The use of digital tools by secondary school teachers for the implementation of distance learning in the context of digital transformation in Ukraine

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Abstract

In this paper, we raise the discussion on the use of digital learning tools by teachers of Ukrainian secondary schools for the organization of distance learning. In order to collect data we have used the survey instruments (Google questionnaire) and involved 1463 respondents who revealed the state of the use of digital learning tools for the organization of distance learning in the quarantine period caused by COVID-19 pandemic. The study was conducted in all regions of Ukraine. The results show that teachers have a need to master their knowledge and practical skills on digital instruments for the organization of distance learning with students. On the other hand the paper presents the experience on how the problem of the mastering of teachers' digital competencies can be organized and what are the steps to the organization of special distance learning courses for teachers in Ukraine. The experience of the creation of Web portal of Ukrainian Open University of Postgraduate Education is presented. We propose on how the needs and requirements of teachers regarding the implementation of the distance learning in schools and the development of their digital competencies should be resolved.

Keywords
secondary education, digital learning tools, distance learning, teacher

1. Introduction

The main goal of building an information society and its next phase – the knowledge society, is the formation of a developed information environment focused on the interests of citizens in Ukraine. This gives everyone the opportunity to fully realize their potential, as well as contribute to the sustainable development of the country and improve the quality of life. That is why the Government of Ukraine presented the Concept of Development of the Digital Economy and Society of Ukraine 2020, which identified opportunities for society to adapt to the realities of the digital world. One of the important factors of such adaptation is the development of the ability of the general population to use digital technologies in everyday life and at work [1]. We consider digital transformation as a strategic vision for how educational organizations evolve from a traditional model, for example, during traditional classroom learning, to student and teacher engagement to the new digitally enabled and data paradigm [2, 3, 4, 5].

The main role in the process of acquiring digital skills is played by teachers, who must not only be able to use IT to implement the learning process, but also be able to create a digital learning environment for students. The focus of our study is on teachers who answered the questionnaire about their readiness to use digital learning tools and who outlined the problems in the implementation of distance learning in schools that face them today during the quarantine period.

One of the main challenges facing education today is the lack of awareness of teachers about digital tools for distance learning in modern conditions. In addition, in today's digital society in Ukraine, the education system faces a limited number of available teaching materials and guidelines on how to use IT to teach their subjects; there is a problem of insufficient training of teachers to use digital tools in professional activities. This is evidenced by the results of recent research, which determined the readiness and needs of Ukrainian teachers for the use of digital tools and IT in quarantine [6, 7, 8, 9].

The study also outlines Ukraine's experience in creating a web portal of Ukrainian Open University of Postgraduate Education to improve the skills of teachers to acquire digital skills and reveals opportunities and prospects for improving the digital competencies of teachers [10, 11]. Additionally we give examples of good practices in creating a digital environment and the use of digital tools on the example of civic education in Ukrainian schools.

2. Literature review

The problems of using IT for distance learning by teachers in educational institutions are covered by Bobyliev and Vihrova [12], Franchuk and Prydacha [13], Havrilova et al. [14], Kukharenko and Oleinik [15], Mintii et al. [16], Syvyi et al. [17], Vakaliuk et al. [18]. These researchers raise questions about the implementation of IT in education, the methodology of using digital tools, creating a digital environment for teachers and students.

The issues of the development of digital competence of pedagogical university students are revealed by Hodovaniuk et al. [19], Kuzminska et al. [20], Moiseienko et al. [21], Soroko [22], The Council of the European Union [23], Yaroshenko et al. [24] who describe the definition, structure and didactic conditions in the context of lifelong learning.

