

# The practical experience of the use of digital learning resources by Ukrainian teachers to ensure the sustainable development and democratization of education process

Oksana V. Ovcharuk, Iryna V. Ivaniuk, Oleksandr Yu. Burov, Maiia V. Marienko, Nataliia V. Soroko, Olena O. Gritsenchuk and Oksana Y. Kravchyna

*Institute of Information Technologies and Learning Tools of the NAES of Ukraine, 9 M. Berlynskoho Str., Kyiv, 04060, Ukraine*

## **Abstract**

The article deals with the revealing and analysis of the practical experience of the Ukrainian teachers' use of the digital resources in the classroom activities with pupils. The online instruments and digital resources for the realisation of STEM-education, Education for Democratic Citizenship, and Entrepreneurship Education are presented in the article. The national online resources revealed in the article ensure the creation of the sustainable, multicultural, and democratic environment for teachers and students including key competencies areas: entrepreneurship, citizenship, civic education and STEM. The presented digital learning tools reveal the results of the teachers' works on the implementation of the key subject areas through ICT and allow to creative use of digital technologies, identify teachers' and pupil' needs and finding didactic approaches, solve technical problems, identifying gaps in digital and civic competencies. Using the analysed resources teachers become aware of the need to improve and update their own digital competence and pupils' digital competence as well; ability to support the creative and sustain digital environment in their schools; search for opportunities for self-development and awareness of digital evolution that is proclaimed by the UN '2030 Agenda for Sustainable Development' adopted in 2015; the need to raise awareness how to organise distance learning in the conditions caused by COVID-19 pandemic. The objective is to present the examples and the experience of the use of digital educational resources by Ukrainian educators, which are aimed at building the digital environment, developing the key competencies: digital civic and entrepreneurship according to the European tendencies. The presented experience can be applied in the schools and improve the existing gaps in the teachers' use of digital learning tools.

## **Keywords**

digital learning resources, sustainable development, education process, teachers, democratization, digital competence

# 1. Introduction

An urgent issue for educators all-over the world and in particular in Ukraine is the implementation of training in the context of the COVID-19 pandemic, which has led to a change of approaches to finding effective ways on how to organize the educational process in schools [1, 2, 3, 4]. Digital technologies that provide access to educational resources and forms of distance learning have come to the fore [5, 6, 7, 8, 9]. Ensuring the sustainable development of education in the framework of modern educational reforms remains as an important task of the Ukrainian state [10, 11]. This task is of particular importance in the context of the European integration processes taking place in education, as well as in the context of democratization of society, and revision of the methods and content of education [12]. A number of international education organizations have issued the responses to COVID-19, calling on governments and educators to join forces to improve the distance learning process, given the educational opportunities available in different countries. The issues of digital literacy, digital competence of teachers and pupils have acquired a special role in this process [13, 14]. These issues are important areas in which such international organizations as the Council of Europe, UNESCO, OECD and others are engaged. Thus the ICTs as a tool can be used by teacher, who plays an important role in these processes. The modern teacher has to follow the best European teaching practices, and in the same time to keep up with the innovations that are implemented not only in Europe but also in his own country.


Sustainable Development Goals (SDGs) are outlined in the document ‘Transforming our world: the 2030 Agenda for Sustainable Development’ adopted by the General Assembly of the United Nations stated in 2015 [15]. This resolution identified 17 Sustainable Development Goals including education. Goal 4 is to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

The purpose of the article is to present the current experience of the use of digital learning resources by Ukrainian teachers aimed at the promoting the development of digital competencies of their pupils as well as ensuring the democratization of learning process in the schools from SDGs perspective, and to reveal the approaches to the development of the sustainable, democratic, multicultural digital environment in the educational institutions. The research

---

*AET 2020: Symposium on Advances in Educational Technology, November 12-13, 2020, Kyiv, Ukraine*

✉ oks.ovch@hotmail.com (O. V. Ovcharuk); irinaivanyuk72@gmail.com (I. V. Ivaniuk); burov.alexander@gmail.com (O. Yu. Burov); popelmaya@gmail.com (M. V. Marienko); nvsoroko@gmail.com (N. V. Soroko); helenakyiv2017@ukr.net (O. O. Gritsenchuk); oxi-krav@ukr.net (O. Y. Kravchyna)  
🌐 <https://iitlt.gov.ua/eng/structure/departments/komparaktiv/detail.php?ID=300> (O. V. Ovcharuk); <https://iitlt.gov.ua/eng/structure/departments/komparaktiv/detail.php?ID=304> (I. V. Ivaniuk); <https://iitlt.gov.ua/eng/structure/departments/technology/detail.php?ID=281> (O. Yu. Burov); <https://iitlt.gov.ua/eng/structure/departments/cloud/detail.php?ID=565> (M. V. Marienko); <https://iitlt.gov.ua/eng/structure/departments/technology/detail.php?ID=301> (N. V. Soroko); <https://iitlt.gov.ua/eng/structure/departments/komparaktiv/detail.php?ID=303> (O. O. Gritsenchuk); <https://iitlt.gov.ua/eng/structure/departments/komparaktiv/detail.php?ID=305> (O. Y. Kravchyna)  
📞 0000-0001-7634-7922 (O. V. Ovcharuk); 0000-0003-2381-785X (I. V. Ivaniuk); 0000-0003-0733-1120 (O. Yu. Burov); 00000-0002-8087-962X (M. V. Marienko); 0000-0002-9189-6564 (N. V. Soroko); 0000-0003-3173-7649 (O. O. Gritsenchuk); 0000-0002-3903-0835 (O. Y. Kravchyna)

© 2021 Copyright for this paper by its authors.  
Use permitted under Creative Commons License Attribution 4.0 International (CC BY 4.0).  
 CEUR Workshop Proceedings (CEUR-WS.org)

method involved the analysis of the current research and practices including Ukrainian and European experience of the use of digital resources and instruments in teachers' activities as well finding the ways of introducing innovative technology and didactic into their practice.

## **2. Problem statements**

At the beginning of 2020, educational community in many countries was faced a challenge: the World Health Organization (WHO) declared the pandemic COVID-19 and forced quarantine, which caused the restrictions: physical access of pupils and students to educational institutions. International organizations have responded quickly to these challenges and made a number of recommendations, calling on governments to unite their efforts to harness the potential of digital technologies in school education and teacher support. The Organization for Economic Co-operation and Development (OECD) has published the Framework Guidelines for Education's Response to the 2020 COVID-19 Pandemic [16]. Using the example of countries that were members of PISA, international organizations determined that most countries were not ready to organize distance learning.

The SDGs (Goal 4) states that by 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship. Also by 2030, substantially expand globally the number of scholarships for enrolment in higher education, including vocational training and information and communications technology, technical, engineering and scientific programmes [17]. The development of pupils' digital competence is considered, today, as an integral part of educational process as a whole. The main purpose is to have an educated personality ready to live and to act into the democratic, multicultural and information society who has the necessary abilities, knowledge, skills and information culture. Attention of the teachers should be paid to the acquisition by pupils of digital skills and digital competence. The main components of digital competence include the following components: technical problem solving – the ability to identify technical problems in the operation of devices and the use of digital environments, to be able to solve them; identifying needs and finding technological answers based on needs analysis, the ability to identify, evaluate, select, use digital tools; customize digital environments and creative use of digital technologies: ability to use digital tools and technologies to create knowledge, innovative processes and products; take part individually and collectively in cognitive activities to understand and solve conceptual problems; identifying gaps in digital competence: the ability to recognize the need to improve or update one's digital competence; the ability to support others in the development of their digital competence; look for opportunities for self-development and be aware of modern digital evolution [18].

Modern challenges of the society requires from teachers to act in the multicultural digital environment, be prepared to propose their pupils innovative ways of learning, communication, and investigation that will allow to form not only their digital skills but also prepare them to the labour market, entrepreneurship and citizenship.

The issues of development of digital literacy and competence of pupils as well as the use of information and communication technologies by teachers are revealed in the works of Ukrainian researchers: Binytska et al. [19], Burov et al. [20], Bykov and Lapinsky [21], Kanivets et al.

