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Assessing online education during the COVID-19 pandemic: a survey of lecturers in Ukraine

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Abstract. The winter and spring of 2020 was a challenging time worldwide. The COVID-19 pandemic seriously affected all spheres of life: from an industrial decline to educational transformations. In order to continue the 2019/2020 academic year, higher educational institutions had to adjust in-class learning to online. This paper aims at assessing the satisfaction and acceptance rate of Ukrainian lecturers with online education, as well as indicating problems and benefits they had singled out. The technical side of online education was also of interest. Therefore, the study employed an online survey to investigate technical support and tools used during the quarantine, advantages and disadvantages of online teaching, the level of satisfaction and acceptance. The findings from the study suggest that lecturers got different levels of technical support and used an assortment of tools to organise online education. The study revealed that the main advantage was time efficiency, while internet connection and technical problems were the most commonplace problems. Other findings of the survey are that lecturers were partially satisfied with online education but showed low acceptance of online education.

1. Introduction

The educational sector in Ukraine has been facing tremendous changes for over two decades. They are about content, methods, assessment, etc. On introducing the Bologna system, higher education has switched to ECTS. At the same time, the powerful impact of ICT and smartphone advancements in education worldwide have shifted the modern focus on digitalisation.

In 2013, the Taras Shevchenko National University of Kyiv launched the first massive open online course (MOOC) in Ukraine. About 9,000 students completed the course on Marketing and were awarded a certificate. One year later, three more courses were introduced on History of Ukraine, Programming and Financial Management. They were developed in partnership with Taras Shevchenko National University of Kyiv, Kyiv Polytechnic University, Kyiv-Mohyla Business School and posted at educational platform Prometheus which was a milestone of developing MOOCs in Ukraine [19]. Now it offers more than 100 courses, 80% of them are made from scratch, with the remaining 20% from top universities translated into Ukrainian.

The use of MOOCs was furthered with the program initiated by the Massachusetts Institute of Technology in 2008. It piloted a project combining short videos and in-class teaching. Larson and Murray used the term the Teaching Duet for this phenomenon when there are several segments which involve passing the teaching baton between the video and live face-to-face learning segments. Thus, Blended Learning Open Source Science or Math Studies (BLOSSOMS) were pioneered and the approach became a framework for blended learning [7].

Following suit of MIT, numerous universities and colleges piloted BLOSSOMS programs in the US and around the world, e.g. Universiti Teknologi Malaysia (Malaysia), AUC (Egypt), etc.

Sener defines blended learning in higher education as "courses and programs which combine online and classroom delivery modes". The threshold for materials delivered online varies in different definitions, i.e. 20-79% in the annual Sloan Survey of Online Learning and 50% in the Southern Association of Colleges and Universities as well as the Commission for Higher Education [18].

A growing interest in blended learning (not only developed around MOOCs) in higher education [5] has initiated ample researches. To be exact, the pilot at San José State University based on an EdX course demonstrated a 35% increase success rate of the final exam (from 55% to 90%) [9], while another pilot at Vanderbilt University embedding a Coursera course received positive feedback from students who chose self-paced learning as the main advantage [6]. There are projects which highlight both benefits (personalized learning environments, focus on key skills, cost efficiency, etc.) and obstacles (student engagement and retention, low computer literacy and technology acceptance of students and teachers, etc.).

In 2016, the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", the Ivan Franko National University of Lviv, the Lviv Polytechnic National University and the Ukrainian Catholic University piloted projects on the blended learning technology where MOOCs available at Prometheus were combined with face-to-face learning [19].

Currently, the digitalisation trend in Ukraine is stimulating the introduction of more blended learning courses in higher educational institutions. However, in the spring of 2020 there was a clear shift to online learning when schools, colleges, and universities were closed [11], [16]. With an increasing need of social distancing when in-person schooling posed a threat, students were forced to learn and later take tests online as an emergency response. Concentrating fully on online learning only was a first on the state level for many countries and Ukraine was no exception.

On February 3, 2020, the official letter was sent to higher education institutions with recommendations to organise "distance learning for students from the People's Republic of China and Southeast Asia countries, who are not currently in Ukraine and/or who cannot arrive in Ukraine due to the spread of coronavirus" [14].

