Open Educational Resources as a Trend of Modern Education

O. V. Semenikhina*, M. G. Drushlyak*, Yu. A. Bondarenko*, S. M. Kondratiuk* and I. M. Ionova*

* Makarenko Sumy State Pedagogical University, Sumy, Ukraine

e.semenikhina,@fizmatsspu.sumy.ua, marydru@fizmatsspu.sumy.ua, yuliya-kartavaya@ukr.net,
kondratiuks.m@gmail.com, ira_ionova@ukr.net

Abstract - **The article presents the results of the study of open educational resources in mathematical disciplines. The purpose of the article is to summarize the experience of teaching mathematical courses based on quantitative analysis of the corresponding open educational resources and determination of ways of using such resources in the conditions of Ukrainian universities. The definition of open educational resources and their specific features are specified, in particular, support of different formats for presentation of materials, their publication under conditions of an open license, provision of free access, the possibility of modification of materials by other users. The analysis of the number of open educational resources Coursera, Edx, Udemy, and INTUIT has revealed that the bulk of mathematical courses in relation to others is not large, which suggests a reduction in young people's interest in purely mathematical disciplines. At the same time, it was noted that the presence of such resources on the site of the university contributes to the formation of its positive image within the country and the world. The own experience of studying mathematical online courses on Analytical Geometry, Linear Algebra, Geometry and Mathematical Philosophy is described.**

Keywords - open education, educational resources, open educational resources, open educational resources in mathematics, mathematics courses

I. INTRODUCTION

Nowadays, the information technology (IT) in the learning process is no longer news. In addition to specialized technical equipment and professional support, the Internet has been used in recent years. It brought in a large amount of information in various fields.

This causes the "consumption", but not the use of information content by the youth [1]. It currently leads to a deliberate reduction of areas of interest and reduce the motivation to learn and get a modern professional assistance in acquiring professional competences.

The educators are aware of these trends. They conduct searches of learning strategies that would not only attract IT, but also help in learning different courses, regardless of the age of the educatees, course duration, and the location of the learning process and so on. We distinguish the emergence of open educational resources among these innovations.

The term "open educational resources» (OER) was first introduced at the World Educational Resources Congress for developing countries, organized by UNESCO in July 2002. According to the adopted definition - open educational resources mean the educational and scientific resources that exist in the public domain or released under a license that allows their free use and modification by third parties [2].

According to the definition, the characteristics of open educational resources can be identified: methodical, educational or scientific orientation of materials, support for different formats of materials presentation, publication of educational and scientific material that is in the public domain on an open license, free access, recycling and redistribution of material by others, minimal restrictions (or lack thereof) when working with open educational resources.

We were impressed by arguments that speak in favor of open educational resources [2].

- Educational institutions that receive public funding are required to provide free access and use of created materials because they are partially developed by the taxes of citizens and thereby society already paid for it.

- Limited access to educational materials could lead to duplication of efforts, which also entails additional costs for the society.

- Placement of open educational resources creates a positive image of the university and the country as a whole, helping to attract more students and funding of the institution from private funds.

According to UNESCO [2] in the last decade, the number of open educational resources that provide university repository sites and projects increased significantly. The most famous of them are Coursera [3], Edx [4], Udemy [5], MIT OpenCourseWare [6], OpenLearn [7], and INTUIT [8].

The emergence of these resources, on the one hand, led to the development of ubiquitous learning technologies, on the other hand, made it possible to develop the educational sector under pressure of social needs to deepen knowledge in any desired direction.

In addition, the emergence of open educational resources has led to the globalization of the educational sector, which is why we can talk about blurring boundaries of "scientific schools" and the disappearance of the "closed methods" of learning. This is especially true for established classical disciplines, including Mathematics as one of the sciences that not only actively developed and has a broad scope of application, but characterized by certain ancient traditions in studying the classical mathematical training.

Today we can observe trends in university exchange of scientists, the emergence of specialized courses related to modern problems of Mathematics, developing specialized software designed to solve a wide range of mathematical problems by visualizing numerical and symbolic transformations or the dynamic modelling of processes in formalized systems.

Familiarity with such trends is made possible by the open educational resources created in the leading universities of the world to demonstrate, for example, the latest trends in the field of Mathematics. A detailed study of such resources (not only content, but also presentation technology of learning material, organizing its study, methods of knowledge control, etc.) help educators to understand their own scientific level and trends in educational requirements for professional training in modern Mathematics.

