for getting the most from your analysis. *Practical Assessment, Research, and Evaluation* 10(7), doi: 10.7275/jyj1-4868.
6. Dębicka, O., Reszka, L., Borodo, A., Galik, A., Markiewicz, M. & Reszka, M. (2022) *Technical Platform Booklet. Revision of available IT solutions for online education*. [Online]. InCompEdu IO2 deliverable 1. Available from: https://incompedu.ug.edu.pl/deliverables/ [Accessed: January 28, 2023].
7. Filho, W.L., Wall, T., Rayman-Bacchus, L., Mifsud, M., Pritchard, D.J., Orlovic Lovren, V., Farinha, C., Petrovic, D.S. & Balogun, A.L. (2021) Impacts of COVID-19 and social isolation on academic staff and students at universities: a cross-sectional study. *BMC Public Health* 21(1), 1213.
8. Hebert, E., Wood, R., Jeon, K. & Reena, I. (2022) Faculty making the emergency online transition during the COVID-19 pandemic: Effects of prior online teaching experience and strategies used to learn to teach online (Special Edition 2022). *Higher Learning Research Communications* 12, doi:10.18870/hlrc.v12i0.1322.
9. Hodges, C.B., Moore, S., Lockee, B.B., Trust, T. & Bond, A.M. (2020) *The Difference Between Emergency Remote Teaching and Online Learning*. [Online]. Available from: https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-and-online-learning [Accessed: January 28, 2023].
10. Li, Y., Wen, X., Li, L., Zhou, Y.-E., Huang, L., Ling, B., Liao, X. & Tang, Q. (2021) Exploration of online education mode for postgraduate education under the background of COVID-19. *Advances in Applied Sociology* 11(5), pp. 223–230.
11. Lin, M.-C., Wang, P.-Y. & Lin, I.-C. (2012) Pedagogy technology: A two-dimensional model for teachers' ICT integration. *British Journal of Educational Technology* 43(1), pp. 97–108.
12. Naciri, A., Baba, A.M., Achbani, A. & Kharbach, A. (2020) Mobile learning in higher education: Unavoidable alternative during COVID-19. *Aquademia* 4(1), ep20016, doi: 10.29333/aquademia/8227.
13. Naim, M., Lalwani, C., Fortuin, L., Schmidt, T., Taylor, J. & Aronsson, H. (2000) A model for logistics systems engineering management education in Europe. *European Journal of Engineering Education* 25, 1, pp. 65–82.
14. Pöntynen, R., Nyroos, S., Dadić, L., Orazi, A., Gustavino, B., Dębicka, O., Borodo, A., Galik, A., Paştiu, C., Maican, S., Muntean, A., Bužan, E. & Iacolina, L. (2022) *Report on identified challenges and problems that occurred during the transition to online teaching mode in the COVID-19 pandemic period*. [Online]. InCompEdu IO1 deliverable 1. Available from: https://incompedu.ug.edu.pl/deliverables/ [Accessed: January 28, 2023].
15. Reszka, L. (2021) Decision making process in the management of logistics support system. In: C. Mańkowski, L. Reszka (eds): *Modelowanie procesów i systemów logistycznych, part. XXII.* Gdańsk: Gdańsk University Press.
16. Szołtysek, J. & Twaróg, S. (2013) The concept of social logistics in logistics paradigm (in Polish). In: *Studia Ekonomiczne/Uniwersytet Ekonomiczny w Katowicach* 175*, Demograficzne uwarunkowania logistyki społecznej*, pp. 13–31.
17. Tezci, E. (2011a) Factors that influence preservice teachers' ICT usage in education. *European Journal of Teacher Education* 34(4), pp. 483–499.
18. Tezci, E. (2011b) Turkish primary school teachers' perceptions of school culture regarding ICT integration. *Educational Technology Research and Development* 59, pp. 429–443.
19. Tomczyk, Ł. & Walker, C. (2021) The emergency (crisis) e-learning as a challenge for teachers in Poland. *Education and Information Technologies* 26(6), pp. 6847–6877.
20. Zhou, X. & Milecka-Forres, M. (2021) Two groups separated by a shared goal: how academic managers and lecturers have embraced the introduction of digital technologies in UK Higher Education. *Research in Learning Technology* 29, doi: 10.25304/rlt.v29.2446.

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