Using Online IT-Industry Courses
in Computer Sciences Specialists' Training

Artem Yurchenko†, Marina Drushlyak†, Stanislav Sapozhnykov††, Alina Teplytska†††,
Larysa Koroliova†††† and Olena Semenikhina†,

†Makarenko Sumy State Pedagogical University, Sumy, Ukraine
††Alfred Nobel University, Dnipro, Ukraine
†††PI "Higher Educational Esteblishment "International Humanitarian and Pedagogic Institute Beit-Chana", Dnipro, Ukraine ††††Oles
Honchar Dnipro National University, Dnipro, Ukraine

Summary
The authors provide characteristics of the open educational platforms, classification and quantitative analysis regarding the availability of IT courses, teaching language, thematic directions on the following platforms: Coursera, EdX, Udemy, MIT Open Course Ware, OpenLearn, Intuit, Prometheus, UoPeople, Open Learning Initiative, Open University of Maidan (OUM). The quantitative analysis results are structured and visualized by tables and diagrams. The authors propose to use open educational resources (teaching, learning or research materials that are in the public domain or released with an intellectual property license that allows free use, adaptation, and distribution) for organization of independent work; for organization of distance or correspondence training; for professional development of teachers; for possibility and expediency of author's methods dissemination in the development of their own courses and promoting them on open platforms. Post-project activities are considered in comparing the courses content of one thematic direction, as well as studying the experience of their attending on different platforms.
Key words:
online learning; online courses; distance education; non-formal and informal education; digital technologies.

1. Introduction

The mastering of professional competencies by graduates of and their demand in the world labor market are in the focus of the Ukrainian educational sector. This is evidenced by the adopted normative documents as on the state (Laws of Ukraine "On Higher Education", Decree of the President of Ukraine "On the National Strategy for the Development of Education in Ukraine until 2021", Concept of the Development of the Digital Economy and Society of Ukraine for 2018-2020, Strategy of the reform of higher education in Ukraine until 2020) and the sectoral (Project "Digital Agenda of Ukraine 2020", adopted standards of higher education, in particular, for specialties in the field "Information Technologies") levels. These documents are intended to promote the competitiveness of Ukrainian higher education and its integration into the European educational space. This requires not only the improvement

of curricula for training specialists in order to increase the weight of professional courses and practices, but also the study and implementation of effective foreign training experience.

This is difficult to realize because of objective factors for national educational institutions. Leading teachers of the world are not interesting in coming to Ukraine to have author's special courses because of low salaries of professors and teaching staff. On the other hand, Ukrainian teachers cannot get experience in training directly abroad during a long-term internship. At the same time, the active development of information technologies influenced the educational industry and facilitated the exchange of experience through virtual space, e.g. the emergence of open educational resources (ER) changed the traditional vision of training specialists and made it possible to get the experience not only in mastering methods of courses, but also in mastering their content and awareness of the trends while presenting contemporary scientific results.

Due to the great popularity of IT specialties in Ukraine there is a huge expansion of work in the "freelance" format with customers from abroad, with different standards for creating or presenting virtual content. Therefore the analysis of open educational resources in the IT field on the different educational platforms becomes relevant and would contribute to resolving the contradiction between the demand of Ukrainian society for a competitive IT specialist and the established content, methods, approaches, etc., of the training for such specialists in Ukraine.

2. Analysis of recent findings

By UNESCO's definition, "open educational resources are teaching, learning or research materials that are in the public domain or released with an intellectual property license that allows free use, adaptation, and distribution" [1]. The MOOC is an open platform, which after the help of the recognized specialist in certain industry provides not only the free access, and online resources but also the social networks for active communication between a large number

of students who self-organize their participation according to their own learning goals and prior knowledge and skills [2]. Such course can be positioned as organized according to curricular with certain terms, but at the same time active communication during the course can lead its organizers beyond the chosen problem. Such courses are not accredited and are not intended to guarantee certain learning outcomes, in contrast to open educational resources, which include, in particular, the knowledge / skills testing during or at the end a course study.