As the epidemiological situation worsened, the letter of the Ministry of Education and Science of Ukraine from March 11, 2020, No 1/9-154 announced a three-week quarantine for all types of educational establishments in order to prevent the spread of COVID-19. The letter also recommended using ICT to set distance learning [13]. Later, the quarantine was prolonged and most students didn't even return to higher education institutions to sit exams as there were held online.

It is necessary to point out a variety of terms used worldwide for the same phenomenon as an education response to COVID-19, including e-learning [15], remote learning (UNESCO), digitally-based distance learning (the UN), digital learning, online learning, etc. However, Guri-Rosenblit argues that e-learning and distance learning are not the same. She defines three aspects as a basis of distance learning: 1) remoteness, 2) cost, 3) target audience having a number of social, economic, working and other barriers [10].

Taking into account that ICT, cloud and mobile technologies enabled learning during the pandemic when social distancing was key, the term 'online education' is used in the study.

Rising to educational needs and health- and life-saving measures of COVID-19, several online education solutions were available in Ukraine. School students were offered lessons broadcast on numerous TV channels, which were also added to the official YouTube channel of the Ministry of Education and Science of Ukraine. However, university students were not offered any universal courses because of curricula differences. As a result, digital solutions of higher education varied greatly.

2. Literature review

The quarantine resulted in emergency e-learning in Ukraine. Murphy [15] finds the phenomenon of emergency e-learning (eLearning) programs appropriate crisis-response measures. In the US, the policies were declared in the period of March 6-13, 2020 at all higher educational institutions, mostly

by university Presidents (72%). They stressed that "emergency eLearning is the security measure proposed to protect the community".

Emergency eLearning was first turned to in 2009. In the US, Allen and Seaman stated that 67% of contingency plans under threat of H1N1 had online classes as a substitution for face-to-face classes. 20% had no available online alternatives but were ready to develop them [1]. According to the earlier reports on online education (2005-2009), 60% of administrators agreed it was strategic in the long run and over 10% disagreed, while about 30% remained neutral. Moreover, institutions offering courses and full programs rated learning outcomes as the same as face-to-face (over 60%) and somewhat superior to face-to-face (20%). By contrast, institutions with no online offerings were more pessimistic with the highest result of inferior (about 33%) and almost equal for somewhat inferior and the same as face-to-face (about 30%).

In the 2013 report, Allen and Seaman [2] proved that the number of institutions with complete online programs almost doubled from 34.5% in 2002 and totalled 62.4% in 2012.

Sener argues that online education will attain full scale as it is to become fully integrated into mainstream education. Moreover, the author believes that disasters both natural and manmade (unpredictable sources) are wildcards that have a potential to spread online education [18].

John Katzman, the CEO of Noodle, a Californian company that helps colleges transfer academic programs online, says that the new model creates agility and makes programs available both under normal circumstances and in emergencies [4].

Despite the ongoing growth, academic leaders are reported to estimate that for faculty members teaching on online courses requires more time and effort as compared to corresponding face-to-face ones. It should be noted that in 2006 there were 40.7% supporting the belief, while in 2012 the number increased to 44.6%. This may explain lasting resistance among many faculty members towards online education reported by Allen and Seaman [2]. When analysing the level of value and legitimacy acceptance with the starting point in 2002, it has no steady positive tendency. A slow growth was 6% in 2007 which was followed by a slight drop and another increase resulting in the 2004 level as of 2012. Therefore, the lack of acceptance was rated as important (41.2%) and very important (25,6%) problem of online education adoption in 2012.

Moreover, there are a number of researchers arguing that it takes much planning and investment to develop entirely online courses [3], [8]. Yang and Li support the idea that online teaching training is necessary both for students and instructors [20].

Although some discussions in the literature relate to using MOOCs and blended learning in Ukraine [12], empirical evidence to demonstrate faculty attitude, problems and gains is lacking.

This study reports on research into online education conducted over the quarantine. The research has focused on the faculty satisfaction, pros and cons of online education. The emphasis on faculty experience with e-learning is relevant for further development of e-segment for both entirely online and blended learning programs. Understanding the issues faced, the insights gained as well as perspectives considered helps to strengthen weak points in order to increase the acceptance of online education and satisfaction of instructors.

The researchers developed a multi-item survey to assess satisfaction and acceptance rate of lecturers. First, they were asked whether they got technical support when developing an online learning pattern and tools they used. Next, they were asked whether the general experience was satisfactory, what benefits and problems they had, whether online education was critical in the long run.

