Learning free software using cloud services

Elena H. Fedorenko[1[0000-0002-1897-874X]], Vladyslav Ye. Velychko[1[0000-0001-9752-0907]], Svitlana O. Omelchenko[1[0000-0002-7940-0853]] and Vladimir I. Zaselskiy[2[0000-0002-7517-5433]]

[1] Donbas State Pedagogical University, 19 General Batiouk Str., Sloviansk, 84116, Ukraine
{fedorenko.elena1209, vladislav.velichko, saomel.ddpu}@gmail.com
[2] State University of Economics and Technology,
5 Stepana Tilhy Str., Kryvyi Rih, 50006, Ukraine
zaselskiy52@gmail.com

Abstract. The article deals with the use of cloud technology services in the study of free software. Free software is a social phenomenon based on the philosophy of freedom and the right to intellectual creative activity. To date, a significant number of software products have been created that are licensed under free software and not used in educational activities. The conducted research revealed the factors promoting and hindering the use of free software in educational activities. Conducted questionnaires, analysis of open data, research of scientists made it possible to conclude on the expediency of using free software in educational activities. Cloud technology is not only a modern trend of effective use of information and communication technologies in professional activity, but also a proven tool for educational activities. To get acquainted with the free software, the use of cloud technologies has been helpful, which is the goal of our research.

Keywords: Free Software, Cloud Technologies, Training of Information Technology Specialists.

1 Introduction

Modern teaching methods involve the use of information and communication technologies (ICT) in the educational process. The use of ICT has not only changed the methods of traditional learning, redistributed priorities between forms of learning, but new forms of learning have emerged. For any method or form of training that uses high information technology, software is required, without which the technologies lose their meaning. From the interactive whiteboard controller application to multimedia application creation and distribution programs on the World Wide Web.

Free software is a significant feature of the computer industry. Launched as a philosophical concept, free software has not only found its adherents, but also has a large number of software tools used in various directions in its arsenal. The pedagogical universities are use in educational activity: systems for the organization of distance education MOODLE, ILIAS is not an exception; computer mathematics systems Maxima, Octave, GAP, SAGE, SPP; GIMP, Inkscape graphics packages; OpenOffice,

Copyright © 2020 for this paper by its authors. Use permitted under Creative Commons License Attribution 4.0 International (CC BY 4.0).

LibreOffice office packages. The question remains about the full and systematic use of free software in the educational activities of professionals.

Common problems of free software, legal and philosophical aspects of its existence and use are covered in the works of Eric S. Raymond [31], Richard M. Stallman [34], Andrew S. Tanenbaum [36] and others. In Ukraine the problems of using free software in the education system are devoted to the works of Elena H. Fedorenko [41], Valerii Yu. Habrusiev [6], Yurii V. Horoshko [8], Valerii H. Khakhanovskyi [10], Liubov F. Panchenko [26], Serhiy O. Semerikov [38], Vladimir N. Soloviev [4], Illia O. Teplytskyi [32], Hryhorii H. Zlobin [46] and others. The current state of the issue of the use of cloud technologies in educational activities was revealed in the works of Dmytro S. Antoniuk [39], Vitalina O. Babenko [1], Liudmyla I. Bilousova [2], Olga V. Bondarenko [12], Olena G. Glazunova [5], Anna V. Iatsyshyn [9], Arnold E. Kiv [13], Oleksandr H. Kolgatin [14], Hennadiy M. Kravtsov [17], Iryna V. Lovianova [18], Svitlana H. Lytvynova [19], Maiia V. Marienko [28], Oksana M. Markova [20], Yevhenii O. Modlo [22], Pavlo P. Nechypurenko [23], Yuliia H. Nosenko [24], Vasyl P. Oleksiuk [25], Kateryna P. Osadcha [35], Viacheslav V. Osadchyi [40], Larysa M. Petrenko [27], Maryna V. Rassovytska [29], Ekaterina O. Shmeltser [11], Svitlana V. Shokaliuk [21], Mariya P. Shyshkina [33], Andrii M. Striuk [30], Rostyslav O. Tarasenko [37], Ivan M. Tsidylo [7], Tetiana A. Vakaliuk [16], Nataliia P. Volkova [15], Yuliia V. Yechkalo [44], Vladimir I. Zaselskiy [3], Tetiana I. Zhylenko [45] and others. However, the problem of in-depth exploration of free software capabilities and widespread use in educational activities remains. One possible solution to this problem is to study free software using cloud technology services.

2 Results of the study

Open Education Ideas provide free access to e-learning resources for everyone to learn. Such access is provided by ICT based on free software.

Our research has allowed us to identify the factors that hinder and facilitate the use of free software. One of the stages of the study was to conduct an anonymous survey of higher education teachers regarding the use of free software in their professional activities. The developed questionnaire as a form was made freely available (https://goo.gl/forms/F0BVkSnvwpHTo6H82) using Google Forms, a link to which was circulated via the "Krivorozhsky Conferences and Seminars" (https://groups.google.com/group/cc_seminar) and "Scientific journal Physical and mathematical education" (https://groups.google.com/group/fmo-journal).

The data collected allowed us to determine the following results. 92% of respondents teach science and mathematics. Young teachers, who already have experience in teaching, predominate by age (Fig. 1). 93% use free software in their professional activities. 95% recommend free software to their students for extracurricular activities.

Considering the benefits of using free software, the following were highlighted for conducting the questionnaire:

- legal (licensed purity, non-discrimination, etc.);
- technical (open standards, increased security, vendor independence);

– training (providing the necessary functionality, open source);
– social (trend, modern gadgets).