Scientists from different countries are studying investigation of open ER, MOOC and their implementation into educational practice. These scientific results are important for solving the mentioned contradiction.

I. Batsurovska and A. Dzhalandinova [3] studied the history of the development of open-source online courses in education, where the concept of open education is grounded as the basis for the concept of developing MOOC, outlines prospects for their use and reveals their negative impact on the traditional educational system.

M. Berezytskyi and V. Oleksyuk [4] got the statistical analysis of the use of MOOC in education, in particular, the most popular platforms Coursera, EdX, Udemy, MIT OpenCourse Ware and Udacity.

H. Shalatska [5] prove the effectiveness of the introduction of MOOC in the teaching English of professional orientation, described the possible integration of such courses into the curriculum through special organized independent work.

N. Avshenyuk, V. Berezan, N. Bidyuk and M. Leshchenko [6] made the analysis of foreign experience in the use of MOOC in the international educational space, substantiated the thesis about the spread of open courses through the development of digital humanities and the adoption in the international digital educational humanistic pedagogy space, as well as assistance to MOOC to ensure the openness of education, enrichment of the content of training, its individualization and interactivation.

K. Richards-Schuster, M. Ruffolo and B. Hiltz [7] regarded the innovation of the use of MOOC, which at the same time requires the involvement of various resources, time investments, quality organizational support and awareness of the consequences of their passing by students.

J. Zhang, X. Lou and H. Zhang [8] studied the correlation between the attention and the performance of learning in various open ER, in particular, the authors found that understanding the patterns and dynamics of the attention can positively affect the profitability of learning resources and prevent students from being overloaded.

J. Zhang, H. Sziegat, K. Perris and Ch. Zhou [9] considered the impact of ER and MOOC on the status of elite universities in China, in particular, the strategy for the use of educational resources to improve the teaching quality and enhance the world reputation of Chinese educational institutions.

O. Semenikhina, M. Drushlyak, Yu. Bondarenko, S. Kondratiuk, I. Ionova [10] studied the open educational resources in mathematics, in particular, the authors describe the use of some courses in the learning process.

The mentioned scientific findings in the majority cover general characteristics of open ER and MOOC. At the same time, according to the trends of students' centralization in Ukrainian education, teachers who are involved in the IT professionals' training and who are now increasingly acting as transmitters of knowledge, as consultants, tutors of the individual educational trajectories of pre-service IT specialists, face the problem of lack of scientific findings that characterize at least the quantity and content of such resources in relation to particular scientific fields, in particular, the IT industry.

3. Research Aim and Research Questions

The purpose of the article is to identify the quantitative characteristics of open educational resources in the IT field in order to identify ways to improve the IT professionals' training.

The purpose requires solving the following tasks:

1) to identify the most popular platforms, which provide access to open educational resources, and provide them with a brief general description;

2) to investigate open ER on the platforms by parameters: the relative share of IT courses in general and on each platform in particular, the language of teaching, quantitative content in the thematic directions;

3) provide suggestions for improving the IT professionals' training.

4. Research Methodology

The survey is based on the study of the statistical data about 10 platforms, which provide access to an open ER.

The preliminary analysis and generalization of research and Internet sources in order to determine the popularity of educational platforms and courses on them was preceded by studying the contents of the selected resources.

The method of classification was used for the conditional breakdown of IT courses on a subset in the thematic directions to their arrangement and the possibility of their quantitative analysis.

To process statistical data on the number of some courses on open platforms used the quantitative analysis method (method for determining the quantitative ratio of components that are part of the analyzed category) to determine the relative proportion of IT courses according to various parameters, as well as a method of comparative analysis (definition of similarity and differences) for determination of extreme values of such quantity according

to the selected parameters, their possible direct or indirect communication, development trends, etc.

