Developing and using open electronic educational resources in educational activities

V Ye Velychko, S O Omelchenko, I A Khyzhniak and E G Fedorenko
Donbass State Pedagogical University, 19 Henerala Batiuka Str., Sloviansk, 84116, Ukraine
E-mail: vladislav.velichko@gmail.com

Abstract. The article looks into the effective use of open electronic educational resources. The concept of open electronic educational resources is exposed, their structure and key elements are presented, issues of implementation in educational practice are considered. Requirements for open electronic educational resources are defined, tools for designing and platforms for their support and dissemination are identified. The analysis of the existing open electronic educational resources and the experience of their use is conducted. The principles of open electronic resources design based on crowdsourcing are revealed. The stages of creating e-learning resources that meet open Creative Commons licenses on the examples of pre-service teachers’ training are explored. The essence of Creative Commons licenses is reflected. The theoretical and methodological principles of the use of open electronic educational resources in the educational activity of pre-service teachers are considered. There is a direct link between open educational resources and university education.

1. Introduction
Open education, despite its close connection with information and communication technologies, is considered not only in the field of information. The modern ICTs are powerful tools of intensifying the educational process and related organizational processes and activities within the framework of education gaining greater openness and enhancing the unity and coherence of the educational and scientific system. However, informatization and the implementation of new means, tools and materials into the educational process cannot be considered the ultimate goal of open education.

Open education is not also limited to providing free access to a variety of educational materials. Modern educational practice requires tools not only for publication and storage, but also for a sophisticated set of tools for working with different materials according to clearly defined criteria within educational systems, both within and outside the education institutions. In addition to providing free access, users should also be given the opportunity to work collectively with the materials, modify and adapt them to the needs of their own teaching and learning.

2. The results and discussion
The penetration of computer technology into the educational space has led to the creation of new forms of learning activities and electronic content. The development of the global computer network in 1999 enabled the University of Tübingen in Germany to publish video lectures [40]. The Massachusetts Institute of Technology supported the initiative and launched its MIT OpenCourseWare project in 2002. MIT’s reasoning was to “enhance human learning worldwide by the availability of a web of knowledge”
Researchers at MIT were convinced that the availability of open learning materials would be an additional opportunity for students to prepare better for classes and make learning more active. In the same year, 2002, with the support of Hewlett Foundation, the research began on the issue of using information and communication technologies to increase access to quality educational content.

Identifying free access to quality academic content as a strategic international initiative to extend people’s material freedom, Daniel E. Atkins, John Seely Brown and Allen L. Hammond have planned to overcome such problems as: “poverty, limited economic opportunity, inadequate education and access to knowledge, deficient health care, and oppression” [2]. The overriding task is to use ICT to balance the distribution of high quality knowledge and to increase educational opportunities for people, teachers and institutions around the world. A combination of the following components is required to enable access to high quality educational content:

- **sponsorship of high quality open learning content** (funding and promoting of the best samples of high quality open content; setting quality metrics for different forms of educational content);
- **removal of barriers** (focus on web technology; adherence to open standards; multilingual learning content; availability of technological infrastructure);
- **awareness and stimulation of use** (creating networks of developers and users for sharing and collaboration; supporting scientific research on ways of improving efficiency and enhancing evaluation of results).

Liudmyla H. Havrilova’s research [10] raises issues of open access to scientific information in connection with the development of “green” and “golden” ways of science development. In particular, the researcher highlights the important role of social networks for scholars, which also become popular and describe role of Ukrainian and international educational global networks Academia.edu, ResearchGate, iEARN, ResearcherID etc. for scientists.

Today, this initiative is often known as the Open Content Initiative or Open Educational Resources (OER). We will use the term which, in our view, is more successful “Open Educational Resources” or “Open E-Learning Resource”. OER are teaching resources, learning materials, or research resources that are in the public domain or released under an intellectual property license that allow them to be freely used or reassigned to others. Open educational resources include full courses, training materials, modules, textbooks, streaming videos, tests, software, and any other tools, materials, or methods used to support the access to knowledge.

