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Experience of Environmental Education Products Designing

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***Abstract*—As education advances in digital epoch, the education process becomes adaptive and more and more individual to meet the demands of individual learners. Sustainable development, environmental protection, environmental management and environmental safety are now among the most popular areas of education in order to fulfil the demand in ecological mind formation as an essential soft skill.**

The article describes the experience of implementation of the results of two Erasmus + projects in 2015-2019 (Trans-Regional Environmental Awareness for Sustainable Usage of Water Resources / Treasure Water» and «Enhancing Competences in Sustainable Waste Management in Universities of Russia and Kazakhstan / EduEnvi) in the network interaction of several universities of Russia and Kazakhstan. The Projects aimed to create the most accessible educational products aimed at obtaining a new competence (EduEnvi), necessary for professional activity and vocational education (Treasure Water) using the capabilities of e-learning technologies.

The article discusses the results of projects - strategic positions and conceptual solutions of educational product developers to create the structure of training modules, the choice of specific methods and techniques of distance learning, methods of evaluation of learning outcomes, taking into account different levels of starting training competences of students, their goals and motivation, time frames and forms of educational services (full-time, distant or blended learning).

The effectiveness of the Projects is confirmed by the strengthening of relations in the field of environmental management and environmental education and the development of new areas of interaction between universities, economic entities and other social institutions, both within the partner States and at the regional level.

Keywords: open and distance education, e-learning, problem-based learning, sustainable development, environmental education, higher education, vocational education

I. INTRODUCTION

In January 2016, "17 Goals for Transforming Our World", proclaimed at the UN historic summit in September 2015 as the "2030 Agenda for Sustainable Development" came into force. The goal № 4 "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" states we must elaborate the approaches for advancing access to education process during the whole life for all people. Moreover, 2030 Agenda for Sustainable Development promoted new ideas about XXI century education needs and forms. This fact shows, there is growing interest in skills for sustainable development and especially in peaceful coexistence with the environment such as understanding of planetary boundaries, working in the green economy (knowledge of durable materials, relevant traditional skills,

carbon footprinting and environmental impact assessment skills, improving energy and resource efficiency, complying with environmental legislation, and reducing environmental pollution and waste) [1].

Thus, modern specialists in various fields of activity should have environmental competence - a willingness to take responsibility for actions in the professional sphere based on environmental laws [2], which is not an easy requirement. Training in the field of sustainable development, environmental protection and environmental safety is an interdisciplinary field that requires knowledge of the legal framework, technological and managerial capabilities, taking into account economic aspects, prevailing social relations and other factors.

Taking into consideration the forecasts of promising industries and professions for the next 15–20 years, reflected in the Atlas of New Professions [3], developed by the Agency for Strategic Initiatives and the Moscow School of Management SKOLKOVO, new environmental professions will appear (ecosystem services auditor, nature conservation manager, environmental producer, environmental preacher, ethical consumption consultant, environmental logistics specialist, etc.). Atlas developers noted the need to develop professional and supra-professional skills: systemic thinking, intersectoral communication, multilingualism and multiculturalism, project management, lean manufacturing, environmental thought, programming, working with people, working in conditions of uncertainty. The current situation leads to the need to develop approaches to maximize the formation of hard-skills (professional skills in the field of ecology) and soft skills (communicative, leadership, coworking, public and official communication abilities) of enrolled students.

The current Russian legislation enshrined the principle of the general accessibility of environmental education. Following article № 71 of the Federal Law "On Environmental Protection" № 7-FZ of January 10, 2002, environmental education is carried out in order to form an ecological culture and professional training of specialists in the field of environmental protection and includes general education, secondary vocational education, higher education and additional professional education specialists, as well as the dissemination of ecological knowledge, including through the media, museums, libraries, cultural institutions, environmental institutions, organizations sports and tourism. The subject of this article is higher education and additional professional education of specialists, primarily employees of ecological services of enterprises and specialists in the field of state, municipal and public waste management.

The transformation of higher education in the Russian Federation today is in the direction of expanding access to higher education, increasing flexibility, individualizing education to meet the needs of individual students. Continuing and vocational professional education shows similar trends [4]. The concept of lifelong learning is becoming the new norm; on the part of employees of environmental services of enterprises, there is a constant request for advanced training. One of the critical means of such a transformation is the development of distance education technologies, including the development of online courses, as the main version of online education.