5. Research Results

5.1 Popular platforms and their brief characteristics

Over the last decade, the number of open ER project sites that provide university repositories and site projects has grown considerably. According to Class Central statistical data (Shah, 2020), a free catalog of online courses, more than 11.5 thousand were offered during only 2020 year (more than 900 universities) (Figure 1).
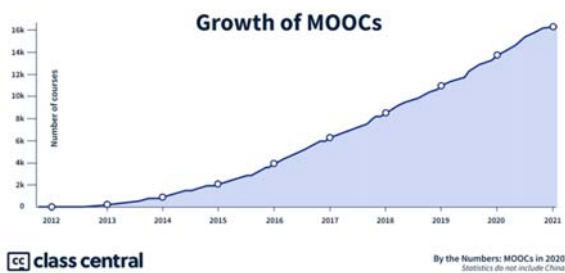

Fig. 1. The number of courses dynamics in open education resources by the research "By the Numbers: MOOCs in 2020" [11]

The objective distribution of courses (Figure 2) indicates the popularity of "Technology" (about 19.3%), "Business" (about 20.4%), "Social Sciences" (about 11.4%) among developers. The smallest number of courses are created in the fields of "Education and Teaching" (7.9%), "Art and Design" (4.4%) and "Mathematics" (2.9%).
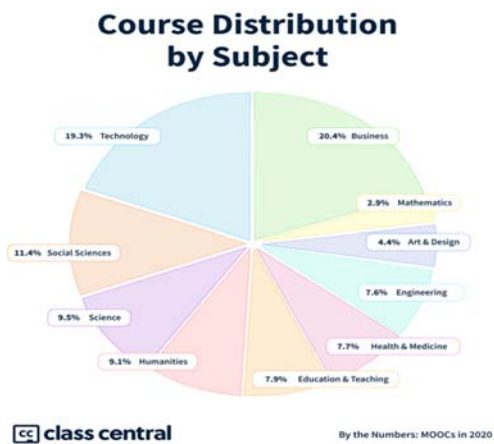

Fig. 2. Course allocation according to the field of knowledge by Class Central research [11]

Among the most popular educational content for consumer according to Class Central are platforms: Coursera – 37 million, EdX – 18 million, XuetangX –

14 million, Udacity – 10 million, FutureLearn – 8.7 million [11].

The generalization of the obtained results and our own impression inclined our choice to study the following 10 educational platforms:

- Coursera (https://www.coursera.org) [12],
- EdX (www.edx.org) [13],
- Udemy (https://www.udemy.com) [14],
- MIT OpenCourse Ware (https://ocw.mit.edu) [15],
- OpenLearn (https://www.open.edu/openlearn/free-courses) [16],
- Intuit (https://www.intuit.ru) [17],
- Prometheus (https://prometheus.org.ua) [18],
- UoPeople (https://www.uopeople.edu/) [19],
- Open Learning Initiative (https://oli.cmu.edu) [20],
- The Open University of Maidan (OUM) (https://vum.org.ua) [21].

Let's describe each of the selected resources.

Coursera. The Ideologists of the massive-online education project of Stanford University [11] are Andrew Ng and Daphne Koller. Now about 30 million users are registered on Coursera, more than 2.5 thousand training courses are offered (physics, engineering disciplines, humanities and art, medicine, biology, mathematics, informatics, economics and business) for 160 specializations by 149 educational institutions. The main part of the courses lasts 6-10 weeks. They are in English, Chinese, Spanish, French, Russian, and Portuguese. The subtitles are actively added. Access to courses is time-limited. Each homework or test must be performed only at a certain period on the Coursera website or in the mobile application. In case of successful testing and final exam the listener gets a certificate.

EdX. Massachusetts Institute of Technology and Harvard University founded the platform in 2012. The project contains open online courses for higher education and it is designed for international audience. Among the peculiarities of training on these courses, we noted such facts: the lectures are separated on modules, which last 10 minutes, intellectual analysis of errors, possibility of self-set speed of lecture, possibility of creation of discussion groups, collaborative training, etc.

Udemy. Educational online platform offers over 80 thousand video courses in 50 languages from more than 30 thousand experienced teachers. The platform provides feedback between the teacher and the course listeners, the ability to choose your own training pace, the built-in subtitle settings. A distinctive feature of Udemy is the wide range of courses in various fields from academically social and humanities to developing mobile applications. It is possible to develop post and then distribute the author's courses. However, it should be noted about the commercial orientation of the resource.

