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APPLICATION OF E-LEARNING PLATFORMS BY HIGHER EDUCATION INSTITUTIONS DURING THE COVID-19 PANDEMIC: THE POLISH PERSPECTIVE

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Abstract: *Contemporaneity, in its complexity, brings progressive and degressive factors that shape the lives of organisations and individuals. Covid-19, as an unforeseen black swan event, was a massive challenge for universities in Poland and around the world. The education system has been transformed as digitisation of documentation and the use of online platforms during classes have become the only way to maintain the continuity of the education process. This article aims to evaluate the effectiveness of technology during the COVID-19 pandemic within the Polish context and to identify potential future opportunities for digital transformation in university teaching through the virtualisation of education. The hypothesis put forward in the paper is that the black swan of Covid-19 and the resulting technological boom have sparked the acceleration of change in higher education. The research data were obtained from secondary and primary sources, using qualitative and quantitative methodology. Using the Web of Science and Scopus databases, the desk research method was used. A diagnostic survey using the Computer-Assisted Web Interviewing (CAWI) technique was used to obtain the primary data. The research findings reveal opportunities for virtualising teaching processes in higher education through e-learning platforms beyond the pandemic.*

Keywords: *virtualisation, e-learning platforms, Covid-19 pandemic, digital university.*

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INTRODUCTION

The modern economics is based on the digital revolution and information management. Its special feature is the speed of information delivery. Numerous studies state that the Covid-19 pandemic has accelerated the processes of digitisation and informatisation in many sectors (Crawford, 2022; Chytilová et al., 2024). These studies reveal a globally accelerating pace of digital transformation across diverse sectors, including healthcare, education, social welfare, public administration, IT, manufacturing, trade, and services (Bilan et al., 2023; Maama, 2024; Schilirò, 2020). These profound changes are affecting both private and public sectors, and apply to small, medium and large organisations (Agostino, 2021). Thus, it is worth looking at the general transformation processes occurring in organisations and management in general, and then try to isolate the specific changes occurring in higher education (Sułkowski, 2020).

The COVID-19 pandemic has dramatically altered both organisational behaviour and consumer attitudes (Alhaimer, 2022). The pandemic has accelerated the shift from traditional, face-to-face organisational interactions to remote and hybrid models, fundamentally altering organisational behaviour, culture, and identity (Spicer, 2020; Mishchuk et al., 2023).

Covid-19 is a catalyst for many changes in higher education. Its primary impact is the accelerated digital transformation of universities, resulting in the emergence of a new digital university model as academic activities shifted to the virtual realm (Hemaswetha, 2022; Davidovitch & Eckhaus, 2022). The university's mission can be accomplished through online communication, although this is not free of certain limitations related to the effectiveness of education. There has been an organisational, technological, social and cultural change that allows the university to educate, conduct research and collaborate with the non-academic environment online. Didactics has undergone a strategic shift characterised by a dramatic increase in the prominence of e-learning and the virtualisation of education. The transition to online education presents significant challenges for both administrators and educators. Synchronous systems such as Teams, Zoom, Meet or advanced specialized LMS platforms are being used, providing opportunities for synchronous and asynchronous e-learning and better control over the verification of learning outcomes and the quality of online learning. The field of learning is experiencing the growth of international and national collaborative networks, resulting in high-impact publications and implementations. Professionalising university management involves training and developing specialised managerial roles, such as financial management (chancellors), academic administration, and knowledge management (Camacho-Javier, 2022). The digitisation and virtualisation of universities is taking advantage of increasingly complex systems that communicate, process, collect and analyse data and manage all aspects of university operations.

The Theoretical Background of Education Virtualisation

The education sector has undergone a profound metamorphosis into remote learning (Arokiasamy, 2017; Kang, 2021; Staniec et al., 2023). Covid-19 has resulted in a forced transition of universities to remote learning on a global scale (Kulikowski et al., 2022). To date, e-learning has primarily been integrated into higher education as a blended learning approach, supplementing traditional face-to-face instruction delivered by academics. Most

universities around the world have the necessary programmes for this, although they are marginal to traditional forms of learning. A smaller number of universities before the pandemic based their offerings primarily on e-learning. Examples include: Open U, Embry-Riddle Aeronautical University-Worldwide, Temple University, University of Oklahoma, Arizona State University, Western Kentucky University (top 5 online bachelor's programs). In the best developed higher education systems, there is a growing trend toward VLE (Virtual Learning Environment), which, combined with Managed Information Systems (MIS), form a control system for the e-learning environment (Managed Learning Environment). LMSs, in turn, allow not only synchronous and asynchronous e-learning, but also the management of quality and the online learning process (Olubiyi, 2024; Sułkowski, 2021).

Another effect of the changes is that the higher education sector is facing financial challenges in many countries. According to a survey of students in the U.S., a significant percentage expect a significant reduction in tuition fees if education is delivered online, which could have significant implications for university budgets (Burki, 2020). Deteriorating financial conditions in higher education could result in university closures and a surge in mergers and acquisitions (Rakshit, 2020).

The literature points to several ways of understanding digital transformation in universities (Benavides, 2020; Jackson & Konczos Szombathelyi, 2022). A review and systematization of definitions and change areas identifies key themes: change management, digital transformation, educational innovation, customer focus, and new business models (Matt, 2015).