Educational organizations actively promote online education; society has a strong demand for it. E-learning is an object of interest for the state, striving to increase its presence in this segment of the educational services market, as evidenced by the implementation of the priority project for 2016–2021 “Modern digital educational environment in the Russian Federation”, the purpose of which is to increase the availability of education and the implementation of the concept of lifelong education “through the development of the Russian digital educational space.” [5].

II. Literature Review and Research Methods

Today, in the scientific literature, there are a large number of review studies in the field of open and distance education. So, Ebben and Murphy, based on a search for articles in nine leading academic databases, performed an analysis of empirical studies on MOOCs taking into account the chronology of their appearance [6].

Chakiroglu et al. [7] conducted a content analysis of 989 articles published between 2009 and 2016. The results showed the following: (1) the main topics in the articles were the basis of open and distance education, the educational process and the results of the application; (2) increased publication of articles on massive open online courses, open educational resources, and students' points of view; (3) new pedagogical approaches and online learning design played a leading role in research topics; and (4) technological and pedagogical developments between 2011 and 2012 influenced the trend of articles.

Zawacki-Richter et al. compiled a research map on the topic of open courses, in which four primary areas of research are distinguished: 1) the potential and problems of MOOCs for universities; 2) MOOC platforms; 3) students and MOOC content; and 4) MOOC quality and curriculum design issues [8].

Zawacki-Richter and Naidu found a similar pattern of research in the last 35 years in the broader field of open, distance, and flexible learning [9].

The correct understanding and use of online terminology, definition of criteria and approaches to classification is important. Grechushkina developed a classification of online courses based on six criteria: the principle of construction, the interaction of students, the duration of training, the organization of training, the purpose of training and access to the course [10]. The named criteria determined the categories of courses, within which thirty-type online courses are presented, which are discussed in detail in the descriptive part of the classification. Each course can be determined unambiguously when classifying according to one attribute and assigned to several types when considering its various attributes.

Researchers are focusing on one of the most severe problems associated with the implementation of online courses

- the high drop-out rates. Vázquez et al. show that the key factors contributing to the completion of courses are motivation, digital skills, available knowledge of the subject and the degree of satisfaction with the courses. The adequate student assessment system is equally important [11, 12].

Closely related to the level of completion of open courses is the question of student contingent studies. Based on an analysis of open Internet sources and open educational resources Datsun N.N. and Urazaeva offered a formal description of models of students studying mass open online courses [13]. The criteria for the interaction of students with educational resources considered in work showed (the reason for subscribing, completing assignments with assessment, the regularity of visits) that these interactions do not depend on the subject area of the course content and the pedagogical approaches used in it. The formalization of models of online students proposed in this work can serve for educational analytics of existing courses in order to identify reserves for reducing the dropout rate of students and individualize the learning process.

However, there are works dedicated to the personality of teachers - developers of electronic courses. So, S. J. Blackmon studied the reasons for learning in the MOOC format, the advantages of MOOC, the problems of teaching MOOC and the consequences for other types of courses [14].

The modern pedagogical practice has gained considerable experience in distance learning courses in the sphere of environmental education and the issues of the impact of environmental distance education on the environmental behaviour of people [15].

The world-famous online learning platforms are Coursera, edX, Udacity, Future Learn, SkillShare, Datacamp, diversity and others. The world leaders in distance environmental education are the educational platforms Coursera and edX.

Courses offered on the Coursera platform on environmental research and sustainable development describe the difficulties of satisfying human needs in the short term and at the same time maintaining ecological systems in the long term. The most popular topics are nature conservation, environmental policy, agriculture, sustainable development, environmental pollution and climate change.

Out of 1,578 courses, 202 on the edX platform address environmental issues. The Lausanne Federal Polytechnic School's "Utilization of Municipal Solid Waste in Developing Countries" (Coursera) and the Delft Technical University "Water management" (edX) courses are examples of those in the thematic areas of waste management and water management.

Two courses ("Introduction to Mineral Geology" (St. Petersburg State University), "Life in the Soil" (National Research Tomsk State University)) form the offer of online courses on environmental topics in the Russian-language Coursera segment. There are no environmentally oriented courses in the Russian-language segment of edX. Comprehensive courses on waste management and water resources management are not offered (except for narrowly oriented courses on engineering and technical aspects of water resources management).