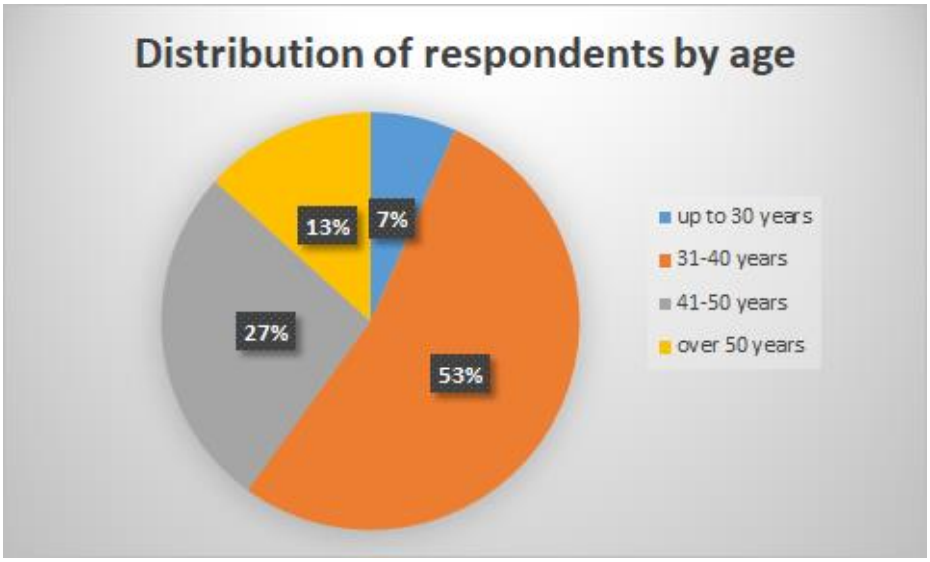

Fig. 1. Distribution of respondents by age

Respondents identified the following factors as facilitating the use of free software (Fig. 2): legal preference was given the highest importance (78%). This result is predictable. According to estimates of the Software Alliance (bsa.org), 82% of the software used in Ukraine is not licensed purity.

75% of the respondents chose among the advantages of free software its educational attractiveness. This result indicates that sufficient free software is available for educational activities. Also important is the availability and openness of software source code.

The analysis of the survey answers indicates that there are technical advantages of using free software in the process of training future professionals. This is noted by 65% of respondents. Open storage standards are an important factor in the software selection process. This gives you confidence in the continued use of your own work. User gains independence from software developers.

The low percentage (33%) belongs to social preferences. The reason is marketing policy. When promoting new high-tech devices, it does not emphasize that their work is based on free software because of its low social popularity.

The survey revealed a number of shortcomings in the use of free software in educational activities (Fig. 3). We identified the shortcomings in the following groups:

– financial (funds for migration, training, etc.);
– technical (changing the format of existing data, support for peripherals);
– software (lack of specialized software);

– methodical (lack of methodological support for application).

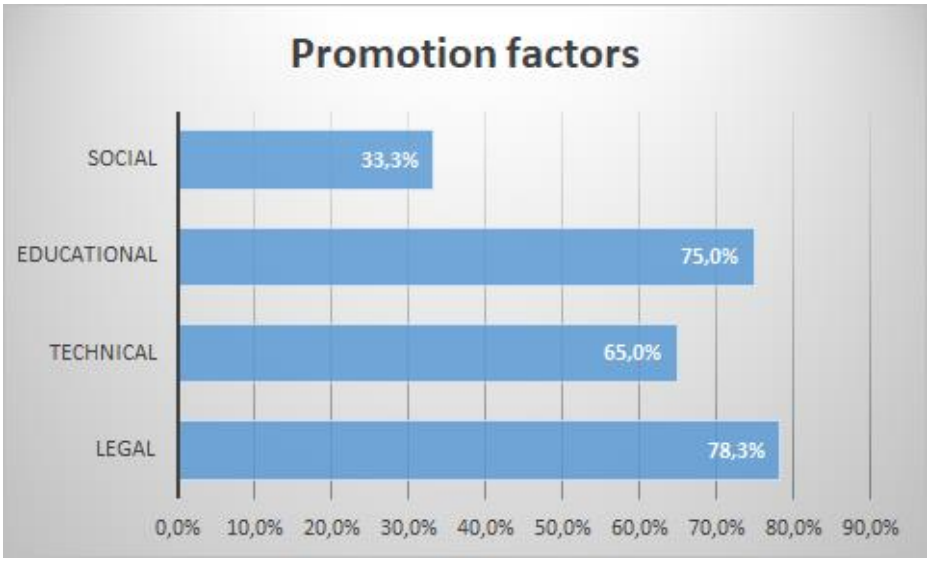

Fig. 2. Factors promoting the use of free software

The lowest percentage (20%) belongs to financial expenses. This low level of concern about financial issues is due to the lack of responsibility for the use of unlicensed software.