Electronic libraries of books, electronic archives and other scientific and educational resources have become very popular in Ukraine in recent years, and information and communication technologies are widely used in the promotion of scientific knowledge. Electronic research and educational resources open to widespread network access are usually funded by donations. National funding programs are also working in several countries. In particular, such programs are available in the USA, Japan and some European countries. We should note that the budget of each program can be up to several million dollars. Online libraries of books and information resources are very much in demand, but not with a great amount of sponsorship money, such as contextual advertising for the sites of publishing houses or best-seller books. These resources live in accordance with the completely different laws. Their goal is not to make money for their owner, but to accumulate and disseminate information electronically to the interested audience. Electronic book libraries greatly contribute to the preservation of scientific and cultural heritage, the development of literacy and knowledge; they increase the efficiency of work and study, regardless of the social status of those who want to study.

In the current legislation of Ukraine, electronic educational resources are divided into the following types: electronic documents, electronic publications, electronic didactic demonstration materials, information and analytical systems, depository of electronic resources, computer tests, electronic dictionaries, electronic directories, electronic libraries of digital objects, e-tutorials, e-textbooks, e-teaching materials, distance learning courses, and e-labs, including virtual labs [28]. However, the issue of openness of electronic educational resources has received little attention.

The quality of e-learning resources is the equally important factor. The International Standard ISO/IEC 40180:2017 “Information Technology – Quality for Learning, Education and Training –
Fundamentals and Reference Framework” [15] is the basis for describing, comparing, analysing, managing quality and approaches to quality assurance in the sphere of e-learning resources. The standard is a tool for comparing already known approaches and agreeing them on the basis of a common quality model. A key element of the standard is The Quality Reference Framework (QRF) for E-Learning. The QRF combines an elaborated and extensive process model with a descriptive model for the processes. ISO/IEC 40180 harmonizes existing approaches, concepts, specifications, terms, and definitions related to quality for E-Learning, education and training. But, unfortunately, most of the requirements of ISO / IEC 40180 apply only to the quality of development of IT systems for teaching, learning and vocational training. Therefore, we can assert that international standards also do not disclose the concept of quality of OER and do not contain requirements for its provision.

In Ukraine, the quality of electronic educational resources is determined by the following state standards: DSTU 7157:2010 “Information and Documentation. Electronic Publications. The main types and background information”; DSTU 4861:2007 “Information and Documentation. Publications. Background Information”; DSTU 3017-95 “Publications. The main types. Terms”. It should be noted that these regulatory documents contain only general classification information. The most extensive information on the classification of e-learning publications is given in the Order of the Ministry of Education and Science of Ukraine [28], which defines the concept of electronic educational resources (EER), their types, and the order of development and implementation. But, unfortunately, these documents do not contain any requirements for the completion and formation of EER.

According to the functional feature, which determines the value and place of electronic educational resources in the educational process, they can be classified as:

- educational and methodological electronic educational resources (curricula, syllabi of disciplines, developed regarding to the curricula);
- methodological electronic educational resources (guidelines, methodological manuals, guidelines for the study of a specific course and guidance on project work, thematic plans);
- teaching electronic educational resources (electronic textbooks and manuals);
- supervising electronic educational resources (testing programs, banks for supervisory questions and course assignments, and other EER to ensure quality control of knowledge);
- auxiliary electronic educational resources (collections of documents and materials, indexes of scientific and educational literature, scientific publications of teachers, proceeding papers, electronic directories, dictionaries, encyclopedias).

A significant number of different types of e-learning resources also cause a significant number of structural components, which they consist of. The simplest version of electronic educational resources is an electronic version of a printed document. And even in this case, it can only be about the availability of electronic document navigation, the ability to search in the content and formats of electronic document presentation. A more sophisticated version of an e-learning resource, such as an e-learning course, consists of several simpler e-learning resources, including: background information, training tools, testing and monitoring quality of learning material, background information on available tools and resources of the e-learning course etc.

Similar components are distinguished in an electronic textbook – an educational tool that contains a systematic presentation of course materials and meets the requirements of interactivity, integrativity, adaptability, modularity, etc. Nowadays, there is a finite number of such publications for higher education institutions in Ukraine, therefore, according to Inna A. Khyzniak [19], educators should regularly explore the market of electronic textbooks on the sites of Ukrainian publishing houses (“Nova Shkola”, “Atlantic”, “Osnova”, “Ranok” and others), on general and special educational sites (http://www.mon.gov.ua/; http://osvita.ua/, etc.), as well as they should critically assess their quality and master methods of their use.