3. Research questions
The study had three main focuses:
1. Technical support and tools
2. Advantages and disadvantages
3. Acceptance and satisfaction with online education.

Accordingly, the questions asked were as follows:

1. Did you get technical support/recommendations when organising online teaching of your course (from the university, tech support, tech department, etc.)?
2. What software were you using to hold classes online?
3. What resource did you ask your students to send assignments to?
4. What problems did you face when organising and holding online classes?
5. What benefits of online learning are there for you?
6. Do you find online education satisfactory?
7. Would you like to teach a part of your course online?
8. Do you find online learning critical in the long run?

4. Method

The researchers created a survey for lecturers who had taught online courses during the quarantine. Google Forms were used. Various types of questions were used, including multiple-choice, check-boxes and open-ended questions.

The survey took place from early May to early June. The link to the survey was posted at Facebook. In total, there were 60 responses. The participants responded to the survey anonymously. The respondents were asked to provide demographic information. The responses were tabulated in Google spreadsheets.

Responses to the questions on the respondents' problems (1) and benefits of online education (2) were grouped according to keywords in order to make categories. The categories of issues (1) were: internet connection, technical problems, lack of face-to-face interaction, technical knowledge, students' work, motivation, efficiency, support from universities, workload and stress, other. "Technical problems" included problems with both software and hardware. "Student work" included quality of work and assignments, readiness to learn online, cheating. The benefits (2) had the following categories: none, mobility, time efficiency, flexible hours, learning tools, clear control, inviting experts, self-development, special education. "Other" was used to include responses that did not fall into any of the stated categories.

5. Results

The study confirmed some commonly held beliefs about online education, refuted others, and provided predictions about the future of online education. The questions on software were with check-boxes, while those one advantages and disadvantages were open-ended.

5.1. Demographics of respondents

A large majority (96.6%) of the survey respondents held teaching positions, while only 3.4% were administrators. Only four respondents said their institutions offer online courses (3.4%) and only one had taught online courses. Mostly, the respondents were from Kharkiv region (86.7%) with only 6.7% from Kyiv, 5% from Ternopil and 1.7% from Poltava regions.

5.2. Technical support and tools

Deciding on digital tools and platforms was up to lecturers mostly, as there were no official recommendations from the Ministry of Education and Science of Ukraine. However, 60% of respondents indicated that they got technical support/recommendations when organising online courses (from the university, tech support, tech department, etc.), while 38.3 got none and only one participant chose the option "Other" to add partial technical support (see figure 1).

As for the software to hold online classes, it is universal worldwide. At Yale, Peter Salovey in the update speech on the first confirmed Yale COVID-19 case mentions holding "classes online using Zoom, Canvas, and other digital tools" [17].

When responding to the check-box question "What software were you using to hold classes online?", the most popular turned out to be Zoom (57 respondents) and communication tools (Viber and Skype were chosen accordingly by 46 and 30 participants). Such video conferencing software as Google Meet,

Canvas, Jitsi Meet and Microsoft Teams were ticked by correspondingly 11, 2, 1 and 1 those surveyed (see table 1).

Did you get technical support/recommendations when organising online teaching of your course?
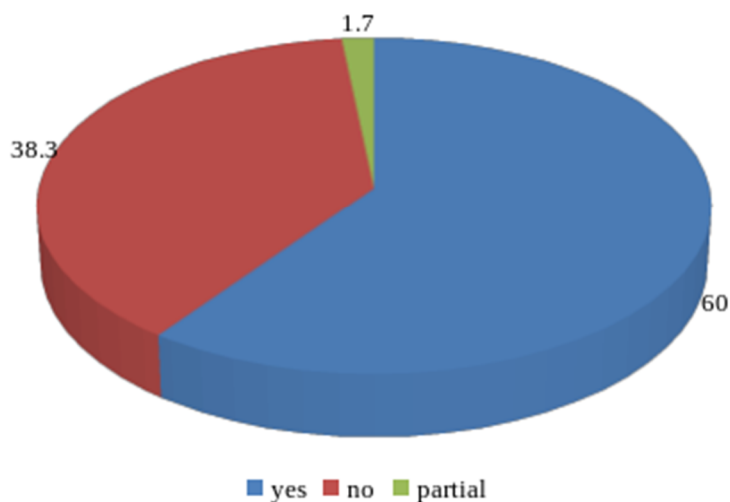

Figure 1. The response rate of getting technical support from universities.