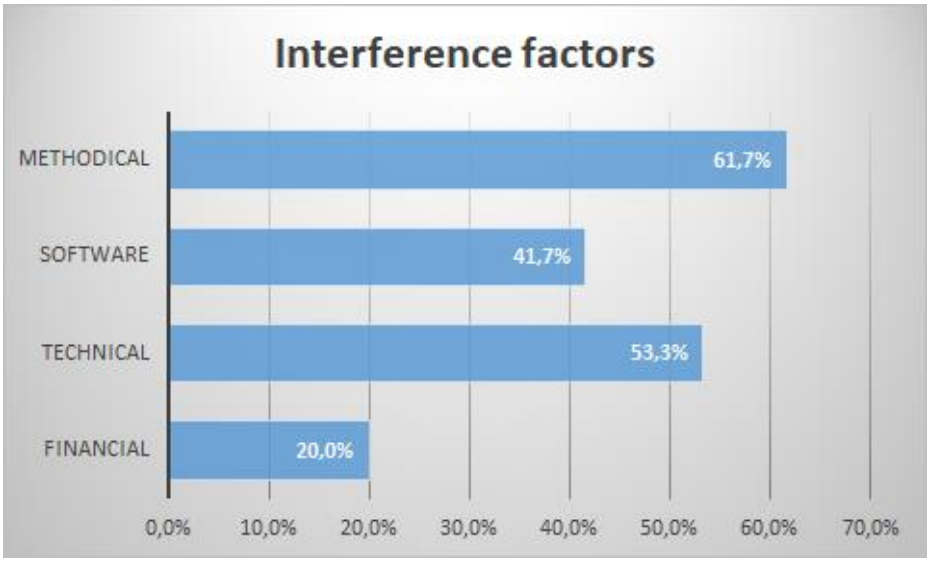

Fig. 3. Factors interferenting the use of free software

42% of respondents are not aware of its existence and localization of specialized software. GitHub.com (64 million projects), SourceForge.net (430,000 projects), bitbucket.org (170,000 projects), CodePlex.com (108,000 projects), launchpad.net (41,000 projects), Savannah.gnu.org (4,000 projects), Gna.org (1,500 projects) hosted a large number of free software products.

The downside of free software is technical issues. These include the transition to new file formats (open file formats) and software for working with peripherals. This concern was expressed by 55% of respondents. Open file formats are currently well developed. Proprietary and closed form owners are taking steps to legalize their openness due to the development of open file format standards. User-generated data can be stored and used for a long time. Users need to have confidence that they can be used for a considerable period of time. Own data must be created using open file formats.

You can estimate the popularity of using file formats by analyzing the approximate number of indexed documents published on the Internet. It is obvious that open file formats are used by both free and proprietary software. However, the results obtained from the number of documents indexed by the search engine (Table 1) indicate the popularity of open file formats.

Table 1. Number of indexed file formats by Google search engine

Format	Property	Number of indexed documents
Binary DOC files (doc)	closed	52,6 million files
Office Open XML (docx)	open	28,4 million files
Portable Document Format (pdf)	open	2,45 billion files
Open Document Format for Office Applications (odt)	open	1,35 million files
Plain Text (txt)	open	21 million files
HyperText Markup Language (html, htm)	open	8,82 billion files
PostScript (ps)	open	8,5 million files
MPEG-4 (mp4)	closed	3,8 million files
Matroska Multimedia Container (mkv)	open	3,3 million files
JPEG (jpeg, jpg)	closed	200 million files
Portable Network Graphics (png)	open	27 million files

A technical problem is the variety of peripherals and the lack of peripheral software. Peripheral developers are trying to keep the technology developed secret. The necessary technical information is not provided for public use. This fact makes it impossible to create free software for peripherals.

The biggest drawback is the lack of methodological support for the use of free software in educational activities. It was identified by 62% of respondents. The lack of free software at the beginning of the informatization led to the installation of proprietary system software as the base. Therefore, proprietary application software has also become widespread. Methodological support for the use of software exists in most proprietary software. Today, the situation with the use of free system software has not

improved. According to the StatCounter resource (http://gs.statcounter.com), only 1.53% of desktop computers in the world have the Linux operating system installed.

The situation is similar in Ukraine. Only 1.42% of desktop systems are running Linux. However, the situation is beginning to change. The results of scientific and methodological research on the use of free software in education are presented at the annual FOSS Lviv conference (http://conference.linux.lviv.ua/) and more [42; 43]. Thus, at the Luhansk Taras Shevchenko National University, pre-service teachers of Mathematics, Physics and Computer science study the Linux operating system, the Maxima computer mathematics system and the Lazarus, Geany programming environment. At Pavlo Tychyna Uman State Pedagogical University, the course "Computer Network Administration" is taught on the Linux operating system. Nizhyn Mykola Gogol State University uses the OpenOffice.org software, Hot Potatoes, to study the subject of Electronic Information Processing. The basic discipline of "PC operating systems" is taught using the Linux operating system as a complete alternative to the proprietary Windows system. The courses "Using Information Technology in Education and Science", "School Computer Science and Teaching Methods" demonstrate the possibilities of using OpenOffice.org and Scribus as an alternative to Microsoft Office, GIMP as an alternative to Adobe Photoshop, Inkscape as an alternative to CorelDraw and more.

GeoGebra Institute operates at the Department of Informatics at H. S. Skovoroda Kharkiv National Pedagogical University. The National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic University" operates the "Linux Professional Institute" (LPI). At the Bogdan Khmelnytsky Melitopol State Pedagogical University, there are such disciplines as "UNIX-like operating systems" and "Programming for open systems" in the bachelor's curriculum.

At the Poltava V. G. Korolenko National Pedagogical University is widely used by GIMP when teaching Computer Graphics and Design, and geometry is supported by Maxima Computer Mathematics. The Maxima computer mathematics system is also widely used in the teaching of students of Physics and Mathematics at Ivan Franko Drohobych Ivan Franko State Pedagogical University.

At Sumy State Pedagogical University named after A. S. Makarenko uses software products such as GeoGebra, Dr Geo, C.A.R., Kig and KSEG to train future math, physics and computer science teachers. At the National Pedagogical Dragomanov University systems of computer mathematics Maxima, Sage, Scilab, Scidavis and many others are used in the study of the disciplines of mathematical and informative cycles. Teachers of Kryvyi Rih State Pedagogical University base their teaching on the Maxima computer mathematics system for basic mathematical training of future teachers of mathematics, physics and computer science. All of the above software products are free software products.