MIT OpenCourseWare. The Massachusetts Institute of Technology (USA) founded the project in 2002. In May

2018, more than 2 thousand courses were available, including lecture notes, homework assignments, and questions for the exam. Video lectures were additionally offered to some courses.

OpenLearn. The open resource of the British Virtual University was opened in 2006. It provides access to over 1000 free courses of various fields of knowledge.

Intuit. A. Shkred founded the project in 2003 as the National Open University, focused on studying mainly IT courses. More than 800 courses are currently available, after which you can get an electronic confirmation certificate. In addition, the organization acts as a publishing house of textbooks.

Prometheus. Ukrainian public project of MOOC was founded in 2014 on the initiative of teachers of Taras Shevchenko National University of Kyiv, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" and Kyiv Mohyla Academy. Among the tasks of the project are not only free access to university courses (business, IT, foreign languages, law, history, etc.), but also the possibility to publish and distribute author's courses. Each course consists of video lectures, interactive tasks, as well as a forum for the communication of teacher and students.

Open University UoPeople. The American nonprofit Open University was founded in California in 2009 and offers to get distance higher education online. The site contains more than 150 courses in English. The university is accredited and recognized by the American Ministry of Education, the Board of Accreditation of Higher Education and the Accreditation Commission for Distance Education. UoPeople is a free university, but students have to pay for exams at the end of each course.

Carnegie Mellon Open Learning Initiative. The platform, founded in 2002 by the foundation of William and Flora Hewlett, offers high quality scientifically-based and audited in classroom online courses and materials (college level) and a platform for research and experimentation in the field of education. Developers offer materials on reimbursable basis, and free of charge.

Open University of Maidan (OUM). It is positioned as the first distance platform of public education in Ukraine launched after the events of 2013. On the platform there are training courses, included video lectures, practical tasks and control questions from leading teachers of business schools, the public sector, business practitioners and social sphere. The topics of training courses are mostly social and related to personal development and realization of their own potential and entrepreneurship.

5.2 Quantitative analysis of open ER in IT sphere

We conducted an analysis of 10 open educational resources regarding the availability of IT courses (analyzed in September 2020).

Quantitative data on the number of courses in total and the number of IT courses are shown in Figure 3.
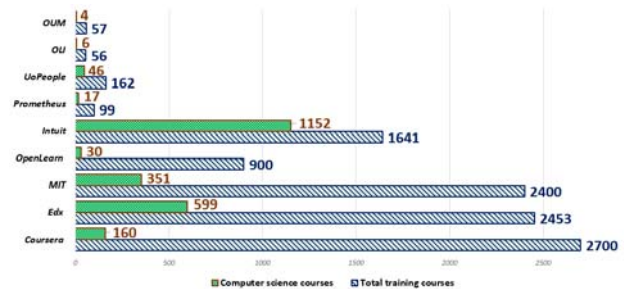

Fig. 3. The proportion of IT courses on different ER

According to Figure 3 analysis, it can be concluded that among well-known educational platforms the most filled by different courses are foreign Coursera, EdX, MIT OpenCourse Ware, OpenLean and Intuit. The number of courses on them exceeds the value of 2.4 thousand, while in the Ukrainian Internet space the most saturated courses platform is Prometeus where about 100 courses are located.

The leadership position (Table 1) is the position of the resource Udemy (in Figure 3 this resource is not displayed for a better visualization of the content of other resources). The number of courses in general is 82943, and on IT is 35727. The second position is a platform Intuit, which offers 1152 courses. The next goes to EdX (599 courses) and MIT OpenCourseWare (351 course). At least ten courses on IT-industry offer Open Learning Initiative (6 courses) and OUM (4 courses).