Digital transformation is a process of change in a university and involves people, projects strategies, structures understood dynamically (Rodrigues, 2017). Digital transformation is a process that aims to change an organisation holistically through a combination of information, computing, communication and connectivity technologies (Vial, 2019). Digital transformation goes far beyond dematerialisation of processes to include innovative use of new technologies to promote new services, redefine business models and interact with users (Faria, 2020). Digital transformation is the process of creating and implementing innovations that change the market and organisations, leading to new solutions (Hinings, 2018). Digital transformation of the higher education system should focus on a broader range of challenges and must include modernisation of ITC architecture management, which could significantly contribute to innovation in education (Kaminskyi, 2018). On the other hand, higher education should also be the place where new skills are taught, those which will prepare people for digital transformation (Jurczuk, Florea, 2022). One can observe a rapid increase in research on Digital Transformation in higher education in recent years. There is a growing interest in the implementation of ITC solutions in university operations, which are moving towards a digital University (Bond, 2018). A key aspect of university digital transformation involves leveraging modern IT solutions to modernise the educational system, which includes integrating digital technologies into teaching, learning, and administrative processes (Potjanajaruwit, 2023). Among the frequently explored topics are: the didactics of e-learning, the use of information and communication solutions in education, the analysis of digital interaction and communication in the learning process (Androutsos, 2019).

Summarising the various interpretations of digital transformation in higher education reveals several common themes in the literature. First, digital transformation is treated as a breakthrough process, leading to profound changes in many aspects of university operations.

The multidimensionality of the changes brought about by digital transformation includes aspects of: organisation and management, pedagogy, infrastructure, academic culture and technology. Digital transformation is fostering innovation in university operations, including organisational structure, management practices, communication channels, teaching methodologies, research approaches, and implementation. Organisational structures within universities that are often radically reconfigured under the impact of digital transformation also include strategy and management: knowledge, human capital, marketing, finance, processes and projects (Mohamed Hashim, 2022). Digital transformation research in higher education is characterised by an inductive and analytical approach (Bygstad, 2022).

Covid as a catalyst for e-learning in higher education - SARS Cov-2 as a destructor and inducer

The Covid-19 pandemic has been repeatedly described in the literature as an unforeseen event, i.e. a "black swan" of socio-economic life (Glette-Iversen, Aven, 2021; Ahmadab Ali, Kutan, Gupta, 2021; Yarovaya, Matkovskyyb, Jalan, 2022). Changes have occurred primarily in healthcare, but also in business. The pandemic impacted the continuity of global supply chains, industries where direct contact with the customer is crucial, and of course in education. The pandemic posed significant challenges to the education of children and youth, placing immense strain on teachers in terms of pedagogy, organization, and instruction. Many people were unprepared for the demands of online teaching and learning. More than three years of experience have shown that, despite concerted efforts, the shift to remote learning has resulted in educational gaps, especially in the youngest children who rely on school not only for academic growth but also for essential social development and learning interpersonal skills.

However, from the point of view of higher education, the experiences of the pandemic are diverse. It can be stated from the conducted participant observations, as well as from the extensive literature on the subject, that higher education responded to challenges in a very diverse way - from a complete lockdown and conducting classes only with the use of remote learning methods and techniques, through the organisation of various hybrid classes (lectures delivered online, exercises and practical classes conducted in person with an academic teacher; part of the group participated in lectures in person, while those under quarantine could participate in classes remotely at the same time), to use e-learning tools to support the traditional teaching process.

From the point of view of the higher education didactic process, an equally important issue was an opportunity to indicate to future potential employees (participants of the labour market) that the skills of independent and remote work, as well as digital competences may become a priority for employers (Núñez-Canala et al., 2022; Zhaoa et al., 2021; Cahena, Mendes Borini, 2020).

It can therefore be concluded that the Covid-19 pandemic has caused bilateral transformations in the world of higher education. On the one hand, the pandemic has wreaked havoc on integration. Societal development and interpersonal relationships have suffered significant and alarming setbacks due to the pandemic. It will certainly be difficult to rebuild them, especially with a noticeable high level of lack of trust in interpersonal, business and institutional relations. On the other hand, the pandemic has shown that there are many

opportunities that have not been used at all or only to a limited extent. E-learning is one of such opportunities, which has been widely used as a tool supporting traditional didactic processes for a long time. Most often, this solution is called *blended learning* (Thorne 2003; Garrison, Vaughan 2008; Hew, Cheung 2014; Bonk, Graham 2006). During the pandemic, this educational model was often referred to as hybrid learning. This, of course, is an incentive to continue such a model of learning, especially in the context of business transformations. In the case of fields of study that most often educate for the needs of broadly understood business, i.e. management, economics, finance, logistics, it is important to respond to the demand by suitably organising work. Consequently, modern universities must prioritise cultivating students' independence, critical thinking, and technological proficiency to prepare them for the future.

The destructive nature of the Covid-19 pandemic also highlighted the problems of academic teachers, especially in the context of their digital skills, which significantly limited the options for using remote learning (Basilotta-Gómez-Pablos et al., 2022; Morze, Buinytska 2019; Sanchez-Cruzado et al., 2021; Pesha, Kamarova, 2020).

The utilitarian nature of science also manifests itself in the possibility of combining studies with gaining professional experience. Unfortunately, student digital competencies proved to be a significant challenge, primarily due to insufficient proficiency in using educational platforms and advanced IT tools (Arokiasamy, 2017; Kostikova et al., 2020). Surprisingly, while initially presenting challenges, the shift to online learning has also unveiled opportunities to develop essential future-oriented skills and competencies for the professional career.

The black swan COVID-19 pandemic developed into an unforeseen crisis, which triggered widespread disruptions, halted supply chains, caused raw material shortages, and the closure of transportation, tourism, and hospitality businesses due to prolonged restrictions and lockdowns are still being felt. However, on the other hand, Covid-19 may be an impulse for positive change in management and teaching processes, contributing to the creation of new standards of education quality, especially for the needs of the labour market. Remote work is rapidly becoming a legal norm in many countries, yet it presents significant organisational challenges for employers as they adapt to employee preferences (Bamieh, Ziegler 2022; Tyutyuryukov, Guseva 2021; Popovici, Popovici 2020; Geldart 2022; Rudnicka et al., 2020). Remote work introduces new challenges for organisational management, including recruitment and work conditions. A crucial aspect is effectively integrating innovative technological solutions into the educational process such as utilising educational platforms to enable and support remote learning.