Until 2014, paid online courses and programs (especially in English, IT) dominated in the Russian market of e-learning. However, since 2015, as part of the "Open Education Project", Moscow State University, HSE, St. Petersburg State University, NITU MISiS have implemented open online courses [16]. Today, other universities are actively involved in the development of online education: TSU (https://mooc.tsu.ru/ru/), Tyumen State University (http://distance.ru/mooc), FEFU (https://www.dvfu.ru/education/online-training/), Voronezh State University (https: //mooc.vsu.ru/) and others. Currently, such open educational systems as "Universarium", "Uniweb", "Lektorium" are actively used, creating a network of an inter-university educational platform.

Frequency charts of language units based on printed sources digitized by Google using the Google-Ngram service illustrate the interest in online education in the field of sustainable development, environmental protection and environmental safety. The resulting figures 1 and 2 show that interest in the topic of environmental education in the world and the Russian Federation reached peak values in the mid-late 1990s. with some delay in Russia, after which it began to decline. However, it is still at a relatively high level. As for distance education, its mention in Russian-speaking countries is generally lower than in English-speaking countries. One can note the high potential of the market of electronic educational services in the Russian Federation, including in the field of environmentally-oriented education.

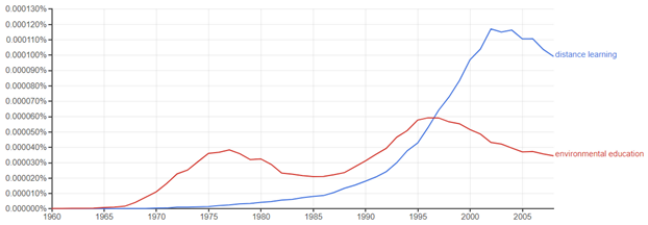

Fig. 1. Frequency of the terms "distance learning" and "environmental education" occurrence according to the Google-Ngram service in English sources

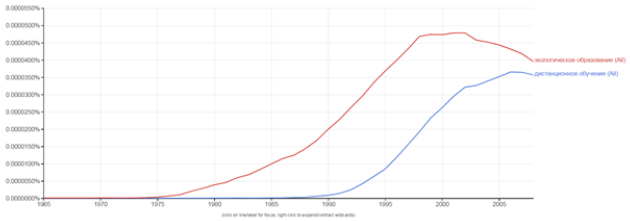

Fig. 2. Frequency of the terms "distance learning" and "environmental education" occurrence according to the Google-Ngram service in Russian sources

Thus, the literature review showed that there is a gap between the need for environmental distance education products and the offer of educational services in the Russian segment of the market, which justifies the need to create a

distance educational product for environmental education, in particular, education on sustainable waste management and transboundary water management.

As a methodological and pedagogical base for creating the structure of training courses, the selection of specific methods and techniques of distance learning, assessment methods, the approaches used in advanced European educational organizations were used [17-18]. As the primary teaching methods, a problem-oriented (practice-oriented approach) and cooperation between educational organizations and industrial partners were chosen.

III. RESULTS

The teaching staff of the Institute of Earth Sciences of the University of Tyumen in 2015-2019 participated in the implementation of two projects within the framework of the EU program "Erasmus +".

The first project (2015-2019), Trans-Regional Environmental Awareness for Sustainable Usage of Water Resources / Treasure Water, had as its main goal the improvement of the interaction of universities with enterprises in Russia and Kazakhstan through the creation of an institutional model and methodology called "Partnership in Learning between industry and universities "and the design (creation) of training courses / curricula in the field of transboundary cooperation in water resources management.

The second project (2017-2020), Enhancing Competences in Sustainable Waste Management in Universities of Russia and Kazakhstan / EduEnvi, aims to modernize, improve the accessibility and to internationalize the higher education in Physical sciences and Environmental protection in Kazakhstan and Russia. This aim will be achieved by building the capacity of the local academic staff (leading target group of the project) in participating partner country universities 1) in sustainable waste management and 2) in the latest European pedagogical approaches. Additionally, eight online learning modules will be built on sustainable waste management to benefit the secondary target group, students and company /local/regional authority staff.