The 10% barrier (IT courses to the total number of courses) underwent Udemy resources (43.1%), UoPeople (28.4%), Intuit (70.2%), EdX (24.4%), Prometheus (17.2%), MIT OpenCourse Ware (14.6%), and Open Lerning Initiative (10.7%). The smallest relative proportion of IT courses on the OpenLern platform (3.3%).

An analysis of the teaching language offered by courses in the IT field in the Table 1.

• Coursera's resource offers only 19 courses (11.9%) in English, 1 course (0.6%) in Ukrainian and 4th course (2.5%) in Russian. All others 136 courses (85%) are offered in other languages.

• EdX Resource offers 90% (539) courses in English and does not have courses in Ukrainian/Russian languages.

• Udemy resource offer more than half of 18758 (52.5%) courses in English, only 4 courses (0.01%) in Ukrainian and 340 courses (0.95%) in Russian;

• MIT OpenCourseWare, OpenLearn, UoPeople, Open Learning Initiative resources offer all IT courses in English;

• Intuit resource has Russian language for all 1152 IT courses;

• Ukrainian resources Prometheus and OUM offer 17 and 4 courses open ER in Ukrainian language in IT

sphere. We have defined 10 generalized thematic directions (TD) according to analysis of courses titles and abstracts:

Software programming and Development (TD 1) – open ER that is connected with learning different languages (e.g. Java, C#, C++, Python, Scratch), development and testing of applications, etc.

Algorithms and data Structures (TD 2) – open ER, which considers methods of structuring data, algorithms and their properties.

Computer security and Networks (TD 3) – open ER, where information systems protection, cyber security, secure surfing network are studied as well as the setting up and use of various types of networks.

Computer graphics, design and data visualization (TD 4) – open ER associated with computer Graphics study, animation, art design, relevant software, visual guidance, drawing illustrations, etc.

Web design and Internet technologies (TD 5) – open ER, which give an idea of modern internet technologies and technology of web-sites development languages HTML, CSS, PHP etc.

DB and SQL Management (TD 6) – open ER, which are connected with database learning, query creation, updating and management of relational databases, creating database diagrams and their modifications, access to database control systems, etc.

Artificial Intelligence and Robotics (TD 7) – open ER, where features of the development and possibility of using artificial intelligence, machine learning and design, creation, operation and use of robots are studied as well as computer systems for their Control, sensory feedback and information processing of automated technical systems, etc.

Table 1: Teaching language of IT courses

Resource		Coursera	EdX	Udemy	MIT	OpenLearn	Intuit	Prometheus	UoPeople	OLI	OUM
Total amount		2700	2453	82943	2400	900	1641	99	162	56	57
IT Courses	%	160 / 5.9	599 / 24.4	35727 / 43.1	351 / 14.6	30 / 3.3	1152 / 70.2	17 / 17.2	46 / 28.4	6 / 10.7	4 / 7
Language	Ukr %	1 / 0.6	0 / 0	4 / 0	0 / 0	0 / 0	0 / 0	17 / 100	0 / 0	0 / 0	4 / 100
	Rus %	4 / 2.5	0 / 0	340 / 1	0 / 0	0 / 0	1152 / 100	0 / 0	0 / 0	0 / 0	0 / 0
	Eng %	19 / 11.9	539 / 90	18758 / 52.2	351 / 100	30 / 100	0 / 0	0 / 0	46 / 100	6 / 100	0 / 0
	Other %	136 / 85	60 / 10	16625 / 46.5	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0

Table 2: The distribution of courses on thematic directions

Resource	Coursera	EdX	Udemy	MIT	OpenLearn	Intuit	Prometheus	UoPeople	OLI	OUM	The total number
TD 1	87	199	15004	80	6	368	7	10	3	0	15764
TD 2	7	30	216	63	0	74	2	4	0	0	396
TD 3	20	36	2342	17	2	112	1	4	0	2	2536
TD 4	31	29	8132	23	2	59	1	2	0	0	8279
TD 5	15	38	965	19	0	122	3	2	0	0	1164
TD 6	0	25	1220	0	2	41	0	4	0	0	1292
TD 7	0	39	681	38	2	27	1	4	0	0	792
TD 8	0	8	312	10	0	0	0	0	0	0	330
TD 9	0	6	1018	2	0	56	0	4	0	0	1086
TD 10	0	189	5837	99	16	293	2	12	3	2	9207

Block chain and Cryptography (TD 8) – open ER, which give an idea of the block chain, as well as encryption methods and mathematical methods for ensuring the confidentiality, integrity and authenticity of information.