Development of Learning Management Systems (LMS)

Learning Management Systems (LMS) are online platforms designed to facilitate and manage the online educational process. These systems are gaining popularity due to their ability to efficiently manage educational content, assessments, and communication between all participants in the learning process. LMS platforms are used in education (at various levels), in higher education and in enterprises as solutions supporting the process of self-improvement of employees. During the Covid-19 pandemic, LMS platforms played a special role by becoming a place of cooperation and implementation of educational processes.

The origins of LMS date back to the 1960s, when the first systems for managing research and publication results appeared at universities. The first LMS systems emerged in the 1970s, initially used in universities to provide students with convenient access to course materials and exam results. In the 1980s, these systems began to be used also in company training. With the development of technology and the Internet in the 1990s, LMS became more accessible and popular. During this period, platforms were developed that were more advanced and allowed the addition of multimedia educational content, as well as integration with other systems, such as content management systems and e-commerce platforms. With the development of e-learning (mainly academic), Learning Management Systems have become an integral part of the teaching and training process. The early 2000s witnessed a surge in LMS adoption, driven by the growing popularity of e-learning, increasing demand for online training, and the corporate training needs of businesses. This period also marked the emergence of fully responsive, mobile-friendly LMS platforms, enabling learners to access training on the go. These platforms empowered users to create courses and integrate them with social networks, fostering a more collaborative learning environment.

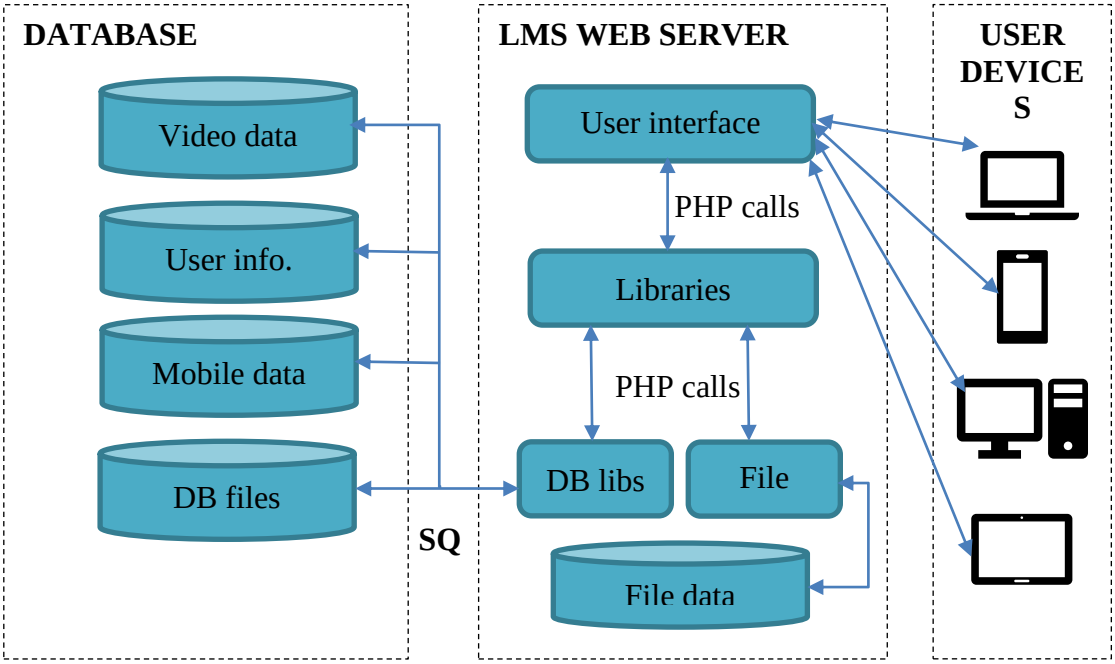

Figure 1. Typical learning management system structure

Currently, LMS continue to be developed and improved to meet the needs of participants of educational and academic courses as well as company training. Many LMS platforms offer a rich variety of learning tools such as quizzes, tests, videos, podcasts, interactive presentations, and more. In addition, Learning Management Systems offer more advanced data analysis functions that allow a user to monitor the progress of participants, track results and create reports.

There are several leading providers of LMS solutions on the market. Among them, the most popular are Moodle, Blackboard, Canvas, D2L and SAP Litmos. Each of these systems has its own unique features, offers different licensing models and pricing policies, and has its own advantages and disadvantages. Moodle is a free and open-source learning management system, which occupies a prominent position in the LMS landscape. Moodle is distinguished by its high flexibility and the ability to adapt to the individual needs of the organisation. It is open-source software, which means that it can be freely modified and adapted, which, combined with low costs of use, makes Moodle the most frequently used Learning Management System in the online education space.

METHODOLOGY

Primary explanatory research, focusing on a single topic, complementing secondary exploratory research, was conducted in Poland in May, October and November, 2022. This research aimed to assess the current state of digital platform integration in communication and education within higher education, as well as the level of acceptance for these innovations. The research focused on the experiences of higher education participants regarding the usefulness of selected digital platforms in communication and educational processes. The researchers wanted to find out how the respondents used selected digital platforms in communication and educational processes and how they assessed their functionality. The research is descriptive and explanatory. Descriptive analysis focused on characterising respondents' educational activities and the functionality of used digital platforms, assessing their communication and educational efficacy. Explanatory analysis aimed to verify hypotheses about the long-term viability of digital platforms in higher education. This involves identifying, determining, and evaluating the causal relationship between the application of digital platforms in education and their potential to enhance digital skills and competencies among higher education participants.