The issue of determining the form of an e-learning resource presentation that is the most appropriate for the certain category is more complex. The correspondence between the style of activity in solving the practical range of problems encountered during life, and the style of learning, and vice versa is proved by David A. Kolb [22]. Nataliia V. Morze and Olena G. Glazunova discuss the relationship
between learning styles and online course performance in detail [30]. This study identifies the optimal structure of the e-learning course and the presentation of learning resources for the students of IT profession according to their learning style. The formats for the presentation of study materials should be selected taking into account the students’ dominant learning style.

Vladyslav Ye. Velychko defines standards for the development and transfer of digital e-learning from one e-learning course to another [41], analyses available tools based on free software for the design of digital e-learning objects. A study of free software tools used to create e-learning courses makes it possible to conclude that the software products not only allow them to be used in the specified way, but also have every reason and are a powerful and practical arsenal that should be purposefully aimed at the process of system use in the creation of automated systems for the development of e-learning courses [6], [42]. These findings are further supported by existing standards for the exchange of educational facilities and their support for e-learning systems, which testifies to the long-term prospects for the use of EER in education and the modernization of teaching methods.

Olena G. Glazunova et al. describes the similar method for designing sophisticated electronic educational resources by the use of digital learning objects [9]. The result of the process of creating e-learning resources should ensure that each discipline has a certified e-learning course, the resources of which correspond to: substantively – the standards of education on the profile; the form of presentation – the order on electronic training courses, and educational style; methods of use – provide an individual trajectory of learning, using both local and network resources. The process of creating electronic educational resources is based on a systematic, synergistic, personally centred and reflective methodological approaches. To create high-quality electronic educational resources, it is necessary to consider the principles of adaptability, flexibility, modularity, accessibility, and individuality.

The use of electronic educational resources in teaching activities is a complex issue [18]. Firstly, it is necessary to determine the very fact of the need for such application. Determining the effectiveness of the use of e-learning resources in educational activities is possible if at least one of the following indicators is improved:

- enhancing the motivational and emotional side of learning;
- improving the quality of training;
- releasing study time;
- reducing financial costs for training.

In this regard, the readiness of pre-service teachers to use e-learning resources is an important issue [23]. To measure this teacher personal phenomenon, Inna A. Khyzhniak [20] has developed a detailed criterion-level structure that illustrates the relationship between components (motivational-value, cognitive, operational-active, and projective) and levels of readiness to use electronic educational resources in professional activities: intuitive-receptive, reproductive, productive, and research-creative. Exploring the practical aspects of creating electronic educational resources by both students and teachers, Inna A. Khyzhniak [21] notes that the degree of teachers’ motivation is generally sufficient, but the level of their technical skills in creating high-quality electronic learning tools, especially using open source software, is a problematic issue for modern secondary and higher education. However, the linear multimedia PowerPoint presentation is the most commonly used in educational practice, and sometimes it is the only variation [3].

The second issue is the quality of e-learning resources. As it has already been shown, the quality of e-learning resources is a complex issue that needs to be taken into account. Thirdly, there is a need to gain sufficient experience of using e-learning resources in educational activities. Pavlo P. Nechypurenko et al. consider the electronic educational resources to be the basis of the modern educational environment of education institutions [31]. The creation of e-learning resources, which has become widespread in countries with a high level of development of education systems, is a necessary process for education increase. This process is also taking place in Ukraine, but its effectiveness is far from desirable. The target of education informatization in Ukraine [7], which has been relevant for more than 30 years, remains completely unfulfilled, since the system of creation and introduction into the educational practice of electronic educational resources is far from perfect. Simple calculations show that it is almost
impossible to fully commercialize the development and production of electronic educational tools in Ukraine. Hence, it becomes clear that we should return to state-level support for this process and begin the creation of a public e-learning repository.