Operating systems (TD 9) – open ER, which view complexes of programs that perform the management of a hardware component of a computer or virtual machine and provide management of computing process, or organize the interaction with users.

Other (TD 10) – open OR, for example, courses related to the study of specialized software of the specific scientific industry, data processing software, cloud computing courses, etc.

The general quantitative characteristics are given in Table 2 and in Figure 4.
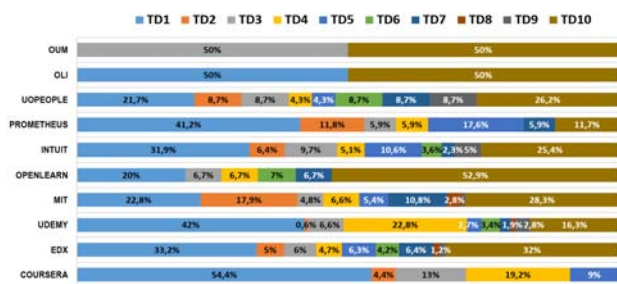

Fig. 4. The distribution of courses on thematic directions

The TD 1 is the other most popular: Coursera (54.4%), EdX (33.2%), Udemy (42.0%), Intuit (31.9%), Prometheus (41.2%), and Open Learning Initiative (50.0%). The largest number of TD1 courses is on Udemy (15004) and Intuit (368) resources. There are no any TD1 courses on the OUM platform.

The TD 2 is less popular. The relative proportion of courses in this direction is from 17.9% (MIT OpenCourse Ware) to 0.6% (Coursera). In a quantitative equivalent, we have the leader-platform Udemy (216 courses). The TD2 is not presented at all on OpenLearn platforms, Open Learning Initiative, OUM.

The TD 3 is most represented on Udemy platform (2342 courses). Other platforms besides Open Learning Initiative, where this direction is absent, offer from 112 courses (Intuit) to one course (Prometheus).

The TD 4 is the most popular on the Udemy platform (8132 courses). This direction is not presented on the Open Learning Initiative platform.

The TD 5 is the most popular on Prometheus platform – 17.6%. At the same time, in absolute numbers, it is not a leader, because the number of courses for Udemy is 965 courses and for Intuit is 122 courses.

The TD 6 is not presented on Coursera platforms, MIT OpenCourse Ware, Prometheus, Open Learning Initiative, OUM. The largest number of courses is on Udemy (1220 courses) and Intuit (41 course).

The TD 7 has relative small indicators for each platform: the largest on MIT OpenCourse Ware (10.8%), there are no TD 7 courses on Coursera, Open Learning Initiative, and OUM.

The TD 8 is poorly represented on the analyzed platforms. The direction is represented on only three platforms: EdX (8 courses), Udemy (312 courses) and the MIT OpenCourse Ware (10 courses).

For the TD 9 the absolute leaders are Udemy (1018 courses) and Intuit (56 course). EdX proposes 6 courses and MIT OpenCourse Ware – 2 courses.

The TD 10 has a significant relative weight for EdX (189 courses or 31.6%), Udemy (5837 courses or 16.3%), MIT OpenCourse Ware (99 courses or 28.2%), OpenLearn (16 courses or 53.3%), Intuit (293 courses or 25.4%).

A more detailed analysis of this direction showed popularity: cloud technology and augmented and virtual reality on EdX; open media learning, ecommerce, and Office software on Udemy; computing theory and machine interfaces on MIT OpenCourse Ware; Computing theory, e-commerce, work in the Internet on OpenLearn and Open Learning Initiative; Office technologies, mobile technologies, hardware on Intuit; computer systems, cloud computing and information retrieval on UoPeople.