[22], Morze and Kucherovska [23], Morze and Strutynska [24, 25], Morze et al. [26, 27], Oleksiuk et al. [28], Osadcha et al. [29], Osadchyi et al. [30], Ovcharuk [31], Ovcharuk et al. [32], Semerikov et al. [33, 34, 35, 36, 37, 38, 39, 40], Shyshkina [41], Shyshkina and Marienko [42, 43], Shyshkina and Kohut [44], Shyshkina et al. [45], Soroko [46], Soroko et al. [47, 48], Spirin et al. [49, 50], Spivakovsky et al. [51, 51], Symonenko et al. [52], Vakaliuk et al. [53], Zhaldak and Franchuk [54], Zhaldak et al. [55] and others.

The article is aimed at the presentation of the diverse digital resources that Ukrainian teachers use to ensure the development of the key competencies: digital, civic and entrepreneurial as well as to reveal on how teachers support the sustainable and democratic environment in their schools using ICTs. The study of these tools by the authors led to the proposals for the Ukrainian teachers on the improvement of the existing digital educational environment regarding the challenges of the quarantine in 2020–2021 school years.

### 3. Results

The Council of Europe is one of the international organizations that quickly responded to the COVID-19 pandemic and to the situation with the quarantine in schools in the European countries, and proposed to support digital citizenship through the creation and the support of the digital environment in schools and other educational institutions. As was noted in the CoE Multi-Stakeholder Consultation Report [56], the educational professionals should determine the administrative and legal responsibilities of school principals, teachers, students and parents; make efforts to involve parents in initiatives of pupils and schools on digital citizenship; develop and publish lesson plans and illustrative opportunities for learning digital citizenship and create a database of the most interesting online resources; identify opportunities for the development of this area, its teaching and instilling values, views, skills, knowledge and critical understanding of the digital and real world to their pupils [57].

To ensure the development of the democratic digital environment in the classroom the teacher should first of all take into the account the multicultural composition of the pupils. This makes it possible to include in the curriculum different discourses on the interpretation of history and geography according to a specific cultural context, mutually enriches pupils by exchanging knowledge, experiences, values belonging to different cultures, allows to use the cognitive preferences of bilingual children. The documents of the Council of Europe, the EU, the UNESCO, the UN recognize Multicultural Education as a fundamental principle that guides teachers and schools of different countries to conduct educational activities with the mutual recognition and interaction of cultures [58].

The Multicultural Education strategy emerged in response to the exacerbation of ethnic, national, and religious conflicts in modern society as a result of significant migration processes between countries in different regions of the world. Multicultural competence and multicultural dimension in education with the use of ICT play a special role in lifelong learning today.

The Ukrainian NGO Association of Teachers of History and Social Studies “Nova Doba” invites teachers to use electronic teaching materials on intercultural interaction and multicultural education: “Common history. Dialogue of Cultures”, “Together on One Earth. History of Ukraine is multicultural”, “New approaches to historical education in a multicultural environment”,

“Common stories for Europe without borders”, “Multicultural history of Ukraine”, “We are among others. Others among us. Forms and methods of multicultural education”, “Religious diversity and intercultural education”, etc.[59]. The most of the indicated resources are designed as manuals and guidelines for teachers ready to be used for different school subjects. In other hand the Multicultural Interdisciplinary Handbook created as part of an international (EU) project with the financial support of the European Commission (Comenius program) proposes a digital modules of a learning course for training future teachers of history and geography, and professional development of working teachers. The developed teaching materials help teachers to immerse themselves in the culture of other people through the study of geography and history, to motivate them to learn the foreign languages. The handbook presented online is written on six languages and can be used by all history and geography teachers interested in developing Multicultural Education in schools [60].

The Ukrainian experience of implementing multicultural education using ICT includes an integrated e-learning course “European Studies” for pupils of the grades 8–12 on a modular basis. Course modules mix elements of multicultural education for use in lessons of geography, history, and economics [61]. The course is developed on the basis of the Concept of the content of education for the European dimension of Ukraine. Teacher’s manual “Media literacy in social studies lessons” provides the use of critical thinking techniques, lesson plans-summaries for teaching courses “History of Ukraine”, “World History”, “Man and the World” using electronic educational resources [62].

The use of ICT helps to preserve pupils’ cultural identity, improves intercultural dialogue between pupils and increases their overall level of academic achievements. A special place in the development of multicultural education is given to online games (multicultural role-playing online game), that reproduce the multicultural model of the world. Distinctive features of these games are: the ability to play at the same time for a number of players from different parts of the world; a variety of virtual worlds games are created using international English and national languages. One of the Ukrainian examples is the game that is widely used by Ukrainian teachers – “Civilization” (<http://gamer-info.com/game/civilization-online/>). In this game the player acts as the leader of a certain civilization (nation). It allows the participants of the game to develop science and culture, establish cities and colonies, create ways and wonders of the world, conduct wage wars and diplomatic negotiations. The game presents seven religions and cultures: Buddhism, Hinduism, Islam, Judaism, Confucianism, Taoism, and Christianity. It exists in the different languages: English, Spanish, French, German, Italian, Chinese, Russian, Japanese, Polish and Finnish.

Such games increase pupils’ language and communicative competence. It should be noted that online games resources should be used wisely by the teacher, focusing on the importance of the fact that some pupils tend to overload their time in favor of computer games. It should also be borne in mind that certain online games can be a threat to students in shaping their behavior in real life. When discussing online games with pupils, the teacher must first determine their attitude to how the game takes place and ask for their assessment of game events, etc. [63].

The multicultural experience of communicating with representatives of other countries and cultures is of great importance for the development of multicultural competence. Therefore, one of the most effective means of forming multicultural competence is the “Culture Assimilator” method [64]. “Cultural Assimilators” is a training tool that includes: a brief description of

situations where there is a problem of cultural adaptation or a problem related to cultural diversity between two interacting representatives of different cultures. Assimilator proposes four options for interpreting the behavior of the acting characters and explanations for each interpretation that involve discussing and determining the most appropriate answer. The methods' goal is to teach a person to consider different situations from the perspective of members of another's cultural group, to understand their vision of the world. The tasks of the cultural assimilator are the following: the acquisition of isomorphic attributions as the ways of interpretation of human behavior by representatives of other cultures; the experience of their emotional reactions in the circumstances of interethnic interactions and their correction; the formation of the tolerant behavior in a multicultural environment.

Another interesting experience is the practice of implementing STEM education and creating a digital learning environment for pupils. The Concept for the Development of STEM education adopted in 2017 proclaims the implementation of STEM at all levels of education, in establishing partnerships with employers and research institutions and their involvement in the development of this education. The training methods and training programs of STEM education are aimed at the development of competencies relevant to the labor market: critical, engineering and algorithmic thinking, skills of information processing and data analysis, digital literacy, creative qualities and innovation, communication skills etc. [65]

Lozova et al. [66] analyze the issue of creating a STEM environment in schools. They draw attention that electronic educational resources of such an environment have to meet the requirements of the intellectual and technological capacities of the pupils and should provide them by the modern integrated knowledge; to promote self-development of the individuality, to support the realization of his/her creative potential.

Stroud and Baines [67] believe that to create a STEAM-oriented educational environment of the school, the electronic platform has to meet the requirements of all participants in the learning process, namely:

- the platform should provide tools for the teacher: modeling of educational STEAM-projects, creation of joint with pupils and other participants of educational process communication, support evaluation of pupils' activities in the project, creation of archive of educational projects and their results;
- the platform should provide for the pupil: feedback from teachers and other professionals involved in the educational project, free access to educational and scientific materials necessary for the project, communication with other pupils and teachers who are part of the group, tools, that can help to obtain data and test designs, models, game resources to motivate pupils to learn, virtual laboratories, etc.;
- the unregistered user should be provided by the access to open educational and scientific resources, news and announcements of STEAM-projects, instructions for using tools, including ICT, for the implementation of STEAM-projects.

Among the electronic educational resources of Ukraine that influence the active development of STEAM education are the following: the Ukrainian project "Quality of education" with the "Web-STEM-school-2020" created by Ukrainian teachers; Distance Academy (<https://osnova.d-academy.com.ua/?s=STEM>), that proposes the distance courses and webinars; web portal



“Na urok” (<https://naurok.com.ua/>), proposing the distance education by the different school disciplines; virtual STEM Center of Junior Academy of Sciences of Ukraine (<https://stemua.science>) that offers plans and guidelines for research work for the STEM disciplines.