The expediency of using free software in the educational process of future professionals is quite high. Free software gives freedom to its users to choose to use and study both the free software products themselves and their applications. It is a direct factor in stimulating the desire for learning and self-education. The use of free software in the training of future professionals will increase the level of information culture, will teach themselves to choose forms and methods of education, will form skills for the use

of free software in further professional activity, will be able to be competitive in the labor market and meet the requirements of social ordering information society in the modern specialist.

To get acquainted with the free software, it is not necessary to download it to your own personal device. You do not have to visit the computer systems labs where the appropriate software is installed. Cloud technologies make it possible to use the software as a network service. OffiDocs Cloud (https://www.offidocs.com/) is a flexible and powerful platform. It allows you to browse the web with applications using only a web browser. OffiDocs provides users with Internet applications for any device (desktop, tablet, mobile, etc.) such as LibreOffice, GIMP, Dia, AudaCity, OpenShot and many more through a web browser.

A prerequisite for using a cloud service is logging in with an ID. This account creates an account. It is available from any cloud application. Cloud applications are categorized as productivity, images & graphics, video & audio, messaging, education, games, utilities, programming.

Each of these sections of the cloud application is noteworthy. Just as interesting are mobile apps, extensions, resources and templates. Let's take a closer look at the cloud-based LibreOffice suite of services included with the file manager. It is worth noting that there are two options – the first (Fig. 4) is adapted for use in browsers, and the second, launching applications with Gnome interface with image translation in the frame of a hypertext document. Cloud service integration includes integration with Google Drive and Dropbox cloud file repositories.

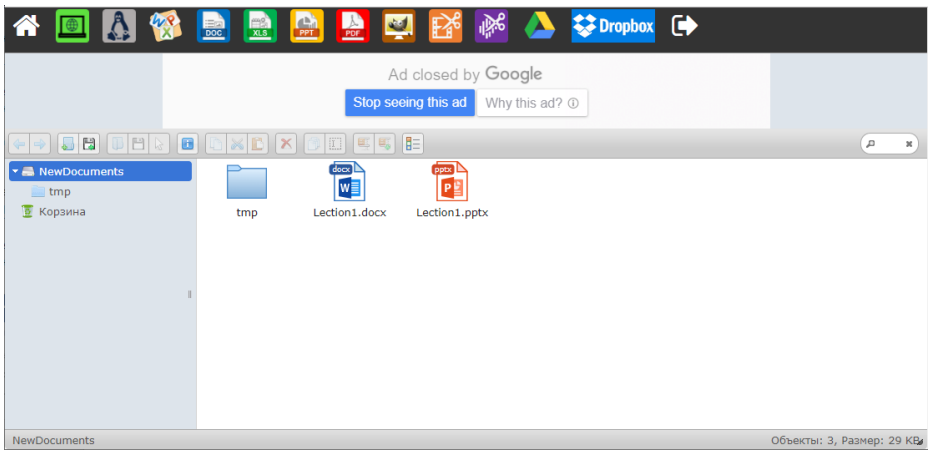

Fig. 4. An example of how a file manager works in LibreOffice

With the ability of a cloud-based environment to study free software, it becomes available to perform standard operations to create electronic educational resources. There is a possibility to use various ways of registration of the textual information (styles, fonts, font sizes, etc.). Text documents and presentations can be supplemented with illustrations (you can use the resource http://editor.pho.to/en/edit/ to process the

illustrations). Once created, documents can be downloaded to your own device in ODT, PDF, and more. With http://odfviewer.nsspot.net/ you can view downloaded documents in ODT format. Use the https://smallpdf.com/edit-pdf service to view and compare PDFs visually.

Image creation, video editing and audio editing programs are just as functional. The typical task of using this cloud application is to create an online educational resource for one of the training topics using the learned applications.

Another cloud service that allows you to get acquainted with free software is the service https://www.rollapp.com/ (Fig. 5). In this dream, educational applications, utilities, office applications, games, graphics applications, development programs are available to users. Free software is available for use in this cloud after user registration. In addition, there is a rating system for evaluating the available software by users.