The diagnostic survey method was used for the study. Indirect research using the “user-centric” Internet was limited to the use of the CAWI (Computer Assisted Web Interview) online survey method. A questionnaire consisting of 26 closed questions, including 9 based on ordinal assessment scales, placed in a Google spreadsheet form was used as the visual measurement tool.

Due to the scope of the measurement, the study carried out can be defined as fragmentary and deterministic with characteristics representative for the surveyed population. The empirical material was obtained from primary sources, i.e. people with the status of a student (having a student record number) and participating in classes at universities operating in Poland. Not all students studying in Poland in the academic year 2021/2022 were surveyed, only a selected sample. The selection of units for the sample was carried out in two stages.

In the first stage of the study, out of 426 universities operating in Poland in 2021/2022 (according to POLON - System of Information on Science and Higher Education in Poland) constituting the statistical population of universities operating in Poland, $n_1=23$ statistical units were indicated in which the research should be conducted. The determination of the number was carried out based on the formula for the minimum number (1), with an indication of the components of the fraction 0.9 for universities that in the academic year preceding the

study, i.e. 2020/2021, used digital platforms in the education process and 0.1 for universities that did not use such solutions, 10% random error and a confidence level of 0.90.

$$n_{min}=NP(\alpha 2 \cdot f(1-f))/NP \cdot e2+\alpha 2 \cdot f(1-f)$$

where:
nmin – is the minimum sample size
NP – the size of the study population
α – confidence level for the results
f – fraction size
e – assumed maximum error

The operational method of stratified selection with proportional allocation with systematic sampling, taking into account the following criteria: public university (0.4) / non-public university (0.6) according to the number of universities operating in Poland in 2021, 23 universities were selected in which the study should be conducted - including 9 public and 14 private. The sample of universities was collected using the method of systematic selection with proportional allocation.

Then, in the second stage, the number of statistical individual units that were subject to the study was specified in the selected statistical collective units. Using the method of selecting typical units from the population of individual units at each of the indicated universities, those students who had the status of a student and used digital platforms during their studies in the academic year preceding the study, i.e. in 2021/2022, were indicated as study units. Again, using the formula for the minimum sample size, the minimum sample size of statistical units was obtained, this time for viable units - students at the level of $n_2 = 369$ units. The components used were the fraction of 0.6 for students who represented public universities and 0.4 for the others, with a random error of 5% and a confidence level of 0.95.

$$Z = n_2/n_1$$
$$Z = 369/23$$
$$Z = 16{,}043 \approx 17 \text{ viable units (students)}$$

Finally, it was assumed that at each of the 23 selected universities, at least 17 students would be asked to participate in the study (adjusted Z indicator expressing the ratio of the minimum number of students to the minimum number of university samples). Finally, after converting the total units, the minimum sample size was calculated at 391 individual units that should be tested. It was assumed that if a greater number of responses were obtained, it would work in favour of the study.

The study was conducted by sending invitation emails to participate to 23 universities. In this email there was a request to forward information about the study to the minimum number of students who agreed to participate in an anonymous study - that is, at one university it was 17 people. The email included a link that redirected to the research website.

Finally, consent was obtained from 528 students who filled out questionnaires from 23 selected universities as respondents. The collected material was archived in an Excel spreadsheet. Then, the raw data was encoded in the Statistical Package for Social Sciences (SPSS) software. The prepared material prepared was verified and validated. In the first stage, an analysis of the structure of the distribution of the values of the features characterising the study sample, i.e. the students participating in the study, was presented. A

comparative analysis of the collected material's sample characteristics in relation to the study population was conducted using a non-parametric chi-square test (χ^2) of correspondence.

$$\chi^2 = \sum_{i=1}^{r} \frac{(n_i - np_i)^2}{np_i}$$

where:
p_i — is the probability that the feature X will take a value belonging to the class interval
np_i — is the number of units that should be in the i-th interval, assuming that the feature has a distribution consistent with the hypothesis.

Statistics, on the other hand, have a distribution χ^2 α o k = (r - 1), where:
k — is the number of degrees of freedom
r — is the number of class intervals
χ^2 is the empirical value of the statistic obtained from the study.
The form of the critical set: P ($\chi^2 < \chi^2\alpha$) = α where $\chi^2\alpha$ is the critical value from the tables of distributions χ^2 for k = r - 1 degree of freedom and p = α.

Therefore, at the beginning, the null hypothesis (H_0) was adopted about the consistency of the distributions of selected variables (gender, level of education, mode of education) from the sample with the distributions characterising the general population of people studying in Poland, respectively, and the alternative hypothesis (H_1) about the existence of a mismatch.

Thus, in the surveyed sample of 528 respondents, women (55.4% of the respondents) dominated over men (44.6% of the respondents). The majority of respondents (61.4% of respondents) compared to men (38.6% of respondents). Most of the participants were aged 19-24 (47.3% of the respondents). More than half of the respondents (75.8% of the respondents) study at first-cycle and uniform master's studies, and more than half (62.5% of the respondents) are full-time students.

The analysis results indicate that the null hypothesis (H_0) was rejected. Therefore, the hypothesis H_1 about the compatibility of distributions is true, i.e. the sample of students from the selected universities coincides with the general population of all students in Poland studying in the academic year 2021/2022 in terms of the share of students by university status, gender, level and mode of education (Table 1). Regarding representativeness, a systematic random sampling method with proportional allocation was used in the first stage of the study, however, the second stage employed non-random selection of typical units. Consequently, due to the non-random selection of the n_2 student sample in the second stage, fully assessing the sample's representativeness in statistical terms is challenging. Nevertheless, the authors drew inferences based on the sample size.