There are tools for meaningful visualization of educational material [16], [27]. An example of such a visualization is an interactive image or video. An interactive image is understood as a photo, image or video fragment in which there are active areas, the choice of which leads to the corresponding action. For example, following a link, showing a card, an additional text, a photo demonstration, etc. With these images, you can create many interesting projects: interactive biographies, timelines, experimental results, content and history of mathematical and physical formulas, etc. [17], [25]

The benefits of such systems usually lie in a wide range of project types (travel maps, tutorials, posters, interactive diagrams, virtual tours); each project can be created both individually and together with other users of the platform, including teamwork; other users’ library, each project can be copied and then edited; editing projects is possible at any time with a wide range of options. The completed project can be saved online, distributed on social networks, or embedded in HTML into your own blog or site.

Interactive image creation tools include Thinglink (thinglink.com), Glogster EDU (edu.glogster.com), H5P (h5p.org); many other systems can be used for creating tests, crossword puzzles, quizzes, educational games, surveys, etc. [1], [29], [34], [37], [39].

Vladyslav Ye. Velychko’s study examines in detail the tools for developing e-learning courses that include Xerte Online Editor, eXe e-learning XHTML editor and Reload Editor [41].

Founded in 2001, the Creative Commons Initiative is a satellite of the Open E-Learning Resource initiative. The main purpose of the organization is to help to revive the public domain among creative achievements, as the level of copyright for the produced electronic content has repeatedly increased due to the pressure from the media industry. Creative Commons as well as the initiatives for free software and open source are promoting collective goals focused on community and based on the principles of crowd sourcing. Creative Commons has developed a Web application that helps people provide their creative work with public license or partly retain copyright while licensing them as free for certain uses under certain conditions. Unlike the General Public License, Creative Commons licenses are intended not for software, but for other types of creative work: websites, music, movies and videos, photos, literary works, training courses, and more. The purpose is not only to increase the amount of open content on the Internet, but also to make access to materials free and easy. Regarding to this, metadata has been developed. They can be used by search engines and other online applications for searching photos that are free of charge when the original photographer is mentioned, or songs that can be copied, distributed or downloaded without any restrictions.

Today there is a considerable range of e-learning resources available for information supporting, functioning and developing of the education system. Among them Mariya P. Shyshkina distinguish the following resources [36]:

- local and network electronic educational tools, in particular optical digital media;
- educational web-resources: special sites, electronic collections, libraries, collections of learning materials, etc.;
- electronic databases and bases of knowledge of educational purpose;
- e-learning systems and platforms, including distance learning and virtual learning.

Also, there are other types of classification of electronic educational resources in accordance with: areas of use, interaction architecture, form of implementation, spatial limitations, etc. It is a significant issue for our study to classify the electronic educational resources by the type of learning activity (table 1).

Tian Luo, Kirsten Hostetler, Candice Freeman and Jill Stefaniak present an analysis of the current state of using the open electronic educational resources. The researchers came to the following conclusions: “discoverability, sustainability, and remixing are significant barriers that stand in the way of OER disrupting traditional textbook models; there is no significant difference in learning outcomes
when instructors incorporate OER; implementation of OER as instructional strategies is challenging but can be effective in supporting positive learning outcomes when properly designed” [24].

**Table 1.** Classification of the electronic educational resources.

| Type of learning activity                  | Electronic educational resources                                      |
|--------------------------------------------|-----------------------------------------------------------------------|
| story, explanation, conversation, lecture, demonstration | demonstrative, referative, multimedia                                 |
| writing exercises, problem solving, training and consolidating skills, lab work | expert systems, simulation and modelling environments, electronic textbooks, manuals, electronic workshops, simulator programs, electronic laboratories, training programs, laboratory stands |
| written control, laboratory control, machine control, self-control | e-learning training laboratories, e-assessment systems, tests, e-exams, e-assessment systems |

Stefanie Panke, Rick Morse and Spencer Stone [32] investigate the use of open e-learning resources in non-formal learning and methods of implementing open e-learning resources in learning activities. Researchers discuss the benefits of using and creating open textbooks and, as a result, describe the process of creating the textbook “Local Government in North Carolina”. The theme example provides an overview of the open content and resources for developing a creative community for multimedia content and electronic books that meet specific educational requirements of promoting digital citizenship at the local government level.