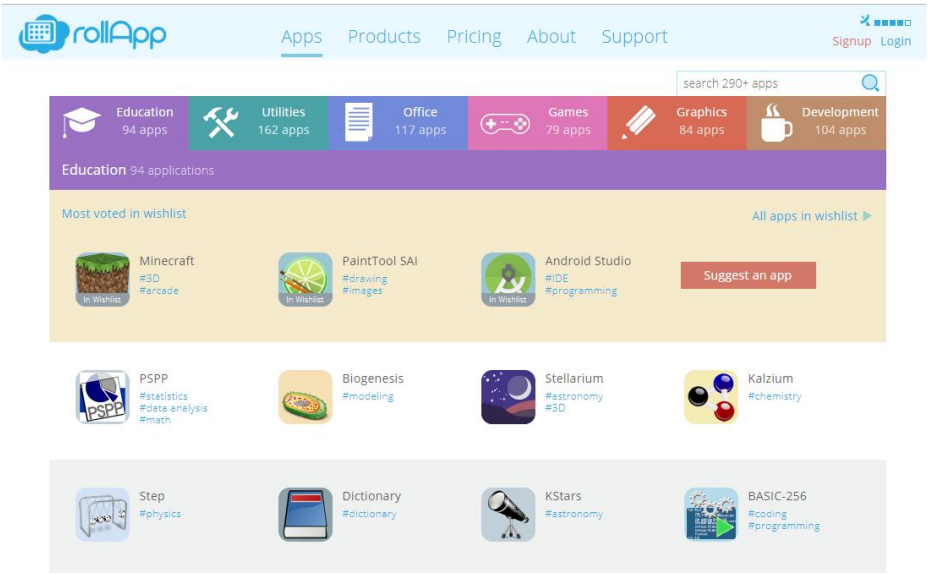

Fig. 5. RollApp cloud service

3 Conclusions and prospects of future research

The results of the long-term use of the OffiDocs cloud service at the Faculty of Physics and Mathematics of the Donbass State Pedagogical University testify to its wide opportunities to become acquainted with free software and its use in the educational activities of pre-services teachers of mathematics, physics and informatics. The availability of alternatives to cloud applications from Google and Microsoft allows us to study information technology rather than specific software. It is not necessary to study the software interfaces, as they are intuitive. The latter provides the opportunity to fundamentally train information and communication technologies and to prepare future professionals for further professional activities.

References

1. Babenko, V.O., Yatsenko, R.M., Migunov, P.D., Salem, A.B.M.: MarkHub Cloud Online Editor as a modern web-based book creation tool. In: Kiv, A.E., Shyshkina, M.P. (eds.) Proceedings of the 7th Workshop on Cloud Technologies in Education (CTE 2019), Kryvyi Rih, Ukraine, December 20, 2019, CEUR-WS.org, online (2020, in press)
2. Bilousova, L.I., Gryzun, L.E., Sherstiuk, D.H., Shmeltser, E.O.: Cloud-based complex of computer transdisciplinary models in the context of holistic educational approach. In: Kiv, A.E., Soloviev, V.N. (eds.) Proceedings of the 6th Workshop on Cloud Technologies in Education (CTE 2018), Kryvyi Rih, Ukraine, December 21, 2018. CEUR Workshop Proceedings **2433**, 336–351. http://ceur-ws.org/Vol-2433/paper22.pdf (2019). Accessed 10 Sep 2019
3. Bondarenko, O.V., Pakhomova, O.V., Zaselskiy, V.I.: The use of cloud technologies when studying geography by higher school students. In: Kiv, A.E., Soloviev, V.N. (eds.) Proceedings of the 6th Workshop on Cloud Technologies in Education (CTE 2018), Kryvyi Rih, Ukraine, December 21, 2018. CEUR Workshop Proceedings **2433**, 377–390. http://ceur-ws.org/Vol-2433/paper25.pdf (2019). Accessed 10 Sep 2019
4. Fedorenko, E.H., Velychko, V.Ye., Stopkin, A.V., Chorna, A.V., Soloviev, V.N.: Informatization of education as a pledge of the existence and development of a modern higher education. In: Kiv, A.E., Soloviev, V.N. (eds.) Proceedings of the 6th Workshop on Cloud Technologies in Education (CTE 2018), Kryvyi Rih, Ukraine, December 21, 2018. CEUR Workshop Proceedings **2433**, 20–32. http://ceur-ws.org/Vol-2433/paper01.pdf (2019). Accessed 10 Sep 2019
5. Glazunova, O., Voloshyna, T., Korolchuk, V., Parhomenko, O.: Cloud-oriented environment for flipped learning of the future IT specialists. In: Semerikov, S., Chukharev, S., Sakhno, S., Striuk, A., Osadchyi, V., Solovieva, V., Vakaliuk, T., Nechypurenko, P., Bondarenko, O., Danylchuk, H. (eds.) The International Conference on Sustainable Futures: Environmental, Technological, Social and Economic Matters (ICSF 2020). Kryvyi Rih, Ukraine, May 20-22, 2020. E3S Web of Conferences **166**, 10014 (2020). doi:10.1051/e3sconf/202016610014
6. Habrusiev, V.Yu.: Zmist i metodyka vyvchennia shkilnoho kursu informatyky na osnovi vilno poshyriuvanoi operatsiinoi systemy LINUX (Content and methodology of teaching school science course based on freely distributed operating system LINUX). Dissertation, National Pedagogical Dragomanov University (2003)
7. Herts, A.I., Tsidylo, I.M., Herts, N.V., Tolmachev, S.T.: Cloud service ThingSpeak for monitoring the surface layer of the atmosphere polluted by particulate matters. In: Kiv, A.E., Soloviev, V.N. (eds.) Proceedings of the 6th Workshop on Cloud Technologies in Education (CTE 2018), Kryvyi Rih, Ukraine, December 21, 2018. CEUR Workshop Proceedings **2433**, 363–376. http://ceur-ws.org/Vol-2433/paper24.pdf (2019). Accessed 10 Sep 2019
8. Horoshko, Yu.V., Kostiuchenko, A.O., Shkardybarda, M.I.: Problemy ta osoblyvosti vprovadzhennia vilnoho prohramnoho zabezpechennia v navchalnyi protses (Problems and features of implementation of free software in the educational process). Kompiuter u shkoli ta simi 7, 8–10 (2010)
9. Iatsyshyn, A.V., Kovach, V.O., Romanenko, Ye.O., Iatsyshyn, A.V.: Cloud services application ways for preparation of future PhD. In: Kiv, A.E., Soloviev, V.N. (eds.) Proceedings of the 6th Workshop on Cloud Technologies in Education (CTE 2018), Kryvyi Rih, Ukraine, December 21, 2018. CEUR Workshop Proceedings **2433**, 197–216. http://ceur-ws.org/Vol-2433/paper12.pdf (2019). Accessed 10 Sep 2019