The main issue, researchers consider the creation of the necessary educational and methodological support of the process distance learning, creating a digital environment in schools and postgraduate educational institutions. Issues of formation of digital competence of teachers and future teachers are revealed by Moiseienko et al. [21], The Council of the European Union [23], Ovcharuk et al. [25], Ovcharuk and Hrytsenchuk [26], Hrytsenchuk [27] from the point of view on how to create the digital support and appropriate environment in the classroom for teacher for successful application of the digital tools for key competencies development including digital competence. The scientists focus on the components of the teacher's digital competence and digital environment in schools. The scientists stress on the need to harmonize the framework for the development of digital competence of students and teachers with European approaches and the necessity to create mechanisms for assessing the level of digital literacy of educators in Ukraine. Gurzhii et al. [28], Kartashova et al. [29, 30], Petrenko et al. [31], Shokaliuk et al. [32], Spirin et al. [33] point out the aspects of the development of teacher's digital competency and the organization of distance learning in schools.

3. Research method

The goal of the article is to reveal the results of the survey about the Ukrainian teachers' readiness to conduct distance learning in schools in the quarantine period during 2020/2021 school year, to reveal problems and challenges, as well as to present the experience on how these problems can be resolved in the system of postgraduate teachers' education. The following methods were used by the authors to reveal this goal: analysis, synthesis, generalization and systematization of scientific sources – to determine the theoretical, methodological and applied aspects of the problem of using digital technologies in the implementation of distance education; empirical methods, in particular, questionnaires, surveys to find out the readiness of teachers to the use of digital learning tools in the process of distance education. In addition, computational methods of information processing were applied during the data processing online survey.

4. Research results

Scientists of the Department of the Comparative Studies for Educational Innovations of the Institute for Digitalisation of Education of the National Academy of Educational Sciences of Ukraine conducted research among teachers (the number of respondents is 1463) through an online survey in January 2021 [6]. The precondition for conducting this research was a preliminary online survey conducted in the spring 2020, which highlighted the problems and needs of teachers in the implementation of distance and blended learning in schools during the first wave of quarantine caused by the pandemic COVID-19 [7, 8, 9].

It was important to determine exactly how the survey participants organized distance learning and what tools they used to conduct lessons during distance and blended learning in a COVID-19 pandemic. It was also interesting to find out which online resources serve respondents to prepare for lessons, which of these resources are the most popular and useful for students and teachers. It was found that most respondents use the following digital tools to organize distance learning: Viber – 83%; Zoom – 58.7%; the site of the educational institution – 58.7%;

My Class – 20.7%; Padlet – 18%; Google Apps for Education – 15.1%; Skype – 14%; Telegram – 13.8%; Electronic diary - 11.7%; Educational platform of the educational institution – 10%; Jitsi Meet – 9.5%.

In addition, respondents pointed out to such tools as: Tik-Tok; Microsoft Teams; Cisco Webex; Class Dojo; Edmodo; Moodle; Twitter; WhatsApp. However, all these tools did not score more than 4% each. If we compare the results of two surveys (2020 and 2021) on the use of digital tools for distance learning, we can see that the most popular tools for teachers are: Viber (83%) and the school website (58.7%); The number of users increased from the 2020 period in comparison with 2021 school year, namely: Zoom (+30.2%), Padlet (+18.2%), Jitsi Meet (+8.8%); Cisco Webex (+3.3%); Edmodo (+3.2%). The responses showed less use of Google Apps for Education (-30.4%), Skype (-23.7%), Telegram (-7.1%); MyClass continues to be used at approximately the same level (+2.2%); Microsoft Teams (-0.7%); Electronic diary (+1.4%); ClassDojo (+1.6%). New tools such as flipped classroom (+4%), Tik-Tok (+4%), Twitter (+4%) were increased.

This indicates that Ukrainian teachers require additional training on the use of digital tools. The most effective online forms of professional development teachers consider the following:

- online courses – 32.1%;
- online master classes – 19.2%;
- webinars – 17.9%;
- online conferences / seminars – 12.1%;
- massive open online courses – 10.6%;
- online professional competitions – 4.6%.