It should be noted that the Ukrainian teachers use such international electronic educational resources for the support and development of STEAM-oriented educational environment of the school, as: Simulate the Natural World with Virtual Biology Lab (<http://virtualbiologylab.org/>) which includes Ecology Models, Evolution Models, Cell Biology Models; Experience a Virtual World of Science Education (<https://praxilabs.com/>) which includes a number of interactive 3D virtual lab simulations in Biology, Chemistry and Physics; Phet (<https://phet.colorado.edu/>) which includes 806 million simulations in Physics, Chemistry, Biology, Mathematics, Earth Science; workshop for teachers for their skills development to discover and reflect on the learning benefits of playing with simulations through open play and reflection time; Physics Simulations (<https://www.myphysicslab.com/>), that provides open source software under the Apache 2.0 License; there are around 50 different simulations in the source code, each of which has an example file which is mainly for development and testing; Go-Lab Platform (<https://www.golabz.eu/>), which consists of the Go-Lab Sharing and Support platform (Golabz) and the Authoring and Learning platform (Graasp); there are around 240 teacher training events, 1800 Classroom implementations, 19152 Teachers creating spaces (20 of them are in Ukrainian language) [68].

It is important that these environments take into account the following user requirements: providing a virtual lab that allows project participants to conduct scientific experiments in the online environment; remotely controlled laboratories (remote laboratories) that allow experimenting with real equipment at a distance; virtual laboratories that simulate scientific equipment; data sets representing information from already conducted laboratory experiments [69, 70, 71, 72, 73, 74, 75]. The laboratories on the platforms can be combined with special programs to create conditions for other educational projects.

Regarding the actual requirements of STEM education the Ukrainian practitioners propose the online course for teachers “Creation and use the STEAM-oriented learning environment for the teachers’ digital competence development” which includes three modules: Module 1 “The STEAM-oriented learning environment for the school”, which includes the following topics: theoretical principles of creation and use the STEAM oriented learning environment for the school; creation and use strategies STEAM oriented learning environment for the school; Module 2 “Use of information and communication technologies to organize and support the STEAM approach in school”, which includes the following topics: e-Learning resources as the means of teacher’s digital competency developing to support STEAM oriented learning environment for school; electronic platform for organizing STEAM oriented learning environment for school; Module 3 “Electronic learning resources on self-assessment and evaluation of teachers’ digital competence to support the STEAM oriented learning environment for the school”, which includes topics such as requirements for assessing a teacher’s [68]. The overarching goal of this course is to develop teachers’ information and digital competence, in particular, to help them to learn new information and communication technologies and to improve the quality of their teaching activities.

One of the successful Ukrainian online projects that allows to create a digital environment for pupils is the “3D Democracy” Project supported by the non governmental organization

“Nova Doba”. There are few educational environments that aim to build civic competence of pupils and teachers. The NGO “Nova Doba” is the All-Ukrainian Association of Teachers of History and Social Sciences. This organisation proposes the “3D Democracy”, “Citizen’s Workshop” online environments <https://citizen.in.ua/about.php>. The 3D Democracy online resource aims to support teachers who teach civic education or implement its elements into the school subjects. It allows to involve pupils into the online community where they can master their civic competencies. In particular “3D Democracy” contains the following resources: “Teacher online” – is a community of civic education teachers united in a virtual educational environment; “School block” contains information about the institution that has joined the network, provides information about the educational institution on the map of Ukraine, posted on the site; “Journal of pupil achievements” that allows to provide activity of each registered pupil and to make records in the “electronic class journal” (by topics and sections); “Current information” that contains methodological materials, information about webinars, training seminars, conferences for teachers, etc.

Among the opportunities for the pupils that this resource proposes are: the online textbook / manual on civic education (texts, videos, life cases); online community for participants from different regions of Ukraine; simulations, games, polls, petitions, elections, flash mobs (on civic topics); personal offices of pupils’ portfolio of civic activities; joint blogs, forums, discussions; the assessment through automatic recording of pupils’ achievements (fixing student activity on each topic, a three-pronged competency approach to final the assessment of student works in each section: online testing, situation analysis, practical tasks (essays), and student motivation scale (through automatic scoring) for involvement in the activities of the “Community”. Participants will receive information about the beginning of each activity and its results through: news on the site, e-mail or SMS [59].

The Citizen Workshop resource offers tools and steps to engage with the online community. The steps to access the Citizen Workshop resource (“Community” block) are:

- step 1: teacher’s registration; teacher is registered as “pedagogue” at the website; teacher receives a password to access the site, in particular to the sections “Teacher’s” and “Journal of Pupil’s Achievement”, etc. The site administrator creates a “School Block” on the site;
- step 2: pupils’ registration; teacher invites pupils from his / her class (s) to register. Each pupil registers on the site; pupil receives the user’s personal account, password to access it;
- step 3: common activity; working with materials, watching videos, life cases, simulations, games, polls, petitions, elections, flash mobs and new friends for pupils. Methodical materials, webinars, forums, discussions, experiences and new friends for teachers; For students and teachers: additional information, new friends, practical skills and first positive experiences in the field of civic activity / civic education.

The Ukrainian educational platform “Living in Democracy” is supported by the international organizations and proposes the resources of the Council of Europe teaching materials <http://www.living-democracy.com.ua>. It is launched as a part of the joint Swiss-Ukrainian project “Development of Civic Competences in Ukraine - DOCCU” with the assistance of the Government of the Swiss Confederation, and it offers the Council of Europe resources for



education for democratic citizenship, tools for the lessons and activities on democracy, human rights and civic participation.

The platform contains educational materials, legal documents, videos, illustrated cards on children's rights, a number of textbooks of the Council of Europe in Ukrainian language including: "Teaching Democracy", "Growing in Democracy", "Living in democracy", "Taking part into democracy", "Exploring children's rights" and "Teaching democracy". Pupils, parents, teachers and school leaders can find useful information on NGO issues. They can learn, develop and improve their knowledge and civic competencies.

The DOCCU online platform presents the Swiss-Ukrainian project supported by the Government of the Swiss Confederation. It envisages the implementation of three main and cross-cutting components: Component 1 "Civil Servants". Introduction of EDC / HRE at the national level in the system of training of civil servants and representatives of local self-government bodies of Ukraine; Component 2 "School Leaders" (school principals). Introduction of Education for Democratic Citizenship and Human Rights education (EDC/HRE) in the system of postgraduate education of school principals in Kyiv, Odesa, Kherson, Poltava, Lviv, Luhansk, Ivano-Frankivsk and Dnipropetrovsk regions; Component 3 "Teachers". Introduction of EDC / HRE in the system of postgraduate teacher education in Kyiv, Odesa, Kherson, Poltava, Lviv, Luhansk, Ivano-Frankivsk and Dnipropetrovsk regions. The DOCCU online platform proposes to the wide educational community manuals and online educational resources (video, posters) than can be used in a daily school activity.

The above mentioned examples of Ukrainian projects that use digital resources and tools serve to the teachers and to the schools as a resource of interesting interactive manuals, teaching materials, tasks for students on various topics (media, human rights, economics, socio-cultural environment, cultural diversity, identity and etc.). These digital instruments are in great demand among teachers and schools: thus, as of August 2020, the 3D Democracy community has 5,035 users, of which about 1,500 are teachers. Such indicators prove the popularity and interest of teachers in digital resource support for civic education nowadays.

In order to ensure the effective use of the STEM instruments in school practices with the pupils the professional development of teachers has to be in the scope of the education policy in Ukraine. In the same time, the international good practices can be used by the Ukrainian pedagogues to improve and to deep the knowledge in the sphere of STEM education. Thus, we have to point the attention on the Massive Open Online Courses (MOOCs) that have being actively introduced in 2008 [76, 77].

The European Schoolnet Academy proposes a free MOOCs that includes theoretical material in the form of texts and video lectures, webinars, videos of teachers of European countries with stories and lessons to share their professional experience, instructions for the practical use of ICT in the professional activity in the classroom, their communication on social networks through course questions and professional solutions, tests for each module of the course and the end result, such as a lesson plan or other ICT training course.