Table I summarizes the key characteristics of both projects, reflecting the starting conditions for designing training courses and their requirements.

As for the implementation of projects, it is necessary to focus on their conceptual differences, which determined the form and content of the proposed training courses: the nature of the tasks and the target audience. In the first case, an educational product aimed to improve skills, to obtain additional competencies or retraining specialists. In the second case, the educational product is focused on obtaining academic knowledge and developing skills covering various aspects of one problem, and involves learning "from scratch" or almost "from scratch".

TABLE I. ONLINE EDUCATION DESIGN BASELINE

Comparison criteria	**"Treasure Water"**	**"EduEnvi"**
Project Objectives	Creation of a dynamic model of cooperation between universities, enterprises and other social institutions in the field of transboundary water management. Modernization of educational resources and professional retraining of academic staff on the basis of an interdisciplinary approach to sustainable water use. Strengthening the capacity of businesses related to the management of transboundary water resources through the development of effective methodological tools and training courses. Introduction of new modules and courses based on the European Credit Transfer System (ECTS) in the professional training of specialists in the indicated direction. Creation and equipping of coordination and resource centres in all university-partners. Quality control of developed programmes. Wide dissemination of positive experience of the project.	· To help the teachers from Russian and Kazakh universities to adopt the latest research, best practices, and latest technology in Europe in Sustainable Waste Management. · To develop new curricula. · To integrate entrepreneurship and innovation methods into the learning modules. · To develop 8 e-Learning modules on sustainable waste management (each university will build one-two modules of 6-9 ECTS).
Team Leader	Albert Ludwigs University Freiburg (Germany) (the project coordinator and the EU subcontractor)	Tampere University of Applied Sciences - TAMK, Tampere, Finland - the chair of the steering group and the coordinator of the European partners
Other participating organisations	1. University of Tyumen, Tyumen (Russia) (non-EU partner coordinator) 2. Aristotle University of Thessaloniki (Greece) 3. University of Athens (Greece) 4. Radboud University, Nijmegen (The Netherlands) 5. University of Wolverhampton (UK) 6. Altai State University, Barnaul (Russia) 7. Tomsk State University, Tomsk (Russia) 8. Yugra State University, Khanty-Mansiisk	1. Erhvervsakademiet Lillebælt; 2. University of Valladolid; 3. ITMO University (former St. Petersburg National Research University of Information Technologies, Mechanics and Optics); 4. Ural Federal University named after the First President of Russia B. N. Yeltsin, UrFU; 5. University of Tyumen, UTMN;

	(Russia) 9. East-Kazakhstan State University, Ust-Kamenogorsk (Kazakhstan) 10. Eurasian National University, Astana (Kazakhstan) 11. Institute for Water and Ecology Problems, Barnaul (Russia) 12. Wasserversorgung, Stuttgart (Germany) 13. Tyumen Municipal Company Vodokanal LLC, Tyumen (Russia)	6. Al-Farabi Kazakh National University - KazNU; 7. Sh.Ualikhanov Kokshetau State University, KokSU; 8. M. Auezov South-Kazakhstan State university, SKSU; 9. Ministry of Education and Science, Kazakhstan
Target group of the project	Learners	Local academic staff
Learning destination (student population)	employees of environmental services of enterprises and representatives of state bodies competent in the field of transboundary water use	undergraduate and graduate students (Bachelor and Master students), specialists in the field of state, municipal and public waste management
Students background particular qualities	There are specialized knowledge and practical experience on the subject of the course. It is necessary to obtain in-depth knowledge of narrow issues, taking into account the latest changes in the regulatory framework.	There is a fundamental knowledge of ecology, waste management issues. It is necessary to give a detailed, comprehensive presentation on the field of waste management, including an understanding of the technological features of the processes of generation, processing and disposal of waste, legal requirements and an understanding of business processes.
By whom and on what basis are the requirements for the content of the training course determined?	Customer enterprises and their employees	The teaching staff of partner universities, taking into account the request from potential employers for a diversified specialist
Training time requirements	Short-term courses and mini-online courses (on request, as needed)	Medium-term courses (average 6-8 weeks)

In the first case, a catalogue of modules has been developed (more than 50 modules). The modules reflect various aspects of transboundary water use from general theoretical issues of the formation of runoff of transboundary water bodies, organization and conduct of environmental monitoring, design and operation of water management systems, to the use of various GIS programs to ensure sustainable water use and management and regulatory support governing water use at national and internationally. Students can independently choose the modules necessary for their individual needs (see fig. 3, 4) and thereby independently determine the training time. Accordingly, the proposed training structure is fully adapted to the needs of the target audience.