The development of high-quality electronic educational resources requires considerable material and human costs. The published materials make it possible to get an approximate cost of developing electronic educational resources. Companies engaged in developing e-learning courses demand minimal expense in 2000 dollars for creating of the script, design, layout, and testing. There is an extra charge for video and audio, animation design etc. The cost of one online course at Coursera, a Stanford University project, is estimated at $15-30,000 [5]. Developing the MIT OpenCourseWare course costs $10,000 – $15,000 [26]. As we can see, the development of e-learning courses is very expensive. Understanding that each e-learning course includes e-learning resources, it is possible to propose the development of an open e-learning course through a combination of an open learning management system and open e-learning resources. And if open learning management systems exist and their functionality is sufficient to organize and support e-learning, there are some difficulties with the development of open e-learning resources at this stage [38].

In order to develop open e-learning resources, we suggest engaging prospective professionals in their training. Learning activity involves not only the study of certain topics and disciplines, but also the practical reproduction of the acquired knowledge in teaching practice lessons. Adding to the practical tasks the condition of creating electronic content rather than paper one, we get a significant number of electronic documents that can serve as a basis for future electronic educational resources. Providing prospective experts with ready-made templates for the results of their research or certain rules for the design of electronic content, we will eliminate the need for formatting. Moreover, such tasks will increase the level of digital competence and introduce practice-based tasks into the learning process. The use of the project method, especially collective ones, is advisable. The project activity of like-minded people not only increases the ability to work in a team, but also improves the content quality of the work performed [4], [8], [14], [33], [35].

The next step to creating open e-learning resources is to publish them with mandatory licensing. Open licenses for Creative Commons electronic content, which are usually ignored, will educate prospective professionals about the licensed purity of electronic content. While training prospective professionals are using existing electronic content for their own reports. Therefore, the legal use of electronic content on the basis of academic integrity is one of the tasks of modern vocational training.
The final step is developing and building a repository of open e-learning resources. There are two different ways to resolve this issue. The first is that the state deals with it, and such projects of the repositories with the open electronic educational resources exist. Unfortunately, it is not the first year when in Ukraine such a repository is going to be created, but to no avail. Experts alone provide access to the electronic content developed on their own sites, pages and blogs, but finding the necessary information is extremely difficult. The second way is the use of resources from various foundations that support the ideas of open education. This example is OER Commons resource (oercommons.org). In any case, a dedicated system is essential for the dissemination of the open electronic educational resources. It will not only motivate professionals to create high quality open e-learning resources, but also maintain a high level due to the competition and collaboration.

A practical example of the introduction of these principles is the work on creating the open electronic educational resources at the SHEI “Donbas State Pedagogical University”. Pre-service teachers at different faculties are developing open e-learning resources that are both a complement to the university’s distance courses and standalone products. The course “Modern Information Technologies in Education”, taught at the faculties of the SHEI “Donbas State Pedagogical University” is aimed at providing prospective specialists with theoretically grounded knowledge and clearly developed skills of using modern information technologies in educational activities; preparing for self-educational activity and self-improvement, and therefore the lecture material contains, in addition to operational information about the considered systems, the methodological component of using their work results.

For the e-learning courses created that: diversify forms of presentation of educational information and types of learning tasks; provide response to learners’ actions; individualize the learning process using basic and auxiliary learning influences; apply game techniques; reproduce fragments of educational activity; activate educational work, increase motivation to study.

The e-learning courses were implemented in two ways. For the courses using blended learning, they were imported into the distance learning system of the Faculty of Physics and Mathematics. The subjects taught in the traditional form used e-learning courses as educational material in independent work.

The reform of New Ukrainian School has given impetus to the development of electronic educational resources at the Faculty of Primary, Technological and Vocational Education of SHEI “Donbas State Pedagogical University” where since 2017 the process of developing electronic educational resources has taken place. For example, the implementation of Interactive Communication Electronic Training Simulator for prospective primary school English teachers [13] has undergone diagnostic, corrective, and analytical stages while being created. The final electronic questionnaire among students using Google Forms shows that the implementation of the simulator has increased the students’ motivation to study, strengthened their practical skills in using a foreign language, and developed acmeological aspirations.