Among other things, teachers indicated the following: online projects, webinars, online face-to-face courses, etc. (figure 1).
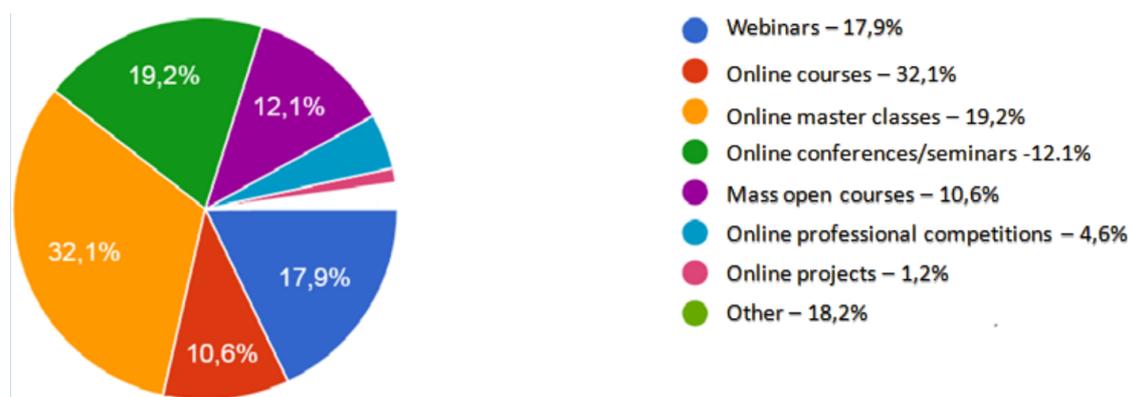
Figure 1: Distribution of respondents' answers to the question 'What online forms of professional development do you consider the most effective?'.

It was also interesting to identify the attitude of teachers to the use of digital learning tools in the teaching of civic education. For example, a study conducted in 2019 found that teachers of various subjects who teach civic education are interested in using digital tools in their professional activities [25].

A survey was conducted with 129 Ukrainian teachers. The results showed that 80% of the positive answers of respondents related to the importance of the use of ICT, namely: promoting the creation of free, accessible and secure information environment – 93.8%; understanding the risks and threats in digital environments; knowledge of security and privacy and data protection measures – 79.8%; knowledge of rules of conduct and know-how on the use of digital technologies and interaction in digital environments – 83.7%.

The answers concerning the awareness of teachers about modern digital tools and the possibilities of their use, demonstrated the lack of awareness and training of teachers and the need for methodological support. The question 'Am I able to protect myself and others from possible dangers in digital environments (for example, from cyber-bullying)' was answered only 18.6%; 'I can create and edit digital content in various formats, express myself digitally on the culture of democracy' – 20.2% of respondents said 'yes'. Cloud services are used remotely for training. Teachers identified Google services as the most popular among them (80.5%). Teachers also use Microsoft Office 365, Dropbox, Padlet, Google Apps, Google Drive and others (figure 2) [25, 29].
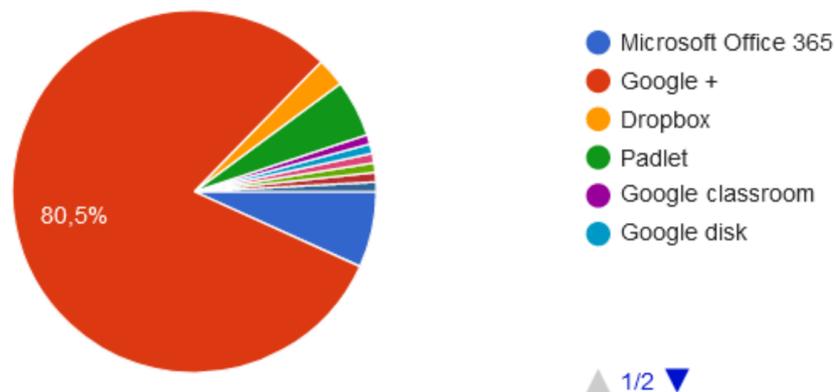

Figure 2: Distribution of respondents' answers to the question 'What cloud services do you use in teaching civic education with students?'.