II. MATH COURSES ON OPEN EDUCATIONAL RESOURCES

A. Quantitative Analysis of Math courses on OER

As part of activity of the Laboratory of information technology in education (Makarenko Sumy State Pedagogical University, Ukraine) open educational resources have been analysed [3-8] to determine the presence of the courses in mathematics. We were interested in the quantity, authors, technology of certificates, etc. Graphical visualization of quantitative analysis shown in charts in percentage form (Fig. 1-6).
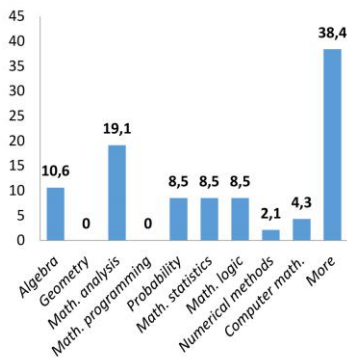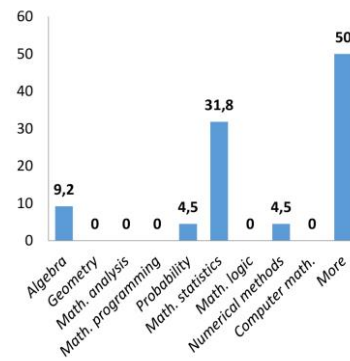
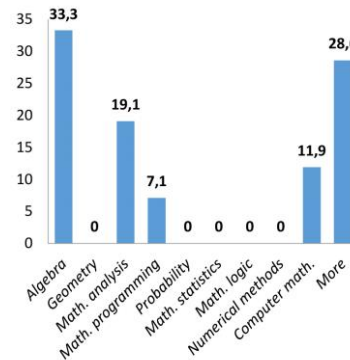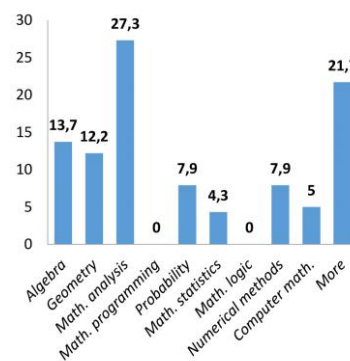

Figure 1. Coursera
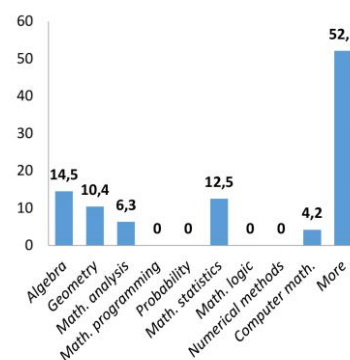

Figure 2. Edx

Figure 3. Udemy

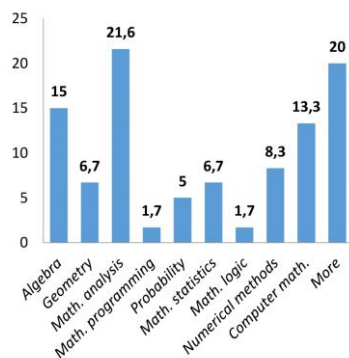Figure 4. MIT OpenCourseWare

Figure 5. OpenLearn

Figure 6. INTUIT

B. Comparative Analysis of Math courses on OER

Quantitative analysis of these resources suggests that in addition to the classical mathematical disciplines much attention is paid to courses that connect Mathematics and other fields of knowledge. Among them there are "Introduction to Mathematical Philosophy", "Mathematical Methods in Quantitative Finance" (OER Coursera); "Effective Thinking through Mathematics", "Relativity and Astrophysics" (OER Edx); "Mathematical Way of Thinking about Biology", "Sinking Fund" (OER Udemy); «Nonlinear Dynamics", "Mathematical Methods in Nanofotonics" (OER MIT OpenCourseWare); "Modelling of Displacement and Speed", "Mathematics Everywhere" (OER OpenLearnresurs) and others.

One of the tasks of our study was to investigate the characteristics of technology of on-line courses. We gained experience learning different professional disciplines, including the course "Fundamentals of Analytic Geometry" (INTUIT), «Introduction to Mathematical Philosophy» (Coursera), «Linear Algebra» (Edx), "Geometry" (Udemy). Brief information about these online courses is given in Table 1.

TABLE I. ANALYSIS OF MATH COURSES ON EOR

Course Name	Fundamentals of Analytic Geometry	Introduction to Mathematical Philosophy	Linear Algebra	Geometry
Source	Intuit.ru	Coursera.org	Edx.org	Udemy.com
Course Description	The aim of the study is the introduction and application of analytical geometry and linear algebra	The course is linked to mathematical philosophy and demonstrates how to analyze philosophical questions based on basic mathematical concepts and methods	The course is designed to study the course of linear algebra. It also researches practical implementation of the theory of algorithms	This course is an introduction to the study of geometry and is designed for students who have not studied geometry before, or have a need to recall the geometric material
Lecturer	Assoc.Prof., Ph.D., B. Boyarshinov	Prof. H. Leitgeb, Prof. S. Hartmann	Prof. R. van de Geijn	Prof. M. Fortress
Language	Russian	English	English	English
Course volume	48 hours (lectures), 24 hours (tests)	10 weeks	12 weeks	7 hours
Accounting	Tests (24 topics), each not less than 60% of correct answers. The exam (30 test questions)	The exam(tests), not less than 70% of correct answers	Homework, tests and exam	Enough to listen to all the lectures
The presentation of electronic materials	Lectures in the form of video fragments. Online test (8 questions) after each lecture.	Lectures in the form of video fragments that contain questions	Lectures in the form of video fragments. Homework (tests).	Lectures in the form of video fragments.
Result	In case of successful completion of the course (at least 60% of the maximum possible points) student receives an online-certificate	In case of successful completion of the course (at least 70% lectures attended) student receives an online-certificate	In case of successful completion of the course (at least 60% of the maximum possible points) student receives an online-certificate	When viewing all lectures online student receives a certificate.