Except of distance learning courses designed on the Moodle platform (“Introduction to the Teacher Profession”, “Linguistic Country Study”, “Electronic Linguomethodics”, “Multimedia Technologies in Art Education”, “Electronic Content of Studying Art Courses in Universities”, “Information and Communication Technologies in Pedagogical Research”), students of the faculty use the following electronic text-books and manuals in the educational process, developed by Liudmila H. Havrilova: “History of Ukrainian Music” and “Ukrainian Spiritual Music”, “Ukrainian Culture of the End of XIX – Beginning of XX Century” and “Information and Communication Technologies in Pedagogical Research” [12]. The electronic textbooks on professional methods of teaching primary school subjects and special courses has been developed: “Methods of Teaching the Ukrainian language”, “Children Literature and Methods of Teaching Literary Reading”, “Methods of Teaching the Subject “I explore the World”, etc.

Aiming at more systematic use of open educational resources, the lecturers of the Department of Primary Education Theory and Practice are designing the educational portal “Primary Education: Lifelong Learning” [11]. Its use, according to Liudmila H. Havrilova and Olena S. Beskorsa, will help
to upgrade the system of professional training of primary school teachers, to create high-quality digital educational content that meets the requirements of New Ukrainian School and global trends of education informatization, based on studying the world and, in particular, the European higher education experience (see figure 1).

Figure 1. The structure of educational portal “Primary Education: Lifelong Learning”.

The educational portal is planned to be launched in 2020, taking into account the requirements of the platform Next Generation of Digital Learning Environment (NGDLE), which is a new generation of learning resources with modern software and has the following structure ([11], p. 55).

The Digital Learning Resources section provides online learning tools for primary school teachers. The Internet Conferences section includes effective scientific communication events by using both free and commercial software: Apache OpenMeetings, Adobe ConnectPro Meeting, BigBlueButton, Microsoft Teams, Microsoft Lync and and others.

The Webinars section is used to provide educational online services on a free webinar platform: MyOwnConference, Google Hangouts, Facebook live, Skype Group Calls, and others. The Scientific and Methodological Repository contains an electronic library for students, the Methodological Portal includes the most successful lesson plans and extracurricular activities for primary school. The Distance Courses section contains links to Moodle or Google Classroom platforms where teachers have developed a great number of distance courses.

3. Conclusion
Providing comprehensive and equitable quality education and promoting opportunities of lifelong learning for all are priorities of society sustainable development. This form of education is realized through the implementation of the ideas of open education, in which open electronic educational resources play a crucial role. The development of electronic educational resources is a responsible and costly process. Implementation of the development of quality electronic educational resources is possible only in cooperation with specialists in various specialties.

We propose to involve pre-services teachers in this activity during their practical training. Developed by the prospective professionals, open e-learning resources hosted on the open platforms are expanding the learning content available. Prospective professionals will gain the skills of teamwork, participating in projects and increasing the level of mastering of information and communication technologies both
for their personal and professional needs. The design and development of open electronic educational resources is a creative process that reflects the level of training of future professionals. Fundamental training of pre-service future teachers, training in teaching methods in combination with ICT competence and soft skills under the guidance of a mentor give good results when working on projects. In addition, we solve issues of practical training for blended learning.

References

[1] Abdula A I, Baluta H A, Kozachenko N P and Kassim D A 2020 Peculiarities of using of the Moodle test tools in philosophy teaching CEUR Workshop Proceedings 2643 306–20

[2] Atkins D, Brown J S and Hammond A L 2007 A review of the open educational resources (OER) movement: Achievements, challenges, and new opportunities URL https://www.oerafrica.org/system/files/7593/review-oer-movement-2007.pdf

[3] Babakina O O, Otroshko T V, Shecherbak I V 2021 Using interactive scribe-presentations when teaching Ukrainian Journal of Physics: Conference Series In press

[4] Balyk N, Grod I, Vasylenko Y, Oleksiuk V and Rogovchenko Yu 2021 Project-based learning in a computer modelling course Journal of Physics: Conference Series In press