The practice of using digital tools for teaching civic education in Ukraine is not wide-spread. However, among some good practices should be singled out, for example, the resource of '3D Democracy: think, care, act' https://citizen.in.ua/about.php, which was created with the support of the NGO 'Nova Doba'. The tools and materials of this digital resource are freely available, not only to students and teachers, but also anyone can join the use of resources and content in civic education remotely [34].

An online course and an interactive civic education textbook for 10th grade are available on a specially created website. Among the opportunities for teachers are the following: 'Online Teachers' is a community of civic education teachers; 'the Block of the School', which contains information about the institution that joined the net-work, provides information about the school on the map of Ukraine; 'Journal of Students' Achievements' is a place where activity of each registered student is fixed in the general 'electronic class journal' (by subjects and sections), it is accessible for viewing by teachers; 'Relevant Information' (methodical materials, information about webinars, training seminars, conferences for teachers, etc.).

'3D Democracy' proposes for students such online learning facilities as: online textbook and manual on civic education; additional information on each topic (texts, videos, life cases); online students' community from different regions of Ukraine that contains online games, polls, petitions, elections, flash mobs (on civic education topics); personal students' offices/portfolios of civic activities (specific practical cases in the course of civic activity, joint blogs, forums, discussions); assessment of student achievements (online testing, situation analysis, practical tasks (essay), and tools for students' motivation (automatic scoring).

Since the start of the project, the number of registered students studying civic education has been constantly increasing. In the 2018/2019 school year, the community consisted of 3,036 students, in the 2019/2020 school year it grew up to 4,996 students. Today, the community has grown up to 7,648 participants. A total of 15,680 students and 2,646 teachers from all over Ukraine have joined the project. Participants worked on the ZOOM platform to create volunteer projects and implement them [34].

The relevance of distance learning by secondary school teachers has increased due to the long period of quarantine restrictions. The new conditions of uncertainty of the further course of events, the remoteness of the participants in the educational process prompted the solution of the problem of providing continuous assistance to teachers. Teachers in the use of digital tools for the implementation of distance learning were not sufficiently prepared.

OECD research states: 'when teachers do not have the skills to effectively integrate digital devices into teaching, they can learn to use them if the resources are available'. However, not all teachers have access to effective professional resources to improve their understanding of technology and their knowledge of how to apply it. On average, in OECD countries, only 65% of 15-years-old attended schools whose principals felt that their teachers had the resources to expand their understanding of digital technologies in the classroom and beyond [35]. UNESCO has a response to these issues and proposes the distance learning solutions [36, 37, 38, 39]. The development of an innovative environment for the professional development of teachers, including distance learning, has become a challenge for Ukrainian teachers.

Currently, among the main functions of postgraduate education is to assist teachers in developing their skills to act well in the digital educational environment, the ability to independently organize distance learning, to independently search and select digital resources and their adaptation to the conditions of the educational process. Based on these problems, the authors have developed an innovative model that provides professional development of specialists – web portal 'Ukrainian Open University of Postgraduate Education' http://uvu.org.ua/ [10]. Web portal 'Ukrainian Open University of Postgraduate Education' is a multi-purpose, dynamic electronic educational resource designed to organize and support postgraduate education. This is a set of digital solutions aimed at the successful operation of virtual departments, the implementation of the educational process, professional development of students, coverage of innovative educational practices. The specialists of the University of Educational Management (Kyiv, Ukraine) taking into account the peculiarities of adult learning developed and put into use the Web platform 'Learning Management System Adult Learning' (LMS AdL) for the introduction of modern technologies of formal and non-formal postgraduate education. The platform is placed on the web-portal in order to provide a remote stage of professional development of students. Educational activities are carried out on the basis of virtual departments. Each virtual department of consists of technological and intellectual potential and resources of individual

scientists, departments, institutes, institutions of higher education, public organizations [30].

Departments provide open access to research carried out within the specified community, which includes: the use of remote communication; consistent formation of an educational virtual community of specialists; marketing of knowledge and distance educational services; protection of joint use of intellectual property of members of the virtual department; integration of extensive educational practices into a holistic system of continuing adult education.