10. Khakhanovskyi, V., Tonevytskyi, A.: Porivnialnyi analiz vilnoho ta propriietarnoho kompiuternoho prohramnoho. zabezpechennia ().Pravova informatyka 2(6), 38–41 (2005)
11. Kholoshyn, I.V., Bondarenko, O.V., Hanchuk, O.V., Shmeltser, E.O.: Cloud ArcGIS Online as an innovative tool for developing geoinformation competence with future geography teachers. In: Kiv, A.E., Soloviev, V.N. (eds.) Proceedings of the 6th Workshop on Cloud Technologies in Education (CTE 2018), Kryvyi Rih, Ukraine, December 21, 2018. CEUR Workshop Proceedings **2433**, 403–412. http://ceur-ws.org/Vol-2433/paper27.pdf (2019). Accessed 10 Sep 2019
12. Kholoshyn, I.V., Bondarenko, O.V., Hanchuk, O.V., Varfolomyeyeva, I.M.: Cloud technologies as a tool of creating Earth Remote Sensing educational resources. In: Kiv, A.E., Shyshkina, M.P. (eds.) Proceedings of the 7th Workshop on Cloud Technologies in Education (CTE 2019), Kryvyi Rih, Ukraine, December 20, 2019, CEUR-WS.org, online (2020, in press)
13. Kiv, A.E., Soloviev, V.N., Semerikov, S.O.: CTE 2018 – How cloud technologies continues to transform education. In: Kiv, A.E., Soloviev, V.N. (eds.) Proceedings of the 6th Workshop on Cloud Technologies in Education (CTE 2018), Kryvyi Rih, Ukraine, December 21, 2018. CEUR Workshop Proceedings **2433**, 1–19. http://ceur-ws.org/Vol-2433/paper00.pdf (2019). Accessed 10 Sep 2019
14. Kolgatin, O.H., Kolgatina, L.S., Ponomareva, N.S., Shmeltser, E.O.: Systematicity of students' independent work in cloud learning environment. In: Kiv, A.E., Soloviev, V.N. (eds.) Proceedings of the 6th Workshop on Cloud Technologies in Education (CTE 2018), Kryvyi Rih, Ukraine, December 21, 2018. CEUR Workshop Proceedings **2433**, 184–196. http://ceur-ws.org/Vol-2433/paper11.pdf (2019). Accessed 10 Sep 2019
15. Korobeinikova, T.I., Volkova, N.P., Kozhushko, S.P., Holub, D.O., Zinukova, N.V., Kozhushkina, T.L., Vakarchuk, S.B.: Google cloud services as a way to enhance learning and teaching at university. In: Kiv, A.E., Shyshkina, M.P. (eds.) Proceedings of the 7th Workshop on Cloud Technologies in Education (CTE 2019), Kryvyi Rih, Ukraine, December 20, 2019, CEUR-WS.org, online (2020, in press)
16. Korotun, O.V., Vakaliuk, T.A., Soloviev, V.N.: Model of using cloud-based environment in training databases of future IT specialists. In: Kiv, A.E., Shyshkina, M.P. (eds.) Proceedings of the 7th Workshop on Cloud Technologies in Education (CTE 2019), Kryvyi Rih, Ukraine, December 20, 2019, CEUR-WS.org, online (2020, in press)
17. Kravtsov, H.M., Gnedkova, O.O.: Methods of using cloud services in foreign language training. In: Semerikov, S.O., Shyshkina, M.P. (eds.) Proceedings of the 5th Workshop on Cloud Technologies in Education (CTE 2017), Kryvyi Rih, Ukraine, April 28, 2017. CEUR Workshop Proceedings **2168**, 54–65. http://ceur-ws.org/Vol-2168/paper8.pdf (2018). Accessed 21 Mar 2019
18. Lovianova, I.V., Bobyliev, D.Ye., Uchitel, A.D.: Cloud calculations within the optional course Optimization Problems for 10th-11th graders. In: Kiv, A.E., Soloviev, V.N. (eds.) Proceedings of the 6th Workshop on Cloud Technologies in Education (CTE 2018), Kryvyi Rih, Ukraine, December 21, 2018. CEUR Workshop Proceedings **2433**, 459–471. http://ceur-ws.org/Vol-2433/paper31.pdf (2019). Accessed 10 Sep 2019
19. Lytvynova, S.H.: Cloud-oriented learning environment of secondary school. In: Semerikov, S.O., Shyshkina, M.P. (eds.) Proceedings of the 5th Workshop on Cloud Technologies in Education (CTE 2017), Kryvyi Rih, Ukraine, April 28, 2017. CEUR Workshop Proceedings **2168**, 7–12. http://ceur-ws.org/Vol-2168/paper2.pdf (2018). Accessed 21 Mar 2019
20. Markova, O.M., Semerikov, S.O., Striuk, A.M., Shalatska, H.M., Nechypurenko, P.P., Tron, V.V.: Implementation of cloud service models in training of future information technology specialists. In: Kiv, A.E., Soloviev, V.N. (eds.) Proceedings of the 6th Workshop

on Cloud Technologies in Education (CTE 2018), Kryvyi Rih, Ukraine, December 21, 2018. CEUR Workshop Proceedings **2433**, 499–515. http://ceur-ws.org/Vol-2433/paper34.pdf (2019). Accessed 10 Sep 2019