Comparing the curricula of mathematicians and mathematics teachers training at Ukrainian universities and online courses mentioned, we note the following.

"Fundamentals of Analytic Geometry" course in a Ukrainian university and on OER INTUIT is identical. We believe that this is because this course is offered by the Russian public resource, and methodological features of studies in Ukraine and Russia are similar. It should be noted that the training of analytical geometry on OER is very similar to the usual lectures. The tasks of the course are also similar.

Analogue to the course "Introduction to Mathematical Philosophy" (OER Coursera) in the curriculum of mathematicians' preparation in Ukrainian universities is the special course of studying philosophical problems of mathematics (normative discipline). The difference in the study lies in the methods of control: enrollment in online courses require fixing the review at least 70% of lectures, in Ukrainian universities it is not usually enough to attend 70% of lectures and require personal communication or writing some control paper.

The essential difference between an online course in linear algebra (OER Edx) and the one studied in Ukrainian universities is allotted number of hours of training and its content (in Ukrainian universities course contains more topics in algebra and more hours of learning). In addition,

there are differences in the tasks proposed in the study and during the course control.

Ukrainian universities do not have analogues to online course "Geometry" (OER Udemy). The material rather designed for Ukrainian school students who are acquainted with the notation of basic geometric objects.

III. CONLUSION

The use of e-learning courses allows receiving education at a distance without direct contact between teacher and educatees. The choice of course not least depends on its short description and possibly a video announcement with details about the course and what skills it teaches and the quality of educational material presentation. It is especially important that e-course is interesting for the educatee, contains various forms of presentation of learning material, reduces dependence on the teacher and allows learning at any convenient time and in any place where there is Internet access.

Analysis of the world's leading open educational resources suggests their active development and implementation in the USA and the EU. This explains that most of the projects are in English.

The part of Math courses on OER comparing to others offered is small. That indicates, in particular, the fact that Mathematics is less popular on these resources in relation to other sciences.

Experience of attending the courses allows talking about similarities and differences between traditional math courses on open educational resources and in Ukrainian universities. Thus, similar to Ukrainian are courses offered by Russian educational resources. It can be explained by established traditions of Soviet (but common) scientific and methodological school. Differences between foreign online courses and Ukrainian courses in technology study due, in our opinion, the various scientific and methodological approaches, and are found in the content of courses, number of hours for their study, practical tasks to form skills and control technologies. We believe that an important role in the development of these resources plays an imperious policy and funding (unfortunately, in Ukraine such projects are not funded and not encouraged because of bureaucratic obstacles in educational sector).

According to the experience obtained in the study of mathematical disciplines on open educational resources it can be determined what should be looked for when it comes to developing own electronic materials for teaching mathematics of the open model. In particular, it is necessary to create online lectures, video or multimedia presentations, taking into account the possible listener fatigue of the teacher, automated control, visualization of the results and communication on-line or off-line.

Assessing labor costs to create an online course, one should remember about not only the content, but also the form and the request. The foundation of classical course can be an educational standard. The content of the special course, usually the variable part of the curriculum, is developed at the discretion of the author or lecturer.

The ideas extend to create not just online video lectures and test control, but also such electronic educational products that provide interactive and multimedia support. This requires the involvement of programmers and psychologists, which increases the cost of quality educational content.

Online Mathematics courses in might be useful to teachers and Ukrainian students:

- While getting acquainted with such courses teachers can not only learn the experience of colleagues and learn specifics of teaching classical and new courses abroad, but also to increase their qualification, having an additional certificate of professional (or non-professional) disciplines.

- The practice of students studying certain subjects may include parallel attending of online course for which additional points can be accrued.

- The use of online courses can be productive in the organization of independent work of students, which is at least a third of all course hours and is not always evaluated by a teacher.

- These courses can be introduced in universities as a variable part of the curriculum of training in their preliminary review of the leading teachers of universities.

- Additional practice of English.

- Substantial support for one's image and promotion of the careers of everyone who dares to do so.

In Ukraine, the development of open educational resources is just beginning. Much of Ukrainian universities that are experienced in distance learning technologies are unwilling to share their own best practices and teach courses in open form. However, there are trends in the development of open content together with changes in the Ukrainian educational sector, that is why we believe that the expectations of the Ukrainian youth of the opportunity to use quality national open educational resources is not wasted.

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