Table 1. Analysing software to hold online classes

No	Response option	The number of response options	Response rate
1.	Zoom	57	38.5
2.	Viber	46	31.1
3.	Skype	30	20.2
4.	Google Meet	11	7.4
5.	Canvas	2	1.4
6.	Jitsi Meet	1	0.7
7.	Microsoft Teams	1	0.7
	Total	148	100

Similarly, there was a variety of software to which students were asked to send assignments. 47 respondents checked the box of E-mail and 45 communication tools (Viber, Telegram, Skype). Much fewer used Google Classroom (37) and Moodle (7). Only one respondent had the Padlet board to gather student work. Some respondents ticked not one but several boxes when answering the questions on software (see table 2).

Table 2. Analysing software for students' assignments sorted by the respondents' answers

№	Response option	The number of response options	Response rate
1.	E-mail	47	34.4
2.	Viber, Telegram, Skype	45	32.8
3.	Google Classroom	37	27.0
4.	Moodle	7	5.1
5.	Padlet	1	0.7
	Total	137	100

5.3. Advantages and disadvantages

When analysing the problems online instructors had, all open-end answers were grouped into nine categories based on keywords (see table 3).

Table 3. Analysing the problems online instructors experienced.

No	Response option	The number of response options	Response rate
1.	Internet connection	31	41.9
2.	Technical problems	10	13.6
3.	Student work	8	10.9
4.	Lack of face-to-face interaction	6	8.1
5.	Computer competency	4	5.4
6.	Lack of support from universities	4	5.4
7.	Workload and stress	3	4
8.	Motivation	3	4
9.	Other	3	4
10.	Efficiency	2	2.7
	Total	74	100

Number one problem was low quality or no internet connection. Online instructors complained that students who don't live in the city missed online classes because of poor internet connection. As a result, instructors had to work extra hours when students were online. Besides, some courses require close contact. An instructor noted that because of bad connection, there was audio latency and it was impossible to perceive a timbre (course specifics matter).

The second most often problem was about software and hardware. Two online instructors regretted that Ukraine wasn't among the countries where Zoom lifted the 40-minute session restriction. As for hardware, it wasn't powerful enough and one instructor even mentioned that a laptop had broken down.

Student work was the third most mentioned problem. Online instructors argued that there was a drop of assignment and work quality as well as some cheating. Moreover, several reported that students were not ready for online learning. Over 8% of respondents missed face-to-face interaction and instant feedback.

Although computer and digital competency is considered commonplace, respondents expressed the lack of it. 5.4% also noted that they had got no support from universities and it would have helped a lot. 4.1% of survey participants reported an increased workload and stress as online work was draining. The same number indicated that students lacked motivation to pursue online education.

After highlighting the problems, the respondents were asked to focus on the benefits they experienced. As open-end answers, they were grouped into ten categories according to keywords (see table 4). Unlike problems when most respondents indicated several challenges, only one respondent expressed two benefits.

Almost a quarter of respondents specified time efficiency (24.6%). Most of the responses showed that working from home saved a lot of time as instructors didn't have to go to higher educational institutions and could have instant access to classes and assignments. 13.1% of respondents mentioned flexible hours, self-development and an assortment of learning tools. Instructors pointed out using time-saving testing services and a lot of new interactive multimedia resources to make learning more engaging, i.e. Mentimeter, Wizer.me, Padlet, etc. Mobility was a benefit of online education for 11.4 participants. Clear control of student work available at digital learning services was appreciated by 8.2%. 3.3% of survey participants enjoyed individualisation of online education, as well as advantages for students who have special educational needs. The same number considered inviting experts to online classes. To be exact, native speakers were mentioned in two responses. However, four respondents (6.6%) chose no benefits adding that online education during the quarantine was time and energy consuming.

Table 4. Analysing the benefits online instructors experienced.