Participation in these courses and analysis of the tasks and topics during 2017–2019 years gave us the opportunity to highlight the following important problems regarding the modernization of the educational process by the teacher according to inquiry-based pedagogy:

- to provide career information to motivate pupils and present a variety of STEAM and ICT-

related jobs and required skills (“Teaching ICT with Inquiry”; “The Networked Teacher – Teaching in the 21st Century”; “Games in Schools”; “Personalised Learning in Practice – are my students driving their own learning?”; “Yes I can” – Empowering Student Learning”; “TeachUP Course: Collaborative Learning in Practice – are my students learning through collaboration?”);

- to become familiar with innovative tools and approaches such as visual programming tools, unplugged activities, robotics, tinkering, and making and coding for all subjects Ukrainian teachers can join to: “EU Code Week - Deep Dive MOOC”; “The Networked Teacher – Teaching in the 21st Century”; “Games in Schools”; “Yes I can” – Empowering Student Learning”; “TeachUP Course: Collaborative Learning in Practice – are my students learning through collaboration?”; “Boosting Bioeconomy Knowledge in Schools”; “Social Media Literacy for Change”;
- to learn about active learning, innovative use of ICT and collaborative teaching and learning teachers can join to: “Teaching ICT with Inquiry”; “EU Code Week - Deep Dive MOOC”; “The Networked Teacher – Teaching in the 21st Century”; “Games in Schools”; “Yes I can” – Empowering Student Learning”; “TeachUP Course: Collaborative Learning in Practice – are my students learning through collaboration?”; “Boosting Bioeconomy Knowledge in Schools”; “Social Media Literacy for Change”; “Become the Next eSafety Champion”.

These courses provide suggestions on how to improve the effectiveness of teaching process in the schools, give advice on how to use the thematic portals and sites, training programs, computer games, etc.

For example, “The Teaching ICT with Inquiry” course allows to use the Go-Lab ecosystem <https://www.golabz.eu/> to enhance:

- students to conduct experiments in on-line laboratories in STEM fields, to participate in educational projects, in the implementation of which they need to use knowledge, skills and competences in the natural sciences, technologies, engineering, various fields of arts and mathematics;
- teachers to create and select didactic materials for teaching their subjects using the STEM approach, to share their pedagogical experience with colleagues from different countries of the world, etc.

Go-Lab ecosystem was launched since 2014. The Go-Lab initiative was created thanks to the successful Go-Lab project, which lasted from November 2012 to October 2016. The goal of the Go-Lab Initiative is to promote the use of online labs and applications for teaching and implementing research projects in schools. The Go-Lab Initiative provides a Go-Lab ecosystem for teachers where they can find various online labs and create their own learning spaces. The Go-Lab Initiative provides training for teachers across Europe on science education in schools and the explains how to use of the Go-Lab ecosystem. The Go-Lab initiative is currently funded by the Next-Lab project. The modern Go-Lab ecosystem consists of two main components. Go-Lab is a Sharing platform that provides hundreds of remote and virtual labs, as well as software and applications for query study. The Go-Lab platform enables teachers to create their

own learning environments, combining labs, applications, and other resources for sharing with their pupils.

What is important about MOOCs, is that the final result of each of these courses should be a personal training event developed by the course participant, such as a training project using the tools offered by the online course. This result is evaluated using the peer-to-peer method.

It should be noted that the content of the courses is renewed every year, namely:

- new topics (eg, the use of computer games to teach and teach different disciplines, training according to the needs of society, the use of new tools for monitoring, control and self-assessment of knowledge, skills and abilities of students and teachers);
- new tools for improve forms of learning (eg, the use of new electronic platforms for STEAM projects in formal, non-formal, informal and inclusive learning; creation of computer-oriented environments, etc.);
- new lessons learned from teachers' experiences in implementing STEAM education in the schools (eg, teaching STEAM projects, lessons on specific topics in STEAM fields, STEAM weeks, etc. using ICT);
- updated country reports on the use of ICT in support of STEAM education and analysis of the results of implementation of the STEAM approach in the schools (eg, Science education now: a renewed pedagogy for the future of Europe: <https://ec.europa.eu/research/science-society/documentlibrary/pdf06/report-rocard-on-science-educationen.pdf>);
- new ideas are being generated to implement the STEAM approach in general education institutions (eg, to create websites that offer weeks of STEAM education in schools around the world: <https://www.science-on-stage.eu/page/display/5/28/13343/coding-in-stem-education>).

The entrepreneurial education is one of the important issue of the sustainable development and democratisation of education process. The vital importance of the development of entrepreneurial competence is defined in the main basic educational documents of Ukraine. The Law "On Education" proclaims entrepreneurial competence and financial literacy as the key competencies for modern citizens [78].

In 2016 the government of Ukraine approved the Concept for the implementation of state policy in the field of reforming general secondary education "New Ukrainian School" until 2029, which states that one of the areas of education reform is to create a modern educational environment that will provide the necessary conditions, tools and technologies for teaching pupils, teachers and parents [79]. According to this reform, a graduate of a new Ukrainian school must be an innovator, able to change the world around him and develop the economy on the principles of sustainable development, compete in the labor market, learn throughout life. Among the key competencies are the information and digital competencies, entrepreneurship and financial literacy, leading a healthy lifestyle [80].

In September 2020, the State Standard for Basic Secondary Education was adopted, which includes key competencies (entrepreneurship and financial literacy), which include initiative, the ability to use opportunities and implement ideas, and create value for others in all spheres of life; ability to actively participate in society, manage their own lives and careers; ability to solve problems; willingness to take responsibility for decision making processes; ability to work in a team to plan and implement projects that have cultural, social or financial value, etc.[81].

The work of Ukrainian scientists is devoted to the problem of formation of entrepreneurial competence of students as a key competence. Thus, Hilberg [82] believes that entrepreneurship is a person's ability to implement ideas, which involves creativity, the desire for innovation and the ability to take risks, as well as the ability to plan activities and implement them in life. Liskovych [83] defines the entrepreneurial competence of the pupil as a structured set of personal qualities that provide effective problem solutions in various spheres of life related to their own social status and well-being, as well as the development of society and the state as a whole. According to Ovcharuk [84], one of the main characteristics of entrepreneurial competence is transverse, cross-cutting nature and flexibility. The researcher also considers it extremely importance in using and implementation of active methods and ICT in the educational process, to involve representatives of the local community and business, entrepreneurs who have experience and are ready to share it with pupils [84]. In the study of entrepreneurship education Nazarenko [85] proposes to use game technologies that will allow students to try the role of experts in a given situation or the role of an entrepreneur, whose functions include: planning economic activities, creating a business plan, planning marketing and advertising, funds analysis at the firm and running business. Dovgan and Chasnikova [86] deal with the issues of integration of entrepreneurial competence into secondary education curricula. The researches noted that the introduction of a cross-cutting content line "entrepreneurship and financial literacy" is facilitated by such factors as: the use of interactive teaching methods (simulation of life situation in lessons), excursions (bank, enterprise, firm, etc.), project activities (application of knowledge in practice), teamwork, the ability to present pupils' works, analyze information and draw conclusions, etc.), appeal to the experience of pupils [86].

To identify key competencies in the curriculum, the concept of "cross-cutting lines" was introduced. The cross-cutting line "Entrepreneurship and Financial Literacy" aims to educate young people: rationally use funds, plan expenses, save, and implement leadership initiatives, to operate successfully in a technologically fast-changing environment. Programs of the Ministry of Education and Science of Ukraine of this content line for grades 5–9 have been developed. This information is presented on the website of the Institute for Modernization of Educational Content [87].

One of the first educational initiatives on the implementation of entrepreneurship education in Ukraine was the Polish Foreign Assistance Program of the Ministry of Foreign Affairs of the Republic of Poland, the Polish-Ukrainian project "School Academy of Entrepreneurship 3". This project was implemented at the all-Ukrainian level and was aimed at the support of the socio-economic sustainable development of the country introduction of elements of entrepreneurial education in schools. This project is a continuation of the Ukrainian-Polish projects "School Academy of Entrepreneurship" (2012–2013) and "Lessons with an entrepreneurial background" (2014). All information and developments of these projects are freely available on the project website [88]. In particular on the website teachers can find a online guidelines for the organization of integrated lessons with "entrepreneurial background" and sample summaries of such lessons.