Table 1. Sample representativeness - Statistical concordance test χ^2.

Item			Value χ^2	Value χ^2_α	Test realisation
	Number n_2	Number N_2	Real	Theoretical	$\chi^2<\chi^2_\alpha$
university status					
Public	346	813 564	0,792	6,635	concordance
Private	182	394 464			
Gender					
Female	324	708 788	1,576	6,635	concordance
Male	204	499 240			
Level of studies					

Ist-cycle and uniform master studies	400	939 173	1,204	6,635	concordance
II-nd cycle – master studies	128	268 855			
Mode of studies					
Full-time	330	774 423			
Part-time	198	433 605	0,592	6,635	concordance

[a] α – confidence level

Then, an analysis of the distributions for selected empirical variables from the main questions was carried out, and based on the measures of distribution location, such as the weighted mean ($\bar{\chi}_\omega$) and the mode (D_o) the platforms were compared according to the respondents' indications. In the case of determining the average values, the formula for the weighted average $\bar{\chi}_\omega$ was used, indicating the size of the weights in such a way that the elements of greater importance had a greater impact on the indicated average value in the form:

$$\bar{\chi}_\omega = \frac{\chi_1\omega_1+\chi_2\omega_2+\ldots+\chi_n\omega_n}{\varpi_1+\varpi_2+\ldots+\varpi_n}$$

where:
ω_i – was the weight value

In the next step, where it was possible and logically meaningful and statistically significant, the hypotheses about the existence of a relationship between the variables from the main questions and the questions of the metric were verified. Each time, an independence (contingency) table was constructed allowing to order two features simultaneously. The table consisted of r rows and s columns, with each row (column) corresponding to variants of the X (Y) feature. The contingency table consists of the nij numbers of those sample elements that have the i-th variant of the feature X (i=1,2, …., r) and the j-th variant of the feature Y (j=1,2, …, s). Then, in the second stage of the analysis, based on the contingency table, the null hypothesis (H_0) of the existence of stochastic independence of random variables X and Y and the alternative hypothesis (H_1) were verified.

The basis for the verification of the H_0 hypothesis of stochastic independence of variables was the value of the χ^2 independence test:

$$\chi^2 = \sum_i^r \sum_j^s \frac{\left(n_{ij}-\tilde{n}_{ij}\right)^2}{\tilde{n}_{ij}} : \chi^2_{(r-1)\cdot(s-1)}$$

where:
n_{ij} – empirical conditional numbers resulting from the contingency table,
$\tilde{n}_{ij}$ – theoretical conditional counts that would appear in the array if the features were independent.

Due to the fact that the rejection area H_0 is always right-sided, its size depends on the adopted α significance level. It is bigger, if α is bigger. It is generally assumed that α <= 0,05. Critical values of the distribution χ^2 o (r-1)*(s-1) levels of freedom. If only $\chi^2_{emp} > \chi^2_\alpha$ then H_0 is rejected in favour of the hypothesis H_1, which means that the pair of features are interdependent. In addition, the analysis of the obtained values when verifying the hypotheses was strengthened by the reference to Cramer's V coefficient

$$v = \sqrt{\frac{\chi^2}{n \cdot \min(r-1, k-1)}}$$

where:
V – Cramer coefficient between two variables,
χ^2 is the empirical value of the statistic obtained from the study for the pair of variables
n – number of observations
r – number of levels of one variable
k – the number of levels of the second variable
$\min(r-1, k-1)$ – the smaller of the two (r-1) or (k-1)

Using the above methodology, the process of testing the statistical significance of the relationship between the selected variables was carried out technically using the SPSS software. Each time, the verification of statistical significance for the indicated variables consisted in checking whether for the statistical value χ^2 of a given pair of analysed variables, the value of the parameter of asymptotic significance is lower than 0.05. If so, the observed relationship between the variables could be considered statistically significant, and the results and conclusions drawn on the basis of the analysis of data obtained from the sample were considered representative and could be used to form conclusions about the entire population.

The collected and analysed research material formed the basis for a comprehensive presentation in the subsequent part of the article, which led to conclusions and recommendations about the potential for virtualising teaching processes using e-learning platforms in higher education post-pandemic.

DISCUSSION

The research enabled an analysis of platform availability, the factors influencing platform selection, platform usage frequency, the frequency of using educational activities on these platforms, the effectiveness of platform features, overall platform functionality, and the technical capabilities of the platforms.

Respondents admit that when connecting to the Internet, they most often use a laptop and a smartphone (73.5%) or a desktop computer and a smartphone (18.6%). Definitely most often, that is, several times a day, the respondents connect on the Internet for private matters (92.8%). Similarly, the majority of respondents (70.1%) use the Internet several times a day for business matters. Respondents primarily use public messaging applications (96.2%), followed by social media platforms (80.7%) and SMS/MMS (75.8%) for private matters. At work, the respondents admit that they most often use email (78.8%), sms and mms (55.3%) and public messaging applications (49.7%).

In order to learn, the respondents use the Internet much less frequently. Most often they connect to the network several times a week (43.2%) or several times a day (30.7%). Respondents use various options, most often they use public messaging applications (93.2%), group messaging applications (89.8%) and email (76.5%). In the learning process, text messages are more often used by undergraduate students (19.3%). Similarly, email is more often used by first-cycle students (55.3%) and full-time students (46.4%). Public messaging applications (e.g. Messenger) are more often used by full-time students (48.7%). Similarly, these students more often use institutional messaging applications (e.g. company chats,

university chats) (24.5%). In turn, group messaging applications (e.g. Teams, Zoom, Google Meet) are more often used by students of public universities (58.8%), first-cycle studies (68.5%) and stationary students (56.2%). On the other hand, dedicated webinar platforms (e.g. ClickMeeting) are more often used by undergraduate students (13.6%) and part-time students (11.7%) in the learning process. Social platforms (e.g. Facebook) are more often used by students of public universities (27.7%) and full-time students (27.3%). E-learning platforms (Moodle, Blackboard Ultra Learn) dedicated to remote learning are most often used by students of private universities (19.1%), undergraduate students (20.8%) and part-time students (17.1%). The existence of the indicated relationships is confirmed by the χ^2 test of independence with the strength of the relationship determined by V-Cramer (Table 2.)