№	Response option	The number of responses	Response rate
1.	Time efficiency	15	24.6
2.	Flexible hours	8	13.1
3.	Self-development	8	13.1
4.	Learning tools	8	13.1
5.	Mobility	7	11.4
6.	Clear control	5	8.2
7.	None	4	6.6
8.	Individualisation	2	3.3
9.	Special education	2	3.3
10.	Inviting experts	2	3.3
	Total	61	100

5.4. Acceptance and satisfaction with online education

Do you find online education satisfactory?
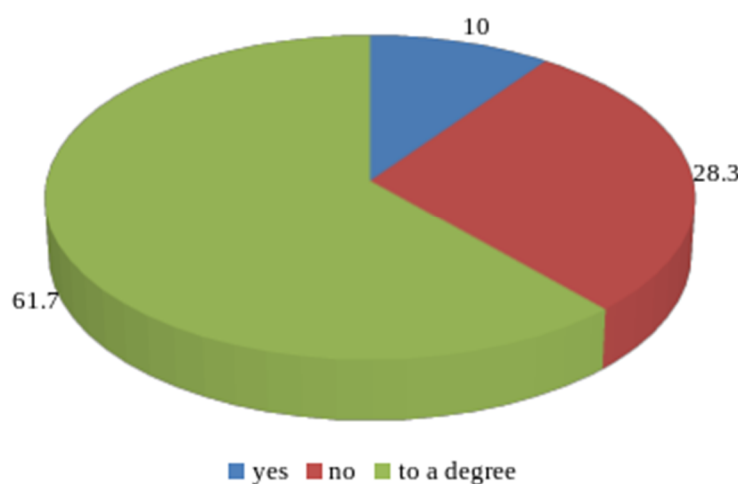
■ yes ■ no ■ to a degree

Figure 2. The response rate of satisfaction with online education.

At the final part of the survey, those participated were asked to consider their satisfaction with online education and general acceptance. More than half (61.7%) chose the option "To a degree". About a quarter of respondents found online education not satisfactory. Only 10% indicated their satisfaction (see figure 2).

When asked about an intention of teaching a part of a course online, almost half (48.3%) expressed their unacceptance of online education and answered they wouldn't like to teach online. One instructor in the "Other field" added "Despite the fact that I would not like to teach a part or the whole course online, it looks like I'll still have to." At the same, almost a quarter of respondents (23.3%) considered the possibility and 20 respondents have already integrated online learning in the courses. 10% of surveyed instructors stated they had already made their course 100% online (see figure 3).

The final question was "Do you find online learning critical in the long run?" and almost half of respondents answered negatively (see figure 4). One instructor indicated a low quality of online education. Two instructors stated that it is an emergency only when online education can be used. Eight respondents considered blended learning emphasising the importance of in-person interaction. Twenty respondents believed online education to be critical in the long run.

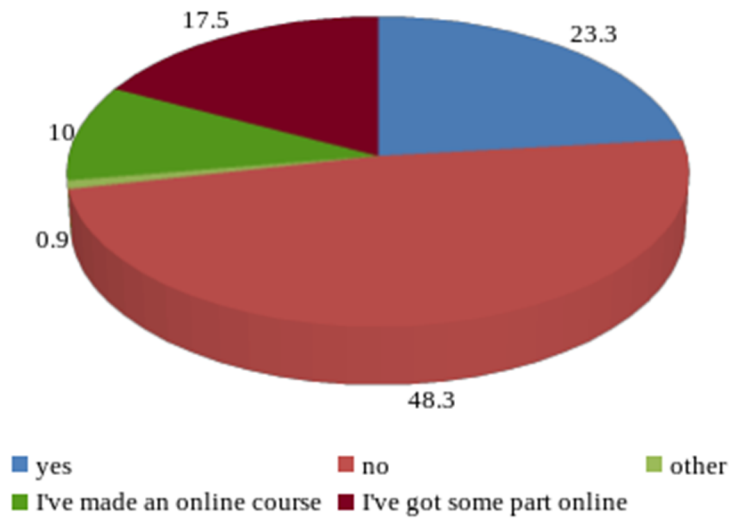**Would you like to teach a part of your course online?**

Figure 3. The response rate of lecturers' intention of teaching a course online.

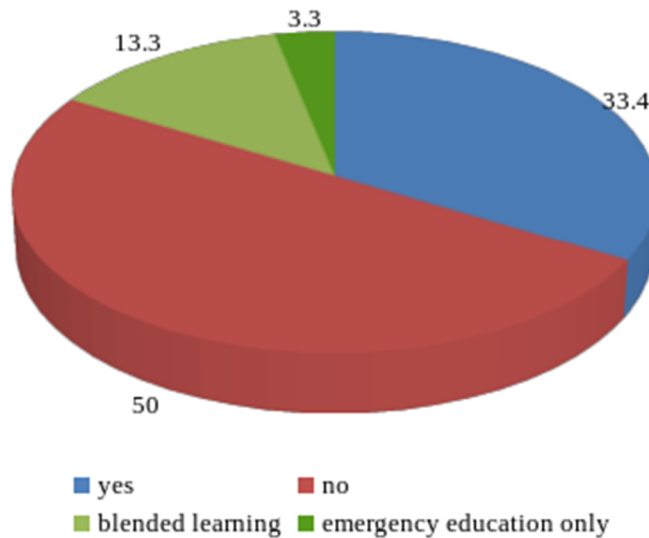**Do you find online learning critical in the long run?**

Figure 4. The response rate of online education importance in the long run.