The authors found two courses "Word and Excel Tools" and "Digital communications in global space" on Prometheus, and two courses "How to understand social networks" and "Internet verification" on OUM.

The last row of Table 2 confirms the popularity of courses on programming and software development (in the TD 1 the generally offered 15764 courses, which is 38.6% of the total number of considered courses) and courses of computer graphics, Design and visualization of data (in the TD 4 is offered 8279 courses, which is 20.2% of the total number of considered courses).

5.3 Suggestions for improvement of the IT professionals' training

The results of quantitative analysis of the open ER in the IT field give grounds to formulate the following proposals for improvement of IT professionals' training.

Organization of independent work in some courses in the curricular of specialists training can be connected with the attending of a non-commercial course on one of the mentioned platforms. It is worth considering the volume of independent work (the volume chosen on the open platform of the course should be about the same or smaller). Getting a course certificate on an open platform will be a condition of actual work credit. The disadvantage of the proposal can be considered a limited number of Ukrainian (Russian) courses and a constant update of the list of available courses on open platforms (every half a year).

We also consider it advisable to use the open non-profit ER for organization of distance or correspondence courses within the elective component of the specialist training curricular. The disadvantage of this proposal will be the constant changeability of the open platform content

(emergence of new courses, modernization of the "old" courses, time rates migration).

The level of the teacher's professionalism directly affects the level of pre-service specialist training, and therefore the successful attending of courses on open platforms should be perceived as a teachers' training. The course certificate of the of 3 or more ECTS credits for a long-term training and 2 credits ECTS for short-term training [22] may be counted as a confirmation of teaching staff's training by the administration of educational institutions. The disadvantage of this proposal is the possibility of "imposing" of some courses, which do not always meet the needs of the teacher or are not free, by the administration of the institution.

The analysis can encourage teachers to research the specific of some open ER depending on their preferences and educational or scientific tasks. The authors believe that this will positively affect the quality of teaching author's courses, the dissemination of author's techniques and the teacher's professionalism. We also note the possibility and feasibility of distributing author's techniques in the development of their own courses and promoting them on open platforms.

6. Conclusions

The conducted quantitative analysis confirms the popularity of open education. There is currently a large number of platforms, which provide access to open educational resources of different fields of knowledge.

The proportion of IT courses on open educational resources with respect to all offered is quite extensive: IT courses on Intuit occupy 70% of all courses, on Udemy – 43%, on UoPeople – 28%, on EdX – 24%.

A large proportion of courses is offered not only in programming and software development, although these rates have the highest relative weight (38.6% of the rates discussed), but also from the directions related to the study of specialized software specific scientific field (mathematics, physics, biology, finances, etc.), with the methods of processing multi-format information content, with cloud computing, etc. There are comparatively many such courses regarding algorithms and data structuring, computer security or network technologies. This suggests that the modern youth has a variety of requests, which are met by author's courses of leading teachers of the world.

The conducted analysis confirms active development and implementation of open ER in the USA and EU countries. This explains the large number of English-language projects. At the same time, there are platforms focused more on world distribution – Coursera and Udemy resources offered by the ER in various languages of the world (not in English only) – 85% and 46.5% respectively.

We can also talk about an extremely large number of courses on foreign open resources and a large number of them in Ukraine. Development and promotion of open ER in Ukraine initiated, but we can not talk about the development of this movement. This is confirmed by Ukrainian Prometheus and OUM platforms, which offer a small number of courses, and not only in the IT industry. They are similar to foreign ER by the form. At the same time we note that this content offers traditional video lectures with familiar methodological approaches to education – this distinguishes Ukrainian educational resources from others.

Among the ways to improve the professional IT specialists' training of due to the open ER we note: organization of independent work in some courses of curricular; use of open non-profit ER for organization of distance or correspondence training; attending open ER as training courses; personal research of open ER; possibility and expediency of author's methods dissemination in the development of their own courses and promoting them on open platforms.

Post-project activities are considered in comparing the courses content of one thematic direction, as well as studying the experience of their attending on different platforms.

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