[5] Eckstein J 2019 How Coursera Makes Money: Certifications, Degree Programs, and Retraining for Businesses Investopedia URL https://www.investopedia.com/articles/investing/042815/how-coursera-works-makes-money.asp

[6] Fedorenko E H, Velychko V Ye, Omelchenko S O and Zaselskiy V I 2020 Learning free software using cloud services CEUR Workshop Proceedings 2643 487–99

[7] Fedorenko E H, Velychko V Ye, Stopkin A V, Chorna A V and Soloviev V N 2019 Informatization of education as a pledge of the existence and development of a modern higher education CEUR Workshop Proceedings 2433, 20–32

[8] Glazunova O G, Parhomenko O V, Korolchuk V I and Voloshyna T V 2021 The effectiveness of GitHub cloud services for implementing a programming training project: students’ point of view Journal of Physics: Conference Series In press

[9] Glazunova O, Voloshyna T, Gurzhii A, Korolchuk V, Parhomenko O, Sayapina T and Semyhinivska T 2020 Cloud resources and services for development of self-educational competence of future IT specialists: Business process modelling and examples of using CEUR Workshop Proceedings 2732 591–606

[10] Havrilova L 2019 Open Access to Scientific Information as a Form of Information and Analytical Support of Scientific Activities and Communication Professionalism of the Teacher: Theoretical and Methodological Aspects 9 5–20 URL https://doi.org/10.31865/2414-9292.9.2019.174531

[11] Havrilova L and Beskorsa O 2019 Digital learning environment for primary school teachers training Professionalism of the Teacher: Theoretical and Methodological Aspects 10 50–64 URL https://doi.org/10.31865/2414-9292.10.2019.182140

[12] Havrilova L H, Ishutina O Ye, Zamorotska V V and Kassim D A 2019 Distance learning courses in developing future music teachers’ instrumental performance competence CEUR Workshop Proceedings 2433 429–42

[13] Havrilova L H, Yaburova O V and Ishutina O Ye 2017 Forming the professional competence of the future english language teachers of primary school using ICT Information Technologies and Learning Tools 60 300–11 URL https://doi.org/10.33407/tilt.v60i4.1760

[14] Horbatiuk R M, Bilan N M, Sitkar O A and Tymoshchuk O S 2021 The formation of educational environment in foreign language training of energy engineering students by means of project technology Journal of Physics: Conference Series In press

[15] ISO 2017 ISO/IEC 40180:2017 Information technology – Quality for learning, education and training – Fundamentals and reference framework URL https://www.iso.org/standard/62825.html
[16] Ivanova H I, Lavrentieva O O, Eivas L F, Zenkovych Iu O and Uchitel A D 2020 The students’ brainwork intensification via the computer visualization of study materials CEUR Workshop Proceedings 2643 185–209

[17] Kazhan Yu M, Hamaniuk V A, Amelina S M, Tarasenko R O and Tolmachev S T 2020 The use of mobile applications and Web 2.0 interactive tools for students’ German-language lexical competence improvement CEUR Workshop Proceedings 2643 392–415

[18] Kholoshytn K V, Bondarenko O V, Hanchuk O V and Varfolomyeyeva I M 202 Cloud technologies as a tool of creating Earth Remote Sensing educational resources CEUR Workshop Proceedings 2643 474–86

[19] Khyzhniak I A 2016 Electronic textbook on language and speech development in the system of e-linguomethodology means for primary school Information Technologies and Learning Tools 51 57–66 URL https://doi.org/10.33407/itlt.v51i1.1308

[20] Khyzhniak I A 2019 Criterial-level structure of future primary school teachers readiness to use electronic linguomethodics tools in professional activities Information Technologies and Learning Tools 69 160–73. URL https://doi.org/10.33407/itlt.v69i1.2165

[21] Khyzhnyak I 2017 State of using electronic linguomethodology tools in the future primary school teachers’ professional training Professionalism of the Teacher: Theoretical and Methodological Aspects 5 221–33 URL http://pptma.dn.ua/files/2017/5-2/22.%20Khyzhnyak%20s.%202021-233.pdf

[22] Kolb D A 2015 Experiential Learning: Experience as the Source of Learning and Development 2nd ed (Upper Saddle River: Pearson Education)