The use of ICT in the learning process provides an opportunity to create an effective computer-based learning environment [89, 90, 91]. In Ukraine, there are online resources and online courses that offer education for pupils and teachers on entrepreneurship. Thus, for students of grades 9–11, teachers of Kharkiv Polytechnic Institute together with the platform "For a lesson"

developed a free online course “StartUpCamp: the path to a dream” [92]. With this course, pupils learn the basics of entrepreneurship, they can get the tools for creation of their own project, and start to implement their business ideas, as well as to learn the basics of financial literacy, work in a team to start their own business project. The course consists of 7 sessions and 300 tasks. Learning takes place in the form of online video lessons with the supervision of a teacher. All lessons can be recorded; there is a gamification of the learning process, the pupils can perform interactively and can deliver presentations on their homework. Also there are a lot of interesting materials for different topics: Philosophy of entrepreneurship; Team game; Business pack leaders; We learn to present our idea; Include critical thinking!; Where to get money? and others.

Another useful digital resource is the National Online Digital Literacy Platform “Action. Digital Education” [93]. This platform proposes the educational series “Entrepreneurship for schoolchildren” which consists of 6 modules, and 36 sessions. The first module is devoted to the idea on the topic of “finding ideas”, their samples, testing and implementation. The series aims to make pupils aware of the benefits of doing business and forming the traits and positions needed by each person for successful self-realization in today’s world. In the process of learning they understand how to find the business idea and test it, promote their own product on the market (from advertising to finding customers), learn about what sources of funding exist and how to attract them. Upon completion of the online course the pupils pass the test.

The Ukrainian online education platform Educational Era is a project that aims to make education in Ukraine at a high quality, accessible and available in a global educational context [94]. This platform offers an online courses for high school teachers, secondary and primary school teachers, social educators, school psychologists, youth workers and parents. The online course “With students about education and career” consists of 4 modules, includes videos, interactive tests, lesson plans. Upon its completion, a certificate (8 hours) is issued. During the training, such issues as educational and career counselling are considered, different tools are available for this; as well as the opportunities for future vocational and higher education in Ukraine and abroad, as well as for non-formal education. Participants are offered tools for working with pupils in grades 8–11: lesson plans, additional materials, presentations, and interactive consultation scenarios. Topics of the modules include: advising pupils on self-knowledge, career and educational trajectory; advising on the choice of vocational education; advising on the choice of higher education; advising on non-formal educational opportunities. To obtain a certificate, participants are tested in each of the modules (middle and end), the final online test is based on the results of the presented materials.

The Educational hub of Kyiv is also one of the useful learning resources [95], that offers its users different courses aimed at the development of soft skills, lifelong learning through blended learning, and serves as a platform for participants’ meetings with the famous Ukrainians. Thus, for senior pupils there are the special courses; “Public Speaking”, “Career Guidance for Students” and “Effective Job Search” are offered [95]. The course “Public Speaking” is aimed at the mastering the skills of speaking convincingly, clearly, and competently, as well as to interest the audience and hold its attention. The basic public speaking course for beginner speakers consists of 7 video lessons: about the qualities that the speaker should have, what goal he/she can set for himself, what information he/she should have depending on the type of speech; how to learn to control yourself and overcome the fear of public speaking; why for the speaker body

language – gestures and facial expressions – is no less important than a well-placed voice; what are the details of the speaker’s image, what are the types and archetypes of speakers; what is the real art of public speaking, what role does improvisation, acting skills, language culture play in it; how to build the structure of the speech and what techniques will help to visualize the information to better convey it to the audience; how to conduct a dialogue and discussion with the audience.

The material of each course consists of theoretical information, tests for understanding certain subtleties of public speeches, illustrative examples of successful and unsuccessful speeches. Subsequent classes include questions on the material of the previous ones, and the participant can move forward only after its successful mastering and proper passing of the online test. The course “Career Guidance for Students” is designed to facilitate the choice of profession by high school pupils before entering higher education. The course raises the awareness of the pupils about the benefits of the subjects they study in school and how they will be needed later in their life, namely: civic education, mathematics, language, literature, physics, chemistry, biology and ecology, history, geography, physical education and computer science. The course “Effective job search” teaches modern methods of job search, the rules of writing a good resume, how to choose the right field of activity, company and interview, how to make a good impression on the first working day and more. There are also other platforms for mass open online courses, such as Google Digital Workshop [96], which offer entrepreneurship courses that differ by the number of modules and their duration. A part of the above mentioned courses are for beginners, others are useful even for experienced participants. After hearing some courses it is necessary to pass testing for consolidation of the received knowledge.

From the above mentioned we can conclude that in Ukraine there are opportunities for entrepreneurship education, but there is a lack of the opportunities to create an effective learning environment in school regarding this issue. It remains an important question that needs further development.

Thus, it is necessary to create the most favorable conditions based on the use of ICT to enhance the cognitive activity of children, the development of their intellectual abilities and communication skills necessary for the successful formation of entrepreneurial competence; to create conditions for training teachers in teaching entrepreneurship, providing them with ICT tools and teaching materials, teach them to use existing resources for learning; to develop educational online resources (textbooks, computer programs, games, virtual communities, portals) on entrepreneurship education to support teachers, students and parents; encourage teachers and students to participate in international projects on entrepreneurship education. The use of the achievements and informational resources by Ukrainian teachers allows creating additional opportunities to pupils in the international perspective. This is why the experience of using digital technology by teachers to gain knowledge in business education is interesting. This confirms the creation of European entrepreneurship education resources, such as the Virtual Entrepreneurship Education Handbook, which allows teachers from different countries to familiarize themselves with and use practical tools for primary, secondary and vocational education in their work.

Teachers from European countries are now successfully using the digital teaching hub (<http://content.ee-hub.eu/>). It brings together over 60 best practices in promoting entrepreneurship education in Europe on: national entrepreneurship education policy (Germany, Italy,



Netherlands, Flanders, Denmark, Estonia, Croatia, Sweden, Finland, Macedonia, Norway, Denmark); teacher training (Enterprising School Program, Entrepreneurship360, Entrepreneurship Educators Program 3EP, 100 Mirrors, LIFE2 Project, STEP Model 2); partnerships (Cisco Networking Academy Networking, Combining Entrepreneurial Competence and STEM Industry Partnerships Skills, Accelerating the StartUp Ecosystem, YES – Finnish Regional Ecosystem Strategies to Implement National Strategies, Employee Volunteering – Added Value of Practical Entrepreneurial Programs, etc.); Entrepreneurship education ecosystem (integrates educational institutions of Spain, Serbia, Belgium, United Kingdom, Norway, Germany, Finland); tools (Measurement Tool for Enterprise Education (MTEE), Entre Intention Tool: Measuring Impact at the Individual Level, Entre Intention Tool: Measuring Impact at Individual Level, Entre-Comp: Entrepreneurial Competence Framework, etc.); Financial Education (Interaction between Entrepreneurship and Financial Education, Financial Education Programs from Primary to Secondary Levels, MoneyIQ and MoneyOnline, Financial Education Curricula, Your Finances, Your Future; I Can Manage My Money) and others.

In order to effectively integrate entrepreneurship education into the school education process, modern digital tools are being used to help creation of resources and projects involving representatives from different countries. This digital resource is the Entrepreneurial School (<http://theentrepreneurialschool.eu/>) that is co-financed by the European Commission, which includes 5 key objectives: teachers' continuing professional development and training; establishing quality supporting frameworks to measure best practice and to evaluate impact; development of appropriate support structures and activities; establishing networks between best practices; focusing on the initial education of teachers and the integration in the curriculum etc. The Entrepreneurial School project has trained over 4,000 teachers from 18 countries over the past three years, and has developed a Virtual Guide to Entrepreneurial Learning (<http://www.tesguide.eu/default.aspx>) [87]. Focus groups from Denmark, Finland, Italy, Norway, Poland, Portugal, Slovakia and the United Kingdom worked on this development. The focus groups consists of representatives of various education, business, governmental and non-governmental institutions who are relevant to entrepreneurship education in their countries and play a key role in promoting entrepreneurship education.