21. Merzlykin, P.V., Popel, M.V., Shokaliuk, S.V.: Services of SageMathCloud environment and their didactic potential in learning of informatics and mathematical disciplines. In: Semerikov, S.O., Shyshkina, M.P. (eds.) Proceedings of the 5th Workshop on Cloud Technologies in Education (CTE 2017), Kryvyi Rih, Ukraine, April 28, 2017. CEUR Workshop Proceedings **2168**, 13–19. http://ceur-ws.org/Vol-2168/paper3.pdf (2018). Accessed 21 Mar 2019
22. Modlo, Ye.O., Semerikov, S.O.: Xcos on Web as a promising learning tool for Bachelor's of Electromechanics modeling of technical objects. In: Semerikov, S.O., Shyshkina, M.P. (eds.) Proceedings of the 5th Workshop on Cloud Technologies in Education (CTE 2017), Kryvyi Rih, Ukraine, April 28, 2017. CEUR Workshop Proceedings **2168**, 34–41. http://ceur-ws.org/Vol-2168/paper6.pdf (2018). Accessed 21 Mar 2019
23. Nechypurenko, P.P., Selivanova, T.V., Chernova, M.S.: Using the Cloud-Oriented Virtual Chemical Laboratory VLab in Teaching the Solution of Experimental Problems in Chemistry of 9th Grade Students. In: Ermolayev, V., Mallet, F., Yakovyna, V., Kharchenko, V., Kobets, V., Korniłowicz, A., Kravtsov, H., Nikitchenko, M., Semerikov, S., Spivakovsky, A. (eds.) Proceedings of the 15th International Conference on ICT in Education, Research and Industrial Applications. Integration, Harmonization and Knowledge Transfer (ICTERI, 2019), Kherson, Ukraine, June 12-15 2019, vol. II: Workshops. CEUR Workshop Proceedings **2393**, 968–983. http://ceur-ws.org/Vol-2393/paper_329.pdf (2019). Accessed 30 Jun 2019
24. Nosenko, Yu.H., Popel, M.V., Shyshkina, M.P.: The state of the art and perspectives of using adaptive cloud-based learning systems in higher education pedagogical institutions (the scope of Ukraine). In: Kiv, A.E., Soloviev, V.N. (eds.) Proceedings of the 6th Workshop on Cloud Technologies in Education (CTE 2018), Kryvyi Rih, Ukraine, December 21, 2018. CEUR Workshop Proceedings **2433**, 173–183. http://ceur-ws.org/Vol-2433/paper10.pdf (2019). Accessed 10 Sep 2019
25. Oleksiuk, V.P., Oleksiuk, O.R.: Methodology of teaching cloud technologies to future computer science teachers. In: Kiv, A.E., Shyshkina, M.P. (eds.) Proceedings of the 7th Workshop on Cloud Technologies in Education (CTE 2019), Kryvyi Rih, Ukraine, December 20, 2019, CEUR-WS.org, online (2020, in press)
26. Panchenko, L.F.: Vykorystannia vilnoho prohramnoho zabezpechennia dlia navchannia studentiv analizu danykh (Using free software to teach students how to analyze data). Visnyk Luhanskoho natsionalnoho universytetu imeni Tarasa Shevchenka (pedahohichni nauky) 17(204), 67–77 (2010)
27. Petrenko, L.M., Varava, I.P., Pikilnyak, A.V.: Motivation readiness of future software engineer's professional self-improvement and prospects of its formation in college cloud environment. In: Kiv, A.E., Shyshkina, M.P. (eds.) Proceedings of the 7th Workshop on Cloud Technologies in Education (CTE 2019), Kryvyi Rih, Ukraine, December 20, 2019, CEUR-WS.org, online (2020, in press)
28. Popel, M.V., Shyshkina, M.P.: The areas of educational studies of the cloud-based learning systems. In: Kiv, A.E., Soloviev, V.N. (eds.) Proceedings of the 6th Workshop on Cloud Technologies in Education (CTE 2018), Kryvyi Rih, Ukraine, December 21, 2018. CEUR Workshop Proceedings **2433**, 159–172. http://ceur-ws.org/Vol-2433/paper09.pdf (2019). Accessed 10 Sep 2019
29. Rassovytska, M.V., Striuk, A.M.: Mechanical Engineers' Training in Using Cloud and Mobile Services in Professional Activity. In: Ermolayev, V., Bassiliades, N., Fill, H.-G.,

Yakovyna, V., Mayr, H.C., Kharchenko, V., Peschanenko, V., Shyshkina, M., Nikitchenko, M., Spivakovsky, A. (eds.) 13th International Conference on ICT in Education, Research and Industrial Applications. Integration, Harmonization and Knowledge Transfer (ICTERI, 2017), Kyiv, Ukraine, 15-18 May 2017. CEUR Workshop Proceedings **1844**, 348–359. http://ceur-ws.org/Vol-1844/10000348.pdf (2017). Accessed 21 Mar 2019