6. Conclusions

The 2019/2020 academic year was challenging in many aspects, most of them triggered by the COVID-19 quarantine. In Ukraine, online learning at higher educational institutions was chosen as an emergency measure. Unfortunately, most institutions had had no previous experience, ready tools or trained faculty. However, there have been discussions about advantages and disadvantages of online education for some years now, under normal circumstances and in emergencies, for example by Allen and Segman [2], Blumenstyk [4] etc. Taking into account a still lasting pandemic and a growing number of online courses worldwide, it was of relevance to examine the general situation of online education, trends and attitudes of lecturers in Ukraine. This study was primarily motivated by the need to investigate and assess the satisfaction and acceptance of Ukrainian higher education teachers. Also it was aimed at distinguishing

problems and benefits of online education. The survey was created to study faculty feedback and insights.

Despite the fact that emergency eLearning was unprecedented in Ukraine, some countries have already had such experience. Allen and Segman analysed that under threat of H1N1, two thirds of US contingency plans accepted online classes as a substitution for face-to-face teaching [1]. Thus taking into an unexpected turn to online education for most Ukrainian lecturers and a limit use of blended learning (otherwise the authors argue that the shift to online education in March 2020 would have been smoother and faster as some survey respondents noted that it took a lot of time to get used to the online paradigm of teaching), those surveyed mostly indicated partial satisfaction with online education. Allen and Segman stress that higher acceptance of online education demonstrated participants which had previous experience of teaching online courses (colleges and universities had online offerings) [1].

The findings of the study revealed the main problems teachers faced and the benefits they experienced. Thus, among main problems the following are indicated: low quality or no Internet connection, software and hardware, a drop of assignment and quality of student work, and computer and digital competency. At the same time there were highlighted main benefits of online education experience: time efficiency, mobility, clear control of student work, and individualisation.

However, there is certain resistance among instructors of online education as a majority of respondents didn't plan to integrate online segments in courses and didn't recognise its importance in the long run. In this aspect the findings of Allen and Segman are noteworthy: the lack of acceptance of online education by faculty is considered either an important or very important barrier to the widespread adoption of the online paradigm [2].

Taking into consideration a gap in computer competency and lack of technical support from universities, the authors argue that it is necessary for faculty and administration to steam-work on developing a pattern on teaching online with strong methodical background and support, namely to hold trainings on online education, to plan and develop internal university platforms, as well as provide support services. This way, lecturers will have a basic set of tools and skills to use them expertly.

The authors report certain limitations of the study. One of the most relevant is a lack of data and prior research studies on online education at higher educational institutions, including blended learning. Moreover, increasing the sample size can be beneficial. In the current survey, 60 respondents participated.

In the post pandemic world of COVID-19, education is likely to face further changes and lecturers should be ready to provide high-quality relevant teaching.

Thus, the perspectives for further research can be such aspects of the problem as professional development of higher education teachers in online education context, preparing lecturers for online or blended teaching, online education impact on student achievements, etc.

References
[1]   Allen I E and Seaman J 2010 *Learning on Demand: Online Education in the United States, 2009* (Needham: Sloan Consortium) URL http://files.eric.ed.gov/fulltext/ED529931.pdf
[2]   Allen I E and Seaman J 2013 *Changing Course: Ten Years of Tracking Online Education in the United States* (Needham: Sloan Consortium) URL http://files.eric.ed.gov/fulltext/ED541571.pdf
[3]   Bao W 2020 COVID-19 and online teaching in higher education: A case study of Peking University *Human Behavior and Emerging Technologies* **2** 113–5 URL https://doi.org/10.1002/hbe2.191
[4]   Blumenstyk G 2020 Why Coronavirus Looks Like a 'Black Swan' Moment For Higher Ed *The Chronicle of Higher Education* URL https://www.chronicle.com/newsletter/the-edge/2020-