#### **4. Conclusions**

The use of the digital educational resources in the classroom activities with pupils is one of the vital issues nowadays. The online instruments and digital resources for the realisation of STEM-education, Education for Democratic Citizenship, and Entrepreneurship Education are not widely presented in the national educational practice today. The above mentioned spheres are the modern trends in the world's educational systems. Ukraine started to adapt the educational standards and meet the requirements of the democratic multicultural society. The Ukrainian online resources presented in the article ensure the creation of the sustainable, multicultural, and democratic environment for teachers and students including key competencies areas: entrepreneurship, citizenship, civic education and STEM.

Moreover the creation of the appropriate educational environment that allows pupils to gain knowledge, skills and competencies for their participation into the democratic society is one of

the important tasks for the educational system in Ukraine. It is also important to use the best experience and educational resources on democratic education, entrepreneurial education and multicultural communication of other countries. Ukrainian pedagogues should pay attention to the following aspects:

- to integrate entrepreneurship education into the school education process. The use of the modern digital educational resources can help teachers to create opportunities for pupils, promote the involvement of pupils to create their own projects and find opportunities;
- to create possibilities for pupils to develop their democratic culture through participation into the decision making process using ICTs. This will allow promoting the development of digital citizenship that is now one of the life realities.

In this view it should be concluded that the use of digital tools, digital resources and media in the classroom is closely linked to the digital competence. This is why the relevant level of the digital competence has to be one of the main targets of the teaching process.

Further research should be carried out in developing approaches, organizational and pedagogical conditions in schools in order to create the learning environment for the sustainable development that can promote to develop digital competence and digital citizenship enhance entrepreneurship education of pupils.

Also, it is important to develop approaches and create the organizational and pedagogical conditions for pupils and teacher to develop their digital competence and digital citizenship, improving the methods and forms of using digital learning tools to create a democratic and sustainable environment in schools.

## References

- [1] S. Semerikov, S. Chukharev, S. Sakhno, A. Striuk, V. Osadchyi, V. Solovieva, T. Vakaliuk, P. Nechypurenko, O. Bondarenko, H. Danylchuk, Our sustainable coronavirus future, E3S Web of Conferences 166 (2020) 00001. doi:10.1051/e3sconf/202016600001.
- [2] O. Burov, A. Kiv, S. Semerikov, A. Striuk, M. Striuk, L. Kolgatina, I. Oliinyk, AREdu 2020 - How augmented reality helps during the coronavirus pandemic, CEUR Workshop Proceedings 2731 (2020) 1–46.
- [3] K. Polhun, T. Kramarenko, M. Maloivan, A. Tomilina, 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 1840 (2021) 012053. doi:10.1088/1742-6596/1840/1/012053.
- [4] V. Tkachuk, Y. Yechkalo, S. Semerikov, M. Kislova, Y. Hladyr, Using Mobile ICT for On-line Learning During COVID-19 Lockdown, in: A. Bollin, V. Ermolayev, H. C. Mayr, M. Nikitchenko, A. Spivakovsky, M. Tkachuk, V. Yakovyna, G. Zholtkevych (Eds.), Information and Communication Technologies in Education, Research, and Industrial Applications, Springer International Publishing, Cham, 2021, pp. 46–67.
- [5] S. Shokaliuk, Y. Bohunenko, I. Lovianova, M. Shyshkina, Technologies of distance learning for programming basics on the principles of integrated development of key competences, CEUR Workshop Proceedings 2643 (2020) 548–562.

- [6] M. Syvyi, O. Mazbayev, O. Varakuta, N. Panteleeva, O. Bondarenko, Distance learning as innovation technology of school geographical education, *CEUR Workshop Proceedings* 2731 (2020) 369–382.
- [7] 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.
- [8] 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>.
- [9] A. I. Abdula, H. A. Baluta, N. P. Kozachenko, D. A. Kassim, F. M. Zhuravlev, The use of Moodle in the teaching of philosophy and distance learning, *CEUR Workshop Proceedings* (2021).
- [10] E. Komarova, T. Starova, Majority values of school biological education in the context of education for sustainable development, *E3S Web of Conferences* 166 (2020) 10029. doi:10.1051/e3sconf/202016610029.
- [11] O. Lavrentieva, V. Pererva, O. Krupskiy, I. Britchenko, S. Shabanov, Issues of shaping the students' professional and terminological competence in science area of expertise in the sustainable development era, *E3S Web of Conferences* 166 (2020) 10031. doi:10.1051/e3sconf/202016610031.
- [12] S. O. Semerikov, I. O. Teplytskyi, V. N. Soloviev, V. A. Hamaniuk, N. S. Ponomareva, O. H. Kolgatin, L. S. Kolgatina, T. V. Byelyavtseva, S. M. Amelina, R. O. Tarasenko, Methodic quest: Reinventing the system, *Journal of Physics: Conference Series* 1840 (2021) 012036. doi:10.1088/1742-6596/1840/1/012036.
- [13] M. Moiseienko, N. Moiseienko, I. Kohut, A. Kiv, Digital competence of pedagogical university student: Definition, structure and didactical conditions of formation, *CEUR Workshop Proceedings* 2643 (2020) 60–70.
- [14] 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, *CEUR Workshop Proceedings* (2021).
- [15] Y. Park, 8 digital life skills all children need – and a plan for teaching them, 2016. URL: <https://www.weforum.org/agenda/2016/09/8-digital-life-skills-all-children-need-and-a-plan-for-teaching-them/>.
- [16] Education responses to covid-19: Embracing digital learning and online collaboration, 2020. URL: [https://oecd.dam-broadcast.com/pm\\_7379\\_120\\_120544-8ksud7oaj2.pdf](https://oecd.dam-broadcast.com/pm_7379_120_120544-8ksud7oaj2.pdf).
- [17] Resolution adopted by the General Assembly on 25 September 2015. Transforming our world: the 2030 Agenda for Sustainable Development, 2015. URL: [https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A\\_RES\\_70\\_1\\_E.pdf](https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_RES_70_1_E.pdf).
- [18] T. Bakka, O. Burim, O. Volosheniuk, R. Yevtushenko, T. Meleshchenko, O. Mokrohuz, Mediahramotnist ta krytychne myslennia na urokakh suspilstvoznavstva (Media literacy in lessons of social sciences), TsVP, AUP, Kyiv, 2016. URL: <https://www.aup.com.ua/mediagramotnist-ta-krytychne-mislen/>.
- [19] K. M. Binytska, O. O. Bilyakovska, O. I. Yankovych, G. V. Buchkivska, O. P. Binytska, V. V. Greskova, I. P. Ocheretna, O. Y. Burov, S. H. Lytvynova, Implicit potential of immer-

- sive technologies implementation in the educational process at the universities: world experience, CEUR Workshop Proceedings (2021).
- [20] O. Burov, V. Bykov, S. Lytvynova, ICT evolution: From single computational tasks to modeling of life, CEUR Workshop Proceedings 2732 (2020) 583–590.
  - [21] V. Bykov, V. Lapinsky, The methodological and methodical basis of the creation and use of electronic educational tools, Computer at school and family (2012) 3–6.
  - [22] O. V. Kanivets, I. M. Kanivets, T. M. Gorda, O. Y. Burov, Development of augmented reality mobile application in physics to study the electric circuit, CEUR Workshop Proceedings (2021).
  - [23] N. V. Morze, V. O. Kucherovska, Ways to design a digital educational environment for K-12 education, CEUR Workshop Proceedings 2879 (2020) 200–211.
  - [24] 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.
  - [25] N. V. Morze, O. V. Strutynska, Model of the competences in educational robotics, CEUR Workshop Proceedings (2021).
  - [26] N. Morze, O. Kuzminska, G. Protsenko, Public information environment of a modern university, CEUR Workshop Proceedings 1000 (2013) 264–272.
  - [27] N. Morze, L. Varchenko-Trotsenko, T. Terletska, E. Smyrnova-Trybulska, Implementation of adaptive learning at higher education institutions by means of Moodle LMS, Journal of Physics: Conference Series 1840 (2021) 012062. doi:10.1088/1742-6596/1840/1/012062.
  - [28] V. P. Oleksiuk, O. R. Oleksiuk, O. M. Spirin, N. R. Balyk, Y. P. Vasylenko, Some experience in maintenance of an academic cloud, CEUR Workshop Proceedings 2879 (2020) 165–178.
  - [29] K. P. Osadcha, V. V. Osadchyi, V. S. Kruglyk, O. M. Spirin, Analysis and summarization of the experience of developing adaptive learning systems in higher education, CEUR Workshop Proceedings (2021).
  - [30] V. Osadchyi, I. Krasheninnik, O. Spirin, S. Koniukhov, T. Diuzhykova, Personalized and adaptive ICT-enhanced learning: A brief review of research from 2010 to 2019, CEUR Workshop Proceedings 2732 (2020) 559–571.
  - [31] 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.
  - [32] 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.
  - [33] S. Semerikov, I. Teplytskyi, Y. Yechkalo, A. Kiv, Computer simulation of neural networks using spreadsheets: The dawn of the age of Camelot, CEUR Workshop Proceedings 2257 (2018) 122–147.
  - [34] S. Semerikov, I. Teplytskyi, Y. Yechkalo, O. Markova, V. Soloviev, A. Kiv, Computer simulation of neural networks using spreadsheets: Dr. Anderson, welcome back, CEUR Workshop Proceedings 2393 (2019) 833–848.
  - [35] S. Semerikov, S. Chukharev, S. Sakhno, A. Striuk, V. Osadchyi, V. Solovieva, T. Vakaliuk, P. Nechypurenko, O. Bondarenko, H. Danylchuk, Our sustainable coronavirus future, E3S