30. Rassovytska, M.V., Striuk, A.M.: The system of cloud-oriented tools of learning computer science disciplines of engineering specialties students. In: Semerikov, S.O., Shyshkina, M.P. (eds.) Proceedings of the 5th Workshop on Cloud Technologies in Education (CTE 2017), Kryvyi Rih, Ukraine, April 28, 2017. CEUR Workshop Proceedings **2168**, 20–26. http://ceur-ws.org/Vol-2168/paper4.pdf (2018). Accessed 21 Mar 2019
31. Raymond, E.: The cathedral and the bazaar. Knowledge, Technology & Policy **12**(3), 23–49 (1999). doi:10.1007/s12130-999-1026-0
32. Semerikov, S.O., Teplytskyi, I.O., Yechkalo, Yu.V., Markova, O.M., Soloviev, V.N., Kiv, A.E.: Computer Simulation of Neural Networks Using Spreadsheets: Dr. Anderson, Welcome Back. In: Ermolayev, V., Mallet, F., Yakovyna, V., Kharchenko, V., Kobets, V., Korniłowicz, A., Kravtsov, H., Nikitchenko, M., Semerikov, S., Spivakovsky, A. (eds.) Proceedings of the 15th International Conference on ICT in Education, Research and Industrial Applications. Integration, Harmonization and Knowledge Transfer (ICTERI, 2019), Kherson, Ukraine, June 12-15 2019, vol. II: Workshops. CEUR Workshop Proceedings **2393**, 833–848. http://ceur-ws.org/Vol-2393/paper_348.pdf (2019). Accessed 30 Jun 2019
33. Shyshkina, M.P., Marienko, M.V.: The use of the cloud services to support the math teachers training. In: Kiv, A.E., Shyshkina, M.P. (eds.) Proceedings of the 7th Workshop on Cloud Technologies in Education (CTE 2019), Kryvyi Rih, Ukraine, December 20, 2019, CEUR-WS.org, online (2020, in press)
34. Stallman, R.M.: Free software, free society: Selected Essays of Richard M. Stallman, 3rd edn. GNU Press, Boston (2015)
35. Symonenko, S.V., Osadchyi, V.V., Sysoieva, S.O., Osadcha, K.P., Azaryan, A.A.: Cloud technologies for enhancing communication of IT-professionals. In: Kiv, A.E., Shyshkina, M.P. (eds.) Proceedings of the 7th Workshop on Cloud Technologies in Education (CTE 2019), Kryvyi Rih, Ukraine, December 20, 2019, CEUR-WS.org, online (2020, in press)
36. Tanenbaum, A.S., Bos, H.: Modern operating systems, 4th edn. Pearson, London (2015)
37. Tarasenko, R.O., Amelina, S.M., Azaryan, A.A.: Features of the use of cloud-based translation systems in the process of forming information competence of translators. In: Kiv, A.E., Soloviev, V.N. (eds.) Proceedings of the 6th Workshop on Cloud Technologies in Education (CTE 2018), Kryvyi Rih, Ukraine, December 21, 2018. CEUR Workshop Proceedings **2433**, 322–335. http://ceur-ws.org/Vol-2433/paper21.pdf (2019). Accessed 10 Sep 2019
38. Teplytskyi, I.O., Semerikov, S.O.: Z dosvidu vykorystannia Vilnoho prohramnoho zabezpechennia u pidhotovtsi maibutnoho vchytelia (The experience of the use of Free Software in training future teachers). Ridna shkola 5, 40–41 (2003)
39. Vakaliuk, T., Antoniuk, D., Morozov, A., Medvedieva, M., Medvediev, M.: Green IT as a tool for design cloud-oriented sustainable learning environment of a higher education institution. In: Semerikov, S., Chukharev, S., Sakhno, S., Striuk, A., Osadchyi, V., Solovieva, V., Vakaliuk, T., Nechypurenko, P., Bondarenko, O., Danylchuk, H. (eds.) The International Conference on Sustainable Futures: Environmental, Technological, Social and Economic Matters (ICSF 2020). Kryvyi Rih, Ukraine, May 20-22, 2020. E3S Web of Conferences **166**, 10013 (2020). doi:10.1051/e3sconf/202016610013
40. Valko, N.V., Kushnir, N.O., Osadchyi, V.V.: Cloud technologies for STEM education. In:

Kiv, A.E., Shyshkina, M.P. (eds.) Proceedings of the 7th Workshop on Cloud Technologies in Education (CTE 2019), Kryvyi Rih, Ukraine, December 20, 2019, CEUR-WS.org, online (2020, in press)

41. Velychko, V.Ye., Fedorenko, E.H., Kassim, D.A.: Conceptual Bases of Use of Free Software in the Professional Training of Pre-Service Teacher of Mathematics, Physics and Computer Science. In: Kiv, A.E., Soloviev, V.N. (eds.) Proceedings of the 1st International Workshop on Augmented Reality in Education (AREdu 2018), Kryvyi Rih, Ukraine, October 2, 2018. CEUR Workshop Proceedings **2257**, 93–102. http://ceur-ws.org/Vol-2257/paper11.pdf (2018). Accessed 30 Nov 2018
42. Velychko, V.Ye.: Cloud technology as a means of switching to free software. New computer technology 12, 125–135 (2014)
43. Velychko, V.Ye.: The use of cloud technologies in the preparation and publication of mathematical texts. New computer technology 13, 323–327 (2015)
44. Volikova, M.M., Armash, T.S., Yechkalo, Yu.V., Zaselskiy, V.I.: Practical use of cloud services for organization of future specialists professional training. In: Kiv, A.E., Soloviev, V.N. (eds.) Proceedings of the 6th Workshop on Cloud Technologies in Education (CTE 2018), Kryvyi Rih, Ukraine, December 21, 2018. CEUR Workshop Proceedings **2433**, 486–498. http://ceur-ws.org/Vol-2433/paper33.pdf (2019). Accessed 10 Sep 2019
45. Zhylenko, T.I., Martynova, N.S., Shuda, I.A., Chykalov, Ye.A., Kuzmuk, D.A.: Auto Checker of Higher Mathematics – an element of mobile cloud education. In: Kiv, A.E., Shyshkina, M.P. (eds.) Proceedings of the 7th Workshop on Cloud Technologies in Education (CTE 2019), Kryvyi Rih, Ukraine, December 20, 2019, CEUR-WS.org, online (2020, in press)
46. Zlobin, H.: Vykorystannia vilnoho prohramnoho zabezpechennia v zakladakh osvity Ukrainy: sproba analizu (Using free software in Ukrainian high schools: an attempt of analysis). Electronics and information technologies 1, 247–251 (2011)