03-11

[5]   Bondarenko O V, Mantulenko S V and Pikilnyak A V 2-18 Google Classroom as a Tool of
       Support of Blended Learning for Geography Students *CEUR Workshop Proceedings* **2257**
       182–91

[6]   Bruff D O, Fisher D H, McEwen K E and Smith B E 2013 Wrapping a MOOC: Student
       perceptions of an experiment in blended learning *MERLOT Journal of Online Learning and
       Teaching* **9** 187–99 URL https://jolt.merlot.org/vol9no2/bruff_0613.pdf

[7]   Cammarata L V and Larson R C 2018 Project-based methods for assessment of active learning
       STEM video lessons *International Journal on Innovations in Online Education* **2** URL
       https://doi.org/10.1615/IntJInnovOnlineEdu.2018026526

[8]   Filius R M, de Kleijn R A M, Uijl S G, Prins F J, van Rijen H V M and Grobbee D E 2019 Audio
       peer feedback to promote deep learning in online education *J. Comp. Ass. Learning* **35** 607–
       19 URL https://doi.org/10.1111/jcal.12363

[9]   Ghadiri K, Qayoumi M H, Junn E, Hsu P and Sujitparapitaya S 2013 The transformative potential
       of blended learning using MIT edX's 6.002x online MOOC content combined with student
       team-based   learning   in   class   URL
       https://images.ctfassets.net/ii9ehdcj88bc/40sNOzvhlP4uIVe8DEHrrF/e5da38375d9839499a
       129f2206cd8f29/ed-tech-paper.pdf

[10]   Guri-Rosenblit S 2005 'Distance education' and 'e-Learning': Not the same thing *Higher
       Education* **49** 467–93 URL https://doi.org/10.1007/s10734-004-0040-0

[11]   Hamaniuk V, Semerikov S and Shramko Y 2020 ICHTML 2020 – How learning technology wins
       coronavirus   SHS   Web   of   Conferences   **75**   00001   URL
       https://doi.org/10.1051/shsconf/20207500001

[12]   Holiver N, Kurbatova T and Bondar I 2020 Blended learning for sustainable education: Moodle-
       based English for Specific Purposes teaching at Kryvyi Rih National University *E3S Web of
       Conferences* **166** 10006 URL https://doi.org/10.1051/e3sconf/202016610006

[13]   Ministry of Education and Science of Ukraine 2020 *On finishing 2019/2020 academic year* URL
       http://osvita.ua/legislation/Vishya_osvita/72094/

[14]   Ministry of Education and Science of Ukraine 2020 *The Ministry of Education and Science of
       Ukraine recommends organizing distance learning for students from The People's Republic of
       China, who are not currently in Ukraine 2020* URL https://mon.gov.ua/eng/news/ministry-
       education-and-science-ukraine-recommends-organizing-distance-learning-students-peoples-
       republic-china-who-are-not-currently-ukraine

[15]   Murphy M P A 2020 COVID-19 and emergency eLearning: Consequences of the securitization
       of higher education for post-pandemic pedagogy *Contemporary Security Policy* **41** 492–505
       URL https://doi.org/10.1080/13523260.2020.1761749

[16]   Polhun K, Kramarenko T, Maloivan M and Tomilina A 2021 Shift from blended learning to
       distance one during the lockdown period using Moodle: test control of students' academic
       achievement and analysis of its results *Journal of Physics: Conference Series* In press

[17]   Salovey P 2020 COVID-19 Update – First Confirmed Yale COVID-19 Case; Extending Online
       Instruction to End of Spring Semester; Campus and Staffing Considerations *Yale University*
       URL   https://covid19.yale.edu/university-announcements-about-covid-19/covid-19-update-
       first-confirmed-yale-covid-19-case-extending

[18]   Sener J 2010 Why Online Education Will Attain Full Scale *Journal of Asynchronous Learning
       Networks* **14** 3–16

[19]   Syzenko A 2016 The Rise of MOOCs: Disrupting Higher Education in Ukraine *DisCo 2016:
       Towards open education and information society* vol **11** ed Beseda J (Prague: Centre for
       Higher Education Studies) pp 204–10

[20]   Yang F and Li F W B 2018 Study on student performance estimation, student progress analysis,
       and student potential prediction based on data mining *Computers & Education* **123** 97–108
       URL https://doi.org/10.1016/j.compedu.2018.04.006