Table 2. Frequency of using digital forms of collective communication in education in relation to the status of the university, the level of education and the mode of education - test of independence χ^2 with the strength of the relationship determined by V-Cramer.

Item	University status			Level of education			Mode of education		
	χ^{2a}	p[b]	V[c]	χ^{2a}	p[b]	V[c]	χ^{2a}	p[b]	V[c]
1. Sms	1,531	0,675	0,054	16,295	0,001	0,176	5,258	0,154	0,100
2. Email	7,284	0,063	0,117	19,206	0,001	0,191	16,800	0,001	0,178
3. Group messaging applications	12,161	0,007	0,152	9,460	0,024	0,134	9,364	0,025	0,133
4. Public messaging applications	3,470	0,325	0,081	3,298	0,348	0,079	12,529	0,006	0,154
5. Institutional messaging applications	2,377	0,498	0,067	1,920	0,589	0,060	10,090	0,018	0,138
6. Dedicated webinar platforms	3,255	0,354	0,079	20,122	0,001	0,195	16,916	0,001	0,179
7. Social platforms	9,777	0,021	0,136	1,379	0,711	0,051	19,945	0,001	0,194
8. E-elearning platforms	18,294	0,001	0,186	30,762	0,001	0,241	23,094	0,001	0,209

[a] χ^2 – test value [b] p – asymptotic significance [c] The strength of the relationship calculated with the use of V-Cramera

Among the messaging applications that the respondents are familiar with and use most often, the following were indicated: Messenger (96.2%), Microsoft Teams (92.4%), WhatsApp (59.8%), SnapChat (34.5%), Discord (32.6%), iMessage (25.0%) and Zoom (20.8%). Other messaging applications operating on the market are used less frequently. These include Skype (20.1%), Google Meet (17.0%), Telegram (14.8%), Click Meeting (6.4%), Viber (6.4%), Slack (3.8%) %), Cisco Webex (3.4%) and WeChat (1.5%).

In turn, the e-learning platforms that are generally known to the respondents and which they have ever used include Microsoft Teams (72.3%), Zoom (36.0%), Moodle (17.0%), Blackboard UltraLearn (15.9%)) and Google Classroom (14.)%. Other Platforms operating on the market or known to a small number of respondents, including Adobe Captivate Prime (4.9%), Navigator (4.5%), Cloud Academy (2.7%), Asseco (1.9%), Edmodo (1.9%), Cloudlabs (0.8%), Business Simulation (0.4%), Cyberskiller (0.4%), Edu Web360 (0.4%), Inspera (0.4%) and Navoica (0.4%). The others are completely unrecognized (Docebo, Litmos, Parlo, Revas and Universality).

Taking into account the most frequently used dedicated learning tools, i.e. e-learning platforms, an analysis of their use and assessment of their functionality and usefulness from the point of view of users will be presented below.

In the era of Covid-19, respondents could use more than one e-learning platform. When asked which e-learning platforms the respondents used in the years 2020-2022, the respondents most often indicated Microsoft Teams (88.3%), Zoom (42.0%), and Blackboard UltraLearn (16.3%). Only a small percentage of respondents indicated the Moodle platform (10.2%) and Google Classroom (8.0%). Respondents admit that the Microsoft Teams (93.5%), Blackboard UltraLearn (93.0%), Moodle (81.5%) and Google Classroom (42.9%) platforms were chosen by the universities where they studied or organisers of events in which the respondents participated. Only the Zoom platform was indicated by the respondents as the one used by the respondents and which they chose themselves (11.7%) or the institutions where the respondents worked (28.8%).

Table 3. Frequency of using educational activities available on selected platforms by respondents (D_o value).

	Google Classroom [a]	Blackboard UltraLearn [a]	Teams [a]	Moodle [a]	Zoom [a]
Item					
1. Lecture	3	4	4	2	2
2. Videoconference	2	3	3	1	2
3. Practical classes	2	4	4	3	2
4. Conversations	2	4	3	2	2
5. Decision games	1	2	1	1	1
6. User manual	1	2	1	1	1
7. IT labs	1	1	2	1	1
8. Project method	1	1	2	1	1
9. Simulations	1	1	1	1	1
10. Seminar/ webinar	2	2	2	1	1
11. Case studies	1	1	1	1	1
12.Workshops	2	2	2	2	1
13. Consultations with lecturers	2	3	3	1	2

[a] for the frequency scale from 1 to 4, where 1 means never, 2 rarely, 3 sometimes and 4 often

Analysis of the measure of diversification of the most frequently occurring feature marked with the dominant (D_o) for the use of platforms (with frequency markings from 1 to 4, where 1 meant never, 2 rarely, 3 sometimes and 4 often) in individual forms of educational activities (Table3.) Respondents' choices show that the Blackboard UltraLearn platform was most often used, apart from lectures, in conducting practical classes or conversations. Sometimes this platform was used in the implementation of video conferences and consultations with the hosts. This platform was rarely or never used for other activities. Similarly, Microsoft Teams was most often used, apart from lectures, for practical classes. It was sometimes used for video conferences, conversations and consultations with lecturers. Other activities were rarely or never supported by this platform. The Moodle platform was sometimes used to conduct practical classes. On the other hand, the Google Classroom platform was sometimes used to conduct lectures and it was generally rarely used for other

activities. The last of the educational platforms, Zoom, was used by far the least and, if at all, for lectures, video conferences, practical classes and conversations. To sum up, the above results show that activities carried out on educational platforms are derivative of those activities that most often occur at universities.