In the second case, the training course consists of 8 modules, including 2-3 courses each, which the student needs to study (see fig. 5) successively. The structure of the modules allows to get a comprehensive understanding of the problems of waste and relevant practical skills: from the general concept of environmental risks and related socio-economic problems, through technical and technological aspects, students come to managerial issues and acquire business competencies. Among the issues addressed there is also the life cycle assessment methodology, since any product sooner or later turns into waste, and the prevention of waste generation lies in the plane of product design taking into account environmental aspects. Each course takes 6-8 weeks, and the total duration of training is measured in many months and can reach two years. The pace of training in this project is quite rigidly fixed - the time taken to complete the tasks and the time limit for mastering the material of each course/module are set.

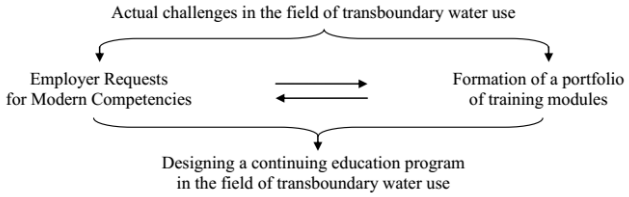

Fig. 3. The mechanism of interaction between academic, managerial and industrial partners in the framework of the Treasure-Water Project

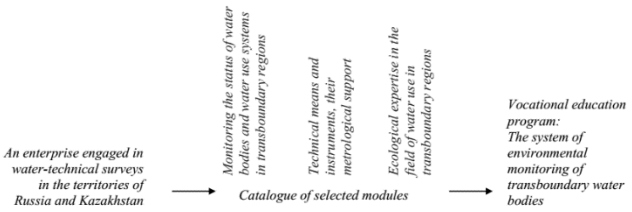

Fig. 4. An example of the implementation of the modular principle of educational-thematic planning in the framework of the Treasure-Water Project

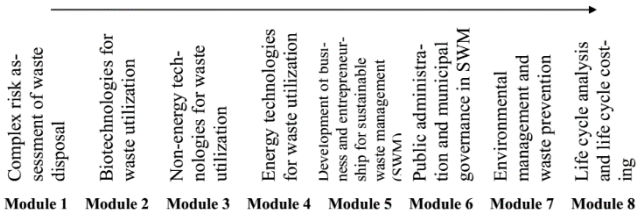

Fig. 5. EduEnvi Project Curriculum Modules

Both projects do not have an exclusively educational-oriented goal (knowledge transfer), but both are focused on

the labour market and the formation of problem-oriented learning.

In the format of massive online courses, the implementation of problem-based learning, based on team collaboration and leadership by the teacher, is more difficult, but not impossible. Virtual teams can collaboratively solve learning tasks online without detailed guidance, but this will require additional communication and technological skills and support. An explicit discussion of the issues of group organization and work on tasks, a positive atmosphere and the acceptance of unequal contributions are decisive factors. Additional support is needed to prepare participants for work in a virtual team, to develop digital literacy and to stimulate more multiple brainstorming sessions and discussions [19].

Competencies were determined based on an analysis of requests from industrial partners, municipal authorities and other persons interested in training personnel in the field of sustainable waste management.

Table II summarizes the characteristics of the result of designing training courses.

TABLE II. RESULTING ONLINE EDUCATION DESIGN SUGGESTIONS

Comparison criteria	**Treasure Water**	**EduEnvi**
Structure of training modules	Catalogue of modules from (at the request of students and employers) for programs of continuing education courses	8 modules covering various interdisciplinary aspects of the issue
Education forms	Mixed: face-to-face, e-learning, full-time. The consumer selects the training modules and their level (basic, advanced, expert). The consumer determines the university and the form of education.	e-learning (academic disciplines should be on the same platform and should be accessible to consumers in Russia and Kazakhstan)
Types of learning activities	Lectures Additional materials (Useful links, Legal framework) Learning and executing tasks: Test questions Learning tasks: 1) Individual tasks: Categorizations (spidergram) flowcharts, calculations, modeling (using softs) 2) Group tasks: case-study, simultational Executing task: Case-study (individual)	· Lectures · Video (5-10 minutes) + Additional materials (Useful links, Legal framework) · Learning and executing tasks: Test questions · Learning tasks: 1) Individual tasks: Categorizations (spidergram) flowcharts, calculations, modeling (using softs) · 2) Group tasks: case-study, simultational · Executing task: Case-study (individual)

The realities of modern life encourage us to keep the educational content up to date; therefore, the training courses developed in both projects require constant updating for lifelong learning [20].