Currently, six virtual departments have been established, that represent the innovative digital space for the professional development of pedagogical, scientific-pedagogical and managerial staff of education. Virtual departments carry out scientific and practical communication of specialists in adult education in various fields and educational institutions, consumers of educational services. Among the advantages of the virtual department are the following: participants' awareness of each other's need for experience and resources, pooling resources on this basis to achieve common goals; electronic integration of the best developments; cooperation and coordination of remote partners; the ability to respond flexibly to changes in the environment, the labor market; implementation of interdisciplinary learning strategy; formation of flexible study groups, the possibility of individual learning.

The innovativeness of the Web portal is that it is an electronic resource and in the same time the open educational and scientific environment for professional and personal development of adults.

The LMS Adult Learning platform, that is the basis of this open educational and scientific environment, has a dynamic navigation structure of logical complexity and content that includes various modules:

- expert council: examination and approval of educational programs, teaching materials; providing consultations to participants of the educational process;
- virtual departments: andragogy http://uvu.org.ua/kafedra-osvity-doroslykh/, education management http://uvu.org.ua/kafedra-upravlinnia-osvitoiu/, vocational education http://uvu.org.ua/kafedra-profesiinoi-osvity/, psychology http://uvu.org.ua/kafedra-psykholohii/, digital technologies http://uvu.org.ua/kafedra-tsyfrovykh-tekhnolohii, New Ukrainian School http://uvu.org.ua/kafedra-nush/;
- electronic dean's office http://uvu.org.ua/struktura/elektronnyi-dekanat/: keeping records of students; formation of the schedule of educational process; development of schedules; formation of study groups; document management; certificates;
- information and consulting centre http://uvu.org.ua/ikcodn/ created at the request of teaching staff): 7x24 consultations; organization of flash courses; organization of webinars, seminars, conferences; individual work with participants of the educational process; marketing;
- department of scientific and methodical support: support and maintenance of the resource; maintenance of the educational environment; filling the web library, technical and methodical processing of materials of short term and special courses; organization of work in social networks; technical support of listeners;
- educational practices: acquaintance with the international experience of training organization; coverage of scientific achievements in the field of education and learning technologies.

Virtual departments include 62 teachers: 15 teachers from the regions, 16 – from Kyiv city, other teachers from the university.

Technical characteristics of the virtual university:

- Availability: The resource is available 24 hours a day, 7 days a week.
- Speed of work and correctness of adjustment: the resource reacts quickly enough to the entered inquiries, transitions between components, filling of forms of feedback; ranks first in the list of Google sites. In order to identify errors and eliminate them in a timely manner, a technical audit of the resource is carried out continuously. Continuous technical audit avoids code 404, which means that the page is unavailable for any reason. Continuous maintenance reduces the risk of search engines treating a resource as untrustworthy and reducing its ranking or exclusion. All pages of the resource are in working order.
- Availability of 'mirror': the resource has a 'mirror' on another server, which helps to save the audience (users) and improve its indexing.

It should be noted that the educational process is provided by training in the format of: flash courses; special courses; webinars; digital dialogues. Currently, there are 46 special courses and 4 flash courses. The list of special courses and flash courses in the virtual university as of 01.01.2022 http://uvu.org.ua/elektronni-resursy/spetsialni-kursy/.

Distance learning was organized for 1,137 students from 401 educational institutions in the period from 12.03.2020 to 01.02.2021 on the Web platform LMS AdL http://uvupo.ues.net.ua. Representatives of 23 regions of Ukraine and the city of Kyiv took part in advanced training courses. To provide distance learning for students, it was created 50 electronic classrooms for teachers, and 186 teaching materials have been posted in the web library. 950 people received certificates of advanced training; 1,362 people received certificates of participation in webinars [**?**].

The Ukrainian Open University of Postgraduate Education has a page in the Facebook, which includes 1.5 thousand regular participants and in total covers a virtual audience of about 40,000 users https://www.facebook.com/groups/217559579605133.