Table 4. Evaluation by the respondents of the features available on selected platforms ($\bar{\chi}_\omega$ value).

	Google Classroom [b]	Blackboard UltraLearn [b]	Teams [b]	Moodle [b]	Zoom [b]
Item					
1. Ability of instructors to enter information	3,26	3,69	3,93	3,38	3,52
2. Placement of teaching materials	3,16	3,76	4,09	3,35	3,53
3. Availability of virtual libraries	3,15	3,18	3,47	3,11	3,51
4. Availability of video materials	3,26	3,63	3,75	3,25	3,50
5. Discussion forums	3,00	4,00	3,42	3,44	3,53
6. Games	2,82	3,22	3,34	3,25	3,56
7. Chats	3,55	3,74	3,99	3,36	3,49
8. Ability to build dictionaries of terms	2,92	3,31	3,41	3,43	3,56
9. Document sharing	3,56	3,54	3,90	2,80	3,43
10. Tests (Quizzes)	3,44	3,92	3,80	3,32	3,48
11. Oral e-passes	3,29	3,84	3,82	3,50	3,52
12. Virtual gradebook	3,31	3,79	3,66	3,55	3,52
13. Helpdesk – platform help instructions	3,15	3,40	3,33	2,83	3,46

[b] on a scale of 2 to 5, where 2 was the lowest rating and 5 was the highest

Respondents were asked to rate the features available on the platforms (on a scale of 2 to 5, where 2 was the lowest rating and 5 the highest). Respondents using the Blackboard UltraLearn platform rated the highest the ability to discuss on forums (4.00), Quizzes (3.92) and the ability to complete oral tests using the video interface (3.84), virtual gradebook of learning progress (3.79), posting teaching materials (scripts, presentations) (3.76) and chats (3.74). In the case of the Microsoft Teams platform, the respondents appreciated the option to post teaching materials (scripts, presentations) (4.09), chats (3.99), the option for lecturers to enter information (3.93) and share documents (3.90), the option to conduct oral tests using the video interface (3.82) and quizzes (3.80). Another Moodle platform was appreciated by the respondents for a virtual gradebook of learning progress (3.55), the ability to build dictionaries of terms (3.43) and discussion forums (3.44). On the other hand, the Google Classroom platform was appreciated by the respondents for the option to share documents (3.56), chats (3.55) and Quizzes (3.44). Using the Zoom platform, they appreciated it for chats (3.46), Quizzes (3.30) and the feature allowing to upload teaching materials (scripts, presentations) (3.24).

The results suggest that users favour platforms providing integrated remote work environments (such as Blackboard UltraLearn) over those solely offering synchronous tools (like Zoom).

Table 5. Evaluation by the respondents of the functionality of selected platforms ($\bar{\chi}_\omega$ value).

	Google Classroom [b]	Blackboard UltraLearn [b]	Teams [b]	Moodle [b]	Zoom [b]
Items					
1. Chat	3,37	3,74	4,02	3,33	3,47
2. Uploading documents	3,61	3,76	4,00	3,59	3,43
3. Discussion	3,28	3,78	3,89	3,60	3,41
4. Recording	3,27	3,43	3,86	3,33	3,43
5. Background effect settings	2,91	3,09	3,79	2,00	3,40
6. Screen sharing	3,07	3,50	3,80	2,00	3,55
7. Participant reactions	3,47	3,87	3,94	3,00	3,44
8. Meetings scheduling	3,43	3,42	3,80	2,00	3,45
9. Dividing meetings into rooms	3,50	3,36	3,73	3,00	3,40
10. Adding members to the meeting	3,33	3,65	3,77	4,00	3,71
11. Giving control during a meeting	2,92	3,38	3,78	3,00	3,35

[b] on a scale of 2 to 5, where 2 was the lowest rating and 5 was the highest

In the next stage of the study, respondents were asked to assess the functionality of the platforms (on a scale of 2 to 5, where 2 meant the lowest rating and 5 the highest). Users of the Blackboard UltraLearn platform rated the highest the discussion (3.78), sending documents (3.76) and chats (3.74). For Microsoft Teams, respondents appreciated chats (4.02), uploading documents (4.00), ability for participants to react (3.94), discussing (3.89), recording (3.86), screen sharing (3.80), scheduling meetings (3.80), setting background effects (3.79), giving control during a meeting (3.78), adding meeting members (3.77), and dividing into rooms (3.73). The Moodle platform was appreciated by the respondents for discussion (3.60) and sending documents (3.59). On the other hand, the Google Classroom platform was appreciated by the respondents for the ability to send documents (3.61), divide meetings into rooms (3.50) and the user reaction feature (3.47). Using the Zoom platform, they appreciated it for adding members to a meeting (3.71), screen sharing (3.55) and chats (3.47).

Respondents indicate a preference for platforms offering a wide range of capabilities that facilitate direct interaction.

Table 6. Evaluation by the respondents of the technical capabilities of selected educational platforms ($\bar{\chi}_\omega$ value).