IV. DISCUSSION

Both educational products are in the piloting stage, so at the moment it is not possible to assess the exact number and contingent of students, the percentage of completion of courses, the degree of satisfaction of students. At the same time, at this stage, the strengths and weaknesses of the projects can be assessed.

Strengths of the products:

1) *The integration of highly qualified scientific and pedagogical personnel at the international level* has been achieved, which is in line with global trends in creating clusters of universities within the regions or on a thematic basis [20].

2) *The success of the model of cooperation between the education system and the industrial sector* in the Russian Federation and Kazakhstan was confirmed.

3) *Adaptability and scalability of projects* to the conditions of different countries (in particular, Russia and Kazakhstan).

4) *Gaining experience in organizing the interaction with target groups* (industrial and institutional partners).

5) *The availability of the proposed models of training "here and now"* and the formation of "best practice".

6) *Designing educational-thematic planning for the target audience* (client-oriented communication).

Weaknesses of the products:

7) *Institutional difficulties*, including reduced development of the Russian segment of online education, lack of resources of educational institutions for the development of e-learning infrastructure and the creation of an online educational product at a high level, the difficulty of ensuring the availability of a personal learning environment for each student.

8) *Environmental legislation in Russia and Kazakhstan is actively developing*, i.e. continually changing, which requires regular updating of course materials and practical tasks.

9) *In Russian and Kazakhstani universities the use of Learning Management Systems (LMS) is not well developed*: there are almost no government services, legal support for online learning and no system for evaluating the quality of online courses has been created.

10) *A high proportion of students with insufficient digital competence*, low motivation and self-organization.

Regarding the prospects for using an educational product, distance learning technologies are developing at an extremely high speed. Distance education can and should become part of the education system of post-Soviet states at the national and regional levels, especially when it comes to such famous areas as education in the field of sustainable development,

environmental protection, nature management and environmental safety.

Subsequently, based on the methodology proposed by Datsun and Urazaeva in Ref. 10, by formalizing the models of online learners, reserves can be identified for reducing the dropout rate and individualization of the learning process.

The modules of the program will ultimately be presented in three languages (English, Russian and Kazakh) and in the future may become the basis for the creation of new master's programs in universities in Russia and Kazakhstan, including with joint diplomas.

The experience of project implementation can be used to develop training courses in other priority areas of environmental education (conservation of biodiversity, elimination of accumulated environmental damage), as well as extrapolated to other priority areas of Russian education.

V. CONCLUSION

Today, humanity faces multiple challenges and environmental threats. One of the most popular areas of education was an education in the field of sustainable development, environmental protection and environmental safety (environmental education), and one of the most popular forms of education is distance education. In Russia and Kazakhstan, there is an urgent need for educational programs in this field of knowledge, since the educational products available on the market are not enough for specialists in this field to take a responsible approach to solve the similar problems.

The article describes the experience of implementing two Erasmus + projects in the field of water resources management and waste management. During their implementation, the authors studied the latest research in the field of online education, advanced methodological approaches to the design of online courses. As a result, decisions were made on the structure of training modules, methods and techniques of training and assessment of results, taking into account the characteristics of each project.

As part of the preparation of this article, a comparative evaluation of the projects was carried out showed that these projects vary significantly, win the nature of the tasks and the target audience. At the same time, in both projects, the practice-oriented approach / problem-oriented training passes through a cross-cutting idea.

The development of educational products had the high number of positive effects, including an expansion of international cooperation between partner universities in the field of higher and additional education, the involvement of government representatives in the development of the program of industrial enterprises. However, it should be noted that for more effective implementation of online education, universities in Russia and Kazakhstan need to master the use of Learning Management Systems (LMS).

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