Web of Conferences 166 (2020) 00001. doi:10.1051/e3sconf/202016600001.

- [36] S. Semerikov, A. Striuk, L. Striuk, M. Striuk, H. Shalatska, Sustainability in Software Engineering Education: A case of general professional competencies, E3S Web of Conferences 166 (2020). doi:10.1051/e3sconf/202016610036.
- [37] S. O. Semerikov, M. M. Mintii, I. S. Mintii, Review of the course “Development of Virtual and Augmented Reality Software” for STEM teachers: implementation results and improvement potentials, CEUR Workshop Proceedings 2898 (2021) 159–177. URL: <http://ceur-ws.org/Vol-2898/paper09.pdf>.
- [38] S. O. Semerikov, M. P. Shyshkina, A. M. Striuk, M. I. Striuk, I. S. Mintii, O. O. Kalinichenko, L. S. Kolgatina, M. Y. Karpova, 8th Workshop on Cloud Technologies in Education: Report, CEUR Workshop Proceedings 2879 (2020) 1–69.
- [39] S. Semerikov, V. Pototskyi, K. Slovak, S. Hryshchenko, A. Kiv, Automation of the export data from Open Journal Systems to the Russian Science Citation Index, CEUR Workshop Proceedings 2257 (2018) 215–226.
- [40] S. O. Semerikov, A. M. Striuk, T. A. Vakaliuk, A. V. Morozov, Quantum information technology on the Edge, CEUR Workshop Proceedings 2850 (2021) 1–15. URL: <http://ceur-ws.org/Vol-2850/paper0.pdf>.
- [41] M. Shyshkina, The problems of personnel training for STEM education in the modern innovative learning and research environment, CEUR Workshop Proceedings 2257 (2018) 61–65.
- [42] M. Shyshkina, M. Marienko, Augmented reality as a tool for open science platform by research collaboration in virtual teams, CEUR Workshop Proceedings 2547 (2020) 107–116.
- [43] M. Shyshkina, M. Marienko, The use of the cloud services to support the math teachers training, CEUR Workshop Proceedings 2643 (2020) 690–704.
- [44] M. Shyshkina, U. Kohut, The method of using the maxima system for operations research learning, CEUR Workshop Proceedings 2393 (2019) 81–92.
- [45] M. Shyshkina, U. Kohut, M. Popel, The comparative analysis of the cloud-based learning components delivering access to mathematical software, CEUR Workshop Proceedings 2393 (2019) 93–104.
- [46] N. Soroko, Methodology for teachers’ digital competence developing through the use of the STEAM-oriented learning environment, CEUR Workshop Proceedings 2732 (2020) 1260–1271.
- [47] N. Soroko, L. Mykhailenko, O. Rokoman, V. Zaselskiy, Educational electronic platforms for STEAM-oriented learning environment at general education school, CEUR Workshop Proceedings 2643 (2020) 462–473.
- [48] N. V. Soroko, O. Y. Burov, L. A. Mykhailenko, O. G. Rokoman, V. I. Zaselskiy, Augmented reality for STEAM-oriented learning environment at school, CEUR Workshop Proceedings (2021).
- [49] 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, CEUR Workshop Proceedings (2021).
- [50] O. Spirin, V. Oleksiuk, N. Balyk, S. Lytvynova, S. Sydorenko, The blended methodology of learning computer networks: Cloud-based approach, CEUR Workshop Proceedings 2393 (2019) 68–80.



- [51] A. V. Spivakovsky, L. Y. Petukhova, S. A. Omelchuk, Y. A. Spivakovska, V. V. Kotkova, Y. Y. Yurchuk, The evolution of the information and educational environment in the context of the theory of generational development, CEUR Workshop Proceedings (2021).
- [52] S. Symonenko, V. Osadchy, S. Sysoieva, K. Osadcha, A. Azaryan, Cloud technologies for enhancing communication of IT-professionals, CEUR Workshop Proceedings 2643 (2020) 225–236. URL: <http://ceur-ws.org/Vol-2643/paper12.pdf>.
- [53] 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.
- [54] M. I. Zhaldak, N. P. Franchuk, Some applications of the GRAN1 to analyze two-dimensional continuous probability distributions, Journal of Physics: Conference Series 1946 (2021) 012002. doi:10.1088/1742-6596/1946/1/012002.
- [55] M. I. Zhaldak, V. M. Franchuk, N. P. Franchuk, Some applications of cloud technologies in mathematical calculations, Journal of Physics: Conference Series 1840 (2021) 012001. doi:10.1088/1742-6596/1840/1/012001.
- [56] J. Richardson, E. Milovidov, Digital Citizenship Education, volume 2. Multi-stakeholder consultation report, Council of Europe, Strasbourg, 2017. URL: <https://www.coe.int/en/web/digital-citizenship-education/a-multi-stakeholder-consultation>.
- [57] The Digital Economy and Society Index (DESI), 2021. URL: <https://ec.europa.eu/digital-single-market/desi>.
- [58] A conceptual model, 2019. URL: <https://www.coe.int/en/web/digital-citizenship-education/a-conceptual-model>.
- [59] Association of Teachers of History and Social Studies “Nova Doba”, 2020. URL: <https://www.novadoba.org.ua/biblioteka-ua>.
- [60] F. J. García-Peñalvo, V. Zangrando, A. M. Seoane Pardo, A. García-Holgado, J. Szczecin-ska, J. M. Baldner, A. Consonni, C. Crivellari, Chapter 5. About the use of the DMS in CLIL classes, in: GRIAL (Ed.), Multicultural Interdisciplinary Handbook: Tools for Learning History and Geography in a Multicultural Perspective, Comenius Multilateral Project. 502461-2009-LLP-ES-COMENIUS-CM, Research GRoup in InterAction and eLearning (GRIAL), Instituto de Ciencias de la Educación (IUCE), Salamanca, 2011, pp. 51–71. URL: <https://repositorio.grial.eu/bitstream/grial/172/5/MIH.Chapter5.AboutTheUseOfTheDMSinCLILclasses.pdf>.
- [61] Y. Bytsiura, O. Vasylieva, Y. Komarov, O. Reuta, A. Syrotenko, F. Stepanov, L. Topchii, European studies. Textbook for students of 8-12 grades, Oranta, Kyiv, 2004.
- [62] F. Reimers, A. Schleicher, A framework to guide an education response to the COVID-19 Pandemic of 2020, 2020. URL: [https://read.oecd-ilibrary.org/view/?ref=126\\_126988-t63lxosohs&title=A-framework-to-guide-an-education-response-to-the-Covid-19-Pandemic-of-2020](https://read.oecd-ilibrary.org/view/?ref=126_126988-t63lxosohs&title=A-framework-to-guide-an-education-response-to-the-Covid-19-Pandemic-of-2020).
- [63] I. V. Ivanyuk, Pedagogical experiment on formation of student multicultural competency under conditions of computer-oriented learning environment, Information Technologies and Learning Tools 51 (2016) 43–56. URL: <https://journal.iitta.gov.ua/index.php/itlt/article/view/1368>. doi:10.33407/itlt.v51i1.1368.
- [64] Centre for Learning and Teaching, Teaching international students, 2014. URL:



<https://cpb-eu-w2.wpmucdn.com/blogs.brighton.ac.uk/dist/2/123/files/2014/08/UoB-International-students-24zo46u.pdf>.