The originality of an innovative model of non-formal postgraduate education and Web portal is to provide conditions for continuous professional development of teachers in accordance with the requirements of the digital society, based on free choice of content and timing, diversification of learning through digital technology.

5. Conclusions and recommendations

The conducted research and the presented experience of the decision on support of distance learning allowed the authors to reach the following conclusions. The results of the teacher surveys revealed a number of problems faced by schools, teachers and school principals in connection with the introduction of quarantine measures in Ukraine. Threats and challenges as signs of crisis have become a determining condition for gaining new experience and opening new opportunities in ensuring the continuous professional development of teachers. Among the main ones: teachers' unwillingness to implement distance learning, gaps in knowledge

of digital teaching tools, insufficient awareness of digital educational resources in teaching subjects, limited access to digital resources, etc.

Particular attention should be paid to the digital competence of teachers, its constant development, which should be provided by teacher training institutions.

New realities of education during the quarantine period prompted to search for innovation solutions for the organization of the educational process and quality assurance of distance learning by teachers of secondary education in the context of digital transformation in Ukraine. We presented the Ukrainian experience in addressing the issue of teacher training not only on digital literacy, but also on professional activities in various fields.

The presented tools of the teacher survey can be used by the heads of educational institutions to identify problems and find solutions on the ground. The questionnaire can also serve as a tool to identify important topics for teacher training courses. We propose to conduct a survey of teachers on the problems of distance learning on a follow-up basis.

The experience of the Ukrainian Open University is a new solution for Ukraine and needs further development, development and renewal. That is why we see further prospects for the study of the problems outlined in the work in the further monitoring of the readiness and competence of teachers to use digital teaching aids; in identifying problems in the implementation of distance learning and finding more workable solutions. In our opinion, such aspects as the creation of short courses for teachers of various subjects in digital literacy, methodological and psychological support for teachers, motivation and encouragement to find creative solutions in distance learning in schools need attention.

References

[1] Concept of the development of digital economy and society in Ukraine for 2018-2020, 2018. URL: https://zakon.rada.gov.ua/laws/show/67-2018-%D1%80#n13.

[2] D. Trcek, Driving digital transformation through e-government, CEUR Workshop Proceedings 2422 (2019) 263–273.

[3] O. P. Pinchuk, O. M. Sokolyuk, O. Y. Burov, M. P. Shyshkina, Digital transformation of learning environment: Aspect of cognitive activity of students, CEUR Workshop Proceedings 2433 (2019) 90–101.

[4] N. V. Morze, O. V. Strutynska, Digital transformation in society: key aspects for model development, Journal of Physics: Conference Series 1946 (2021) 012021. doi:10.1088/1742-6596/1946/1/012021.

[5] M. P. Leshchenko, A. M. Kolomiiets, A. V. Iatsyshyn, V. V. Kovalenko, A. V. Dakal, O. O. Radchenko, Development of informational and research competence of postgraduate and doctoral students in conditions of digital transformation of science and education, Journal of Physics: Conference Series 1840 (2021) 012057. doi:10.1088/1742-6596/1840/1/012057.

[6] I. V. Ivaniuk, O. V. Ovcharuk, Results of an online survey of teachers' readiness and needs for the use of digital tools and ICT during quarantine: 2021, Analytical materials, Institute of Information Technologies and Learning Tools of the NAES of Ukraine, 2021. URL: https://lib.iitta.gov.ua/724564/.

[7] I. V. Ivaniuk, O. V. Ovcharuk, Results of an online survey of teachers' needs for raising the level of professionalism in digital and ICT use during quarantine, Analytical materials, Institute of Information Technologies and Learning Tools of the NAES of Ukraine, 2020. URL: https://lib.iitta.gov.ua/719908/.

[8] I. V. Ivaniuk, O. V. Ovcharuk, The response of Ukrainian teachers to COVID-19: challenges and needs in the use of digital tools for distance learning, Informational Technologies and Learning Tools 77 (2020) 282–291. doi:10.33407/itlt.v77i3.3952.