	Google Classroom [b]	Blackboard UltraLearn [b]	Teams [b]	Moodle [b]	Zoom [b]
Item					
1. Transparency of functions	3,52	3,53	3,82	3,07	3,32
2. Image quality	3,67	3,60	3,80	3,19	3,46
3. Sound quality	3,52	3,49	3,85	3,00	3,43
4. Intuitive operation	3,43	3,44	3,76	2,89	3,24
5. Processing/merging speed	3,33	3,35	3,69	3,11	3,26
6. Safety of use	3,19	3,37	3,69	3,00	3,24

[b] on a scale of 2 to 5, where 2 was the lowest rating and 5 was the highest

The last stage of the study was the respondents' assessment of the technical capabilities of the platforms used (on a scale of 2 to 5, where 2 meant the lowest rating and 5 the highest). The Teams platform received the highest marks for both sound quality (3.85), clarity of functions (3.82), image quality (3.80), intuitive use (3.76), connection speed (3.69) and safety of use (3.69). Nevertheless, users of each platform emphasised its technical advantages. Users of the Blackboard UltraLearn platform rated the highest image quality (3.60), clarity of functions (3.53) and sound quality (3.49). In the case of the Microsoft Teams platform, respondents appreciated the sound quality (3.85), the clarity of functions (3.82) and the image quality (3.80). The Moodle platform was appreciated by the respondents for image quality (3.19), connection speed (3.11) and clarity of functions (3.07). On the other hand, the Google Classroom platform was appreciated by the respondents for image quality (3.67), clarity of functions (3.52) and sound quality (3.52). Using the Zoom platform, they appreciated it for the image quality (3.46) and sound quality (3.43).

The results suggest that users of educational platforms value technical functionalities that support smooth and responsive communication.

CONCLUSIONS

In conclusion, unexpected events are an inevitable part of human life. The future is always marked by uncertainty. The emergence of the Covid-19 virus resulted in the Universities reaching for unknown tools. Although remote education enthusiasts have been promoting digital teaching solutions for many years, they have not gained a large group of supporters. Despite daily use of digital tools, lecturers and students primarily relied on traditional, in-person classroom formats within the university setting. However, the COVID-19 pandemic necessitated an abrupt transition to online platform courses. This shift compelled both lecturers and students to acquire new digital teaching and learning skills. Nearly three years of such experience allow us to conduct analyses of the experience gained. The results presented in this article represent the students' point of view.

The collected data allow us to conclude that students connect to the Internet many times a day or a week to learn. At the same time, they more often choose generally available communication tools, such as public messaging applications, group messaging applications and email. LMS platforms dedicated to learning are used by a small group of students, which depends on the status of the university, the level of education and the mode of education. Non-public universities, first-cycle students and part-time students use the remote formula more often. Respondents identified the most frequently used e-learning platforms as digital replicas of traditional classroom formats. This suggests a direct transfer of familiar teaching methods to the online environment. Students expressed a preference for integrated platforms that combine synchronous and asynchronous activities, offering a wide range of functionality and technical capabilities. While communication platforms are widely used, they are less valued than Learning Management Systems (LMS) by students.

The future of digitalization in higher education is largely contingent upon legislative frameworks and university leadership. The acceleration of digital education has become a fact. However, how the gained experience will be used depends on people. The Covid-19 virus pandemic, becoming a catalyst for change, resulted in the recalibration of the

organisational, didactic and scientific structure of the University, introducing it to the digital world. Universities have changed from an observer of changes to their integral participants. To conclude, leveraging students' acquired experience, skills, and enthusiasm for technology should be the cornerstone for future changes in university didactics, including curriculum and teaching methodologies. This involves adapting, adopting, and actively integrating technology within the academic environment. The goal is to introduce students to digital technologies during their formal education to prepare them for a future increasingly reliant on these tools in the socioeconomic landscape.

SUMMARY

The digitisation of higher education brought about by the Covid-19 pandemic, implemented at universities resulted in a paradigm shift from teaching from ex-cathedral to remote learning supported by digital communication systems and tools. The university walls have been largely replaced with virtual space. The rapid shift to remote learning necessitated by the spectrum of communication tools has led to a reimagining of teaching methodologies, demonstrating that equivalent learning outcomes can be achieved through alternative approaches. Almost the entire academic community has learned a valuable lesson from new technologies. As primary beneficiaries of these changes, students recognise both the strengths and limitations of digital solutions. They advocate for a university transformation that prioritises the accessibility and flexibility offered by remote learning formats. This shift should replace traditional, passive learning with collaborative, interactive, and inclusive learning models facilitated by LMS platforms. The challenges that the modern world poses to the young generation require creative thinking, creating new solutions, social coexistence in decision-making responsibility for sustainable development. Such a new reality requires a new approach to learning and teaching.

The collected research material indicates that with the development of technology and its adoption in didactic processes, universities will increasingly use remote learning, and LMS platforms are an important element of this process. Functional LMS solutions will be increasingly used to conduct entire online study programmes, not just individual subjects, especially in fields of study with fewer experimental classes that require direct contact between the student and the teacher. Such study programmes will not only feature online lectures, but will also incorporate applications and tools such as online discussions, video conferencing, and virtual whiteboards to allow students to interact with faculty and fellow students.

We live in a digital age where technology offers unprecedented access to information and experiences, expanding our world at our fingertips. Technology is ubiquitous. Therefore, it would be more strategic to integrate technology into the educational process rather than cling to outdated procedures and teaching methods. What was good in the past just can't keep up with the changes. Universities must proactively prepare for emerging trends, such as the integration of AI in education and research, given its rapid adoption across various industries (Dias et al., 2023; Prieto-Gutierrez et al., 2023; Kaczorowska-Spychalska et al., 2024). According to the authors, many scenarios for the development of higher education are possible in the future. The future may bring a hybrid education model combining traditional

and digital learning in varying proportions. A full transition to exclusively digital education is also a possibility. The extent of this transformation hinges on the academic community's ability to accommodate, absorb, adapt, accept and activate (5A) new technologies.

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