- [65] T. Kramarenko, O. Pylypenko, V. Zaselskiy, Prospects of using the augmented reality application in STEM-based Mathematics teaching, *CEUR Workshop Proceedings 2547* (2020) 130–144.
- [66] O. Lozova, S. Horbenko, N. Honcharova, The using of STEM-education resources in conditions of modernization of school education system, *Scientific notes minor Academy of Sciences of Ukraine. Series: Education* (2017) 82–87. URL: [http://man.gov.ua/files/49/Naukovi\\_zapysky\\_MAH\\_10\\_2017.pdf#page=82](http://man.gov.ua/files/49/Naukovi_zapysky_MAH_10_2017.pdf#page=82).
- [67] A. Stroud, L. Baines, *Inquiry, Investigative Processes, Art, and Writing in STEAM*, Springer International Publishing, Cham, 2019, pp. 1–18. doi:10.1007/978-3-030-04003-1\_1.
- [68] N. P. Dementievskaya, Teachers training on the use of interactive computer simulations for inquiry-based learning, *Information Technologies and Learning Tools 80* (2020) 222–242. URL: <https://journal.iitta.gov.ua/index.php/itlt/article/view/3916>. doi:10.33407/itlt.v80i6.3916.
- [69] A. Kiv, O. Merzlykin, Y. Modlo, P. Nechypurenko, I. Topolova, The overview of software for computer simulations in profile physics learning, *CEUR Workshop Proceedings 2433* (2019) 352–362.
- [70] P. Nechypurenko, S. Semerikov, VlabEmbed - the new plugin Moodle for the chemistry education, *CEUR Workshop Proceedings 1844* (2017) 319–326.
- [71] P. Nechypurenko, V. Soloviev, Using ICT as the tools of forming the senior pupils' research competencies in the profile chemistry learning of elective course "Basics of quantitative chemical analysis", *CEUR Workshop Proceedings 2257* (2018) 1–14.
- [72] P. Nechypurenko, T. Selivanova, M. Chernova, Using the cloud-oriented virtual chemical laboratory VLab in teaching the solution of experimental problems in chemistry of 9th grade students, *CEUR Workshop Proceedings 2393* (2019) 968–983.
- [73] P. Nechypurenko, V. Stoliarenko, T. Starova, T. Selivanova, O. Markova, Y. Modlo, E. Shmeltser, Development and implementation of educational resources in chemistry with elements of augmented reality, *CEUR Workshop Proceedings 2547* (2020) 156–167.
- [74] P. Nechypurenko, O. Evangelist, T. Selivanova, Y. Modlo, Virtual chemical laboratories as a tools of supporting the learning research activity of students in chemistry while studying the topic "Solutions", *CEUR Workshop Proceedings 2732* (2020) 984–995.
- [75] P. P. Nechypurenko, T. V. Selivanova, M. P. Chernova, O. O. Evangelist, Y. O. Modlo, V. N. Soloviev, Using the virtual chemical laboratories in teaching the solution of experimental problems in chemistry of 9th grade students while studying the topic "Solutions", *CEUR Workshop Proceedings* (2021).
- [76] K. Carey, Into the future with MOOC's, 2012. URL: <https://www.chronicle.com/article/Into-the-Future-With-MOOCs/134080>.
- [77] Z. S. Seidametova, MOOCs types and course development, *CEUR Workshop Proceedings* (2021).
- [78] Law on Ukraine "On Education", 2017. URL: <https://zakon.rada.gov.ua/laws/show/2145-19>.
- [79] I. A. Kravtsova, A. O. Kravtsova, V. A. Hamaniuk, O. S. Bilozir, A. V. Voznyak, Development of professional competence of primary school teachers of the New Ukrainian School in the aspect of foreign language teaching, *CEUR Workshop Proceedings* (2021).

- [80] O. Elkin, L. Hrynevych, S. kalashnikova, P. Khobzey, I. Kobernyk, V. Kovtunets, O. Makarenko, O. Malakhova, T. Nanayeva, R. Shiyan, H. Usatenko, The New Ukrainian School: conceptual principles of secondary school reform, 2017. URL: <https://mon.gov.ua/storage/app/media/zagalna%20serednya/Book-ENG.pdf>.
- [81] Cabinet of ministries of Ukraine, State standard of basic secondary education, 2020. URL: <https://zakon.rada.gov.ua/laws/show/898-2020-%D0%BF#n16>.
- [82] T. Hilberg, Formation of entrepreneurial competence in the integrated course “I explore the world”, Elementary School (2020) 10–15.
- [83] O. V. Liskovych, The structure and essence of students’ entrepreneurial competence in the context of teaching physics, Problems of methods of physical-mathematical and technological education 2 (2016) 69–72. URL: <https://phm.cuspu.edu.ua/ojs/index.php/NZ-PMFMTO/article/view/1042>.
- [84] O. Ovcharuk, Ntegration of entrepreneurship key competence into education curricula in Ukraine: The way toward democratic school, Bulletin of Kremenchuk Mykhailo Ostrogradsky National University 103 (2017) 82–88. URL: [http://www.kdu.edu.ua/PUBL/statti/2017\\_2\\_82-88\\_2-17-2.pdf](http://www.kdu.edu.ua/PUBL/statti/2017_2_82-88_2-17-2.pdf).
- [85] G. Nazarenko, Formation of entrepreneurial competence of students of secondary schools in accordance with the requirements of new state standards, CHOIPOP, Cherkassy, 2014.
- [86] A. I. Dovgan, O. V. Chasnikova, Implementation of the cross-cutting content line ‘entrepreneurship and financial literacy’ in the curriculum of 5-9 grades, in: Information and methodical collection of the Main Department of Education and Science of the Kyiv Regional State Administration and the Kyiv Regional Institute of Postgraduate Education of Teachers, volume 200, Kyiv Regional State Administration and the Kyiv Regional Institute of Postgraduate Education of Teachers, Department of Education and Science of the Kyiv Regional State Administration, 2017, pp. 79–82.
- [87] The Entrepreneurial School, The virtual guide to entrepreneurial learning, 2013. URL: <http://www.tesguide.eu/default.aspx>.
- [88] School Academy of Entrepreneurship, Lessons with an entrepreneurial background: Training materials, 2014. URL: [http://sae-ukraine.org.ua/ua/resource/uroki\\_z\\_pidpriemnytskim\\_tlom/](http://sae-ukraine.org.ua/ua/resource/uroki_z_pidpriemnytskim_tlom/).
- [89] V. Pererva, O. Lavrentieva, O. Lakomova, O. Zavalniuk, S. Tolmachev, The technique of the use of Virtual Learning Environment in the process of organizing the future teachers’ terminological work by specialty, CEUR Workshop Proceedings 2643 (2020) 321–346.
- [90] K. Vlasenko, O. Chumak, V. Achkan, I. Lovianova, O. Kondratyeva, Personal e-learning environment of a mathematics teacher, Universal Journal of Educational Research 8 (2020) 3527–3535. doi:10.13189/ujer.2020.080828.
- [91] O. H. Kolgatin, L. S. Kolgatina, N. S. Ponomareva, E. O. Shmeltser, A. D. Uchitel, Systematicity of students’ independent work in cloud learning environment of the course “Educational Electronic Resources for Primary School” for the future teachers of primary schools, CEUR Workshop Proceedings (2021).
- [92] Kurs z osnov zapusku vlasnoho startapu “StartUp\_Camp: shliakh do mrii”, dlia uchniv 9-11 klasiv, 2021. URL: <https://naurok.ua/course/landing/start-up>.
- [93] Educational series, 2021. URL: <https://osvita.diia.gov.ua/courses>.
- [94] EdEra, 2020. URL: <https://www.ed-era.com/courses/>.

[95] Educational hub of the city of Kyiv, 2019. URL: <https://eduhub.in.ua/>.

[96] Online courses, 2021. URL: <https://learndigital.withgoogle.com/digitalgarage/courses?difficulty=beginner>.