[9] O. Ovcharuk, Attitude of Ukrainian educators toward the use of digital tools for teaching and professional development: Survey results, CEUR Workshop Proceedings 2732 (2020) 746–755.

[10] Ukrainskyi vidkrytyi universytet pisliadyplomnoi osvity [Ukrainian Open University of Postgraduate Education], 2021. URL: https://uvu.org.ua.

[11] L. A. Kartashova, A. M. Gurzhii, V. O. Zaichuk, T. M. Sorochan, F. M. Zhuravlev, Digital twin of an educational institution: an innovative concept of blended learning, in: S. Semerikov, V. Osadchyi, O. Kuzminska (Eds.), Proceedings of the Symposium on Advances in Educational Technology, AET 2020, University of Educational Management, SciTePress, Kyiv, 2022.

[12] D. Y. Bobyliev, E. V. Vihrova, Problems and prospects of distance learning in teaching fundamental subjects to future mathematics teachers, Journal of Physics: Conference Series 1840 (2021) 012002. doi:10.1088/1742-6596/1840/1/012002.

[13] N. P. Franchuk, T. V. Prydacha, Organization and conduct of classes in educational institutions during distance learning, Journal of Physics: Conference Series 1840 (2021) 012054. doi:10.1088/1742-6596/1840/1/012054.

[14] L. H. Havrilova, O. Y. Ishutina, V. V. Zamorotska, D. A. Kassim, Distance learning courses in developing future music teachers' instrumental performance competence, CEUR Workshop Proceedings 2433 (2019) 429–442.

[15] V. Kukharenko, T. Oleinik, Open distance learning for teachers, CEUR Workshop Proceedings 2393 (2019) 156–169.

[16] I. S. Mintii, T. A. Vakaliuk, S. M. Ivanova, O. A. Chernysh, S. M. Hryshchenko, S. O. Semerikov, Current state and prospects of distance learning development in Ukraine, CEUR Workshop Proceedings 2898 (2021) 41–55. URL: http://ceur-ws.org/Vol-2898/paper01.pdf.

[17] M. J. Syvyi, O. B. Mazbayev, O. M. Varakuta, N. B. Panteleeva, O. V. Bondarenko, Distance learning as innovation technology of school geographical education, CEUR Workshop Proceedings 2731 (2020) 369–382.

[18] T. A. Vakaliuk, O. M. Spirin, N. M. Lobanchykova, L. A. Martseva, I. V. Novitska, V. V. Kontsedailo, Features of distance learning of cloud technologies for the organization educational process in quarantine, Journal of Physics: Conference Series 1840 (2021) 012051. doi:10.1088/1742-6596/1840/1/012051.

[19] T. L. Hodovaniuk, T. M. Makhometa, I. M. Tiahai, M. O. Medvedieva, S. M. Pryshchepa, A. V. Voznyak, Educational trainings as one of the effective forms of digital competence development of secondary school teachers, in: S. Semerikov, V. Osadchyi, O. Kuzminska (Eds.), Proceedings of the Symposium on Advances in Educational Technology, AET 2020, University of Educational Management, SciTePress, Kyiv, 2022.

[20] O. Kuzminska, M. Mazorchuk, N. Morze, V. Pavlenko, A. Prokhorov, Study of Digital

Competence of the Students and Teachers in Ukraine, Communications in Computer and Information Science 1007 (2019) 148–169. doi:`10.1007/978-3-030-13929-2_8`.

[21] M. V. Moiseienko, N. V. Moiseienko, I. V. Kohut, A. E. Kiv, Digital competence of pedagogical university student: Definition, structure and didactical conditions of ormation, CEUR Workshop Proceedings 2643 (2020) 60–70. URL: http://ceur-ws.org/Vol-2643/paper01.pdf.

[22] N. V. Soroko, Methodology for teachers' digital competence developing through the use of the STEAM-oriented learning environment, CEUR Workshop Proceedings 2732 (2020) 1260–1271.