[23] Leshchenko M, Hrynoy V and Kosheliev O 2020 Methods of Designing Digital Learning Technologies for Developing Primary School Pre-Service Teachers’ 21st Century Skills CEUR Workshop Proceedings 2732 1028–43

[24] Luo T, Hostetler K, Freeman C and Stefaniak J 2019 The power of open: benefits, barriers, and strategies for integration of open educational resources Open Learning: The Journal of Open, Distance and e-Learning 35 140–58 URL https://doi.org/10.1080/02680513.2019.1677222

[25] Malchenko S L, Mykoliuk D V and Kiv A E 2020 Using interactive technologies to study the evolution of stars in astronomy classes CEUR Workshop Proceedings 2547 145–55

[26] Massachusetts Institute of Technology 2015 About OCW URL https://u.to/B08qGQ

[27] Midak L, Kravets I, Kuzyshyn O, Baziuk L and Buzhdyan K 2021 Specifics of using image visualization within education of the upcoming chemistry teachers with augmented reality technology Journal of Physics: Conference Series In press

[28] Ministry of Education and Science, Youth an Sports of Ukraine 2019 Regulation on Electronic Educational Resources Legislation of Ukraine URL https://zakon.rada.gov.ua/laws/show/z1695-12

[29] Mintii I S, Shokaliu S V, Vakalius T A, Mintii M M and Soloviev V N 2019 Import test questions into Moodle LMS CEUR Workshop Proceedings 2433 529–40

[30] Morze N V and Glazunova O G 2014 Design of electronic learning courses for IT students considering the dominant learning style Communications in Computer and Information Science 469 261–73

[31] Nechypurenko P P, Stoliarenko V G, Starova T V, Selivanova T V, Markova O M, Modlo Ye O and Shmelts O E 2020 Development and implementation of educational resources in chemistry with elements of augmented reality CEUR Workshop Proceedings 2547 156–67

[32] Panke S, Morse R and Stone S 2019 Digital Citizenship meets Open Educational Resources: Local Government Open Textbook Project Proceedings of E-Learn: World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education ed Carliner S (New Orleans: Association for the Advancement of Computing in Education (AACE)) pp 901–12

[33] Pavlenko M and Pavlenko L 2021 Formation of communication and teamwork skills of future IT-specialists using project technology Journal of Physics: Conference Series In press

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

[35] Shuhailo Ya V and Derkach T M 2021 Project-based learning for undergraduate engineering students minoring in textile technology and design. *Journal of Physics: Conference Series* In press

[36] Shyshkina M 2016 The hybrid cloud-based service model of learning resources access and its evaluation. *CEUR Workshop Proceedings* **1614** 241–56

[37] Tabler T 2019 Using of interactive content in the electronic educational resources in the educational process of a modern school. *Ukrainian Journal of Educational Studies and Information Technology* **7** 54–66 URL https://doi.org/10.32919/uesit.2019.01.05

[38] Tokarieva A V, Volkova N P, Degtyariova Y V and Bobyr O I 2021 E-learning in the present-day context: from the experience of foreign languages department, PSACEA. *Journal of Physics: Conference Series* In press

[39] Tokarieva A V, Volkova N P, Harkusha I V and Soloviev V N 2019 Educational digital games: models and implementation. *CEUR Workshop Proceedings* **2433** 74–89

[40] Universität Tübingen 2021 *Tübinger Internet MultiMedia Server* URL http://timms.uni-tuebingen.de

[41] Velychko V Ye 2017 Creating E-learning Means of Free Software. *Information Technologies and Learning Tools* **60** 128–40 URL https://doi.org/10.33407/itlt.v60i4.1619

[42] Velychko V Ye, Fedorenko E H and Kassim D A 2018 Conceptual Bases of Use of Free Software in the Professional Training of Pre-Service Teacher of Mathematics, Physics and Computer Science. *CEUR Workshop Proceedings* **2257** 93–102

[43] Vest C M 2004 Why MIT Decided to Give Away All Its Course Materials via the Internet. *The Chronicle of Higher Education* **50** B20 URL https://www.chronicle.com/article/why-mit-decided-to-give-away-all-its-course-materials-via-the-internet/