[23] The Council of the European Union, Council Recommendation of 22 May 2018 on key competences for lifelong learning (Text with EEA relevance), 2018. URL: https://eur-lex. europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018H0604(01)&from=EN.

[24] O. G. Yaroshenko, O. D. Samborska, A. E. Kiv, Experimental verification of efficiency of the formation of information and digital competence of bachelors of primary education based on an integrated approach, in: S. Semerikov, V. Osadchyi, O. Kuzminska (Eds.), Proceedings of the Symposium on Advances in Educational Technology, AET 2020, University of Educational Management, SciTePress, Kyiv, 2022.

[25] O. Ovcharuk, I. Ivaniuk, N. Soroko, O. Gritsenchuk, O. Kravchyna, The use of digital learning tools in the teachers' professional activities to ensure sustainable development and democratization of education in European countries, E3S Web of Conferences 166 (2020) 10019. doi:`10.1051/e3sconf/202016610019`.

[26] O. Ovcharuk, O. Hrytsenchuk, Digital tools for creating and maintaining educational environment for democratic citizenship in european countries, Computer in school and family 158 (2020) 52–56.

[27] O. O. Hrytsenchuk, Information and educational learning environment as a tool of developing teachers' civic competence in the Netherlands, Ph.D. thesis, Institute of Information Technologies and Learning tools of NAES of Ukraine, Kyiv, Ukraine, 2020.

[28] A. Gurzhii, L. Kartashova, V. Lapinsky, New ukrainian school: digital resources as a necessary factor in maintaining continuity of education, in: Modern Achievements in Science and Education. XII International Conference, Netanya, Israel, 2018, pp. 195–199.

[29] L. Kartashova, N. Bakhmat, I. Plish, Development of teacher's digital competency in terms of information and educational environment of a secondary education establishment, Informational Technologies and Learning Tools 68 (2018) 193–205. doi:`10.33407/itlt.v68i6.2543`.

[30] L. Kartashova, M. Kyrychenko, T. Sorochan, Crisis management in the in-service training, Herald of the National Academy of Educational Sciences of Ukraine 2 (2020). doi:`10.37472/2707-305X-2020-2-1-7-9`.

[31] L. Petrenko, S. Kravets, O. Bazeliuk, L. Maiboroda, I. Muzyka, Analysis of the current state of distance learning in the vocational education and training institutions, E3S Web of Conferences 166 (2020) 10010. doi:`10.1051/e3sconf/202016610010`.

[32] S. V. Shokaliuk, Y. Y. Bohunenko, I. V. Lovianova, M. P. Shyshkina, Technologies of distance learning for programming basics on the principles of integrated development of key competences, CEUR Workshop Proceedings 2643 (2020) 548–562.

[33] O. M. Spirin, K. R. Kolos, O. A. Kovalchuk, O. O. Demianchuk, F. M. Zhuravlev, Build a technology for mass organization of distance learning for pupils in quarantine, in: S. Se-

merikov, V. Osadchyi, O. Kuzminska (Eds.), Proceedings of the Symposium on Advances in Educational Technology, AET 2020, University of Educational Management, SciTePress, Kyiv, 2022.

[34] 3D democracy: thinking, care, acting, 2021. URL: https://citizen.in.ua.

[35] PISA in Focus. Were the schools equipped, ready to study remotely? Programme for International Student Assessment, 2020. URL: http://pisa.testportal.gov.ua/wp-content/uploads/2020/11/PISA_in_Focus108-ukr_gotove.pdf.

[36] Open Access. Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities, 2003. URL: https://openaccess.mpg.de/Berlin-Declaration.

[37] UNESCO, Steering AI and Advanced ICTs for Knowledge Societies, 2019. URL: https://en.unesco.org/system/files/unesco-steering_ai_for_knowledge_societies.pdf.

[38] UNESCO, Fighting COVID-19 through digital innovation and transformation, 2020. URL: https://en.unesco.org/covid19/communicationinformationresponse/digitalinnovation.

[39] UNESCO, Distance learning solutions, 2021. URL: https://en.unesco.org/covid19/educationresponse/solutions.