ИНФОРМАЦИОННЫЕ ТЕХНОЛОГИИ В ОБРАЗОВАНИИ

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Using MOOCs to organise problem-based learning in the professional training of IT students

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Abstract*. Introduction.* The digital transformation of education plays a key role in the formation of in-demand IT specialists. In modern conditions, the method of problem-oriented learning is actively being introduced into the educational process of higher education and contributes to the formation of professional, communicative and digital competencies of IT students. *Aim.* The present research *aimed* to validate the incorporation of massive open online course (MOOC) components in the organisation of problem-oriented training for IT students to enhance their professional competencies. *Methodology and research methods.* The study was conducted over two academic years, beginning in 2022, at Academician E. A. Buketov Karaganda University. A total of 24 teachers participated in the specialised training of IT students, along with 86 students participated. At the first stage, a model was developed to integrate MOOCs into the structure of a specialised IT discipline within the framework of a specialised IT discipline, utilising problem-oriented learning. Additionally, the baseline level of students' readiness to engage with MOOC courses was assessed. At the second stage, the effectiveness of utilising MOOC courses for implementing problem-oriented learning in the study of IT disciplines was assessed. At the third stage, the results were summarised and conclusions were drawn. *Results and scientific novelty.* The approaches to the organisation of problem-based learning in the preparation of IT students were defined. The use of Coursera MOOCs as the most convenient platform for studying IT courses was justified. A model of MOOC integration into the structure of an academic discipline in the organisation of problem-oriented learning was developed and experimentally tested. *Practical significance.* The results of an empirical study of student involvement in the use of MOOCs in problem-based learning prove the functionality of Coursera MOOC courses and their positive impact on the learning process. The feasibility of utilising MOOCs for implementing problem-oriented training aimed at developing students' professional IT competencies is well-supported.

***Keywords*:** massive open online courses, MOOCs, problem-based learning, IT student training

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Использование МООК при организации проблемно-ориентированного обучения в профессиональной подготовке студентов IT-направления

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Аннотация. *Введение*. Цифровая трансформация образования играет ключевую роль в формировании востребованных IT-специалистов. В современных условиях метод проблемно-ориентированного обучения активно внедряется в образовательный процесс высшего образования и способствует формированию профессиональных, коммуникативных и цифровых компетенций студентов IT-направления. *Целью* исследования является обоснование использования компонентов МООК в организации проблемно-ориентированного обучения студентов IT-направления для повышения их профессиональных компетенций. *Методология, методы и методики.* В исследовании, которое проводилось на протяжении двух учебных лет с 2022 года на базе Карагандинского университета имени академика Е. А. Букетова, участвовали 24 преподавателя, осуществляющих профильную подготовку студентов IT-направления, и 86 студентов. На первом этапе была разработана модель интеграции МООК в структуру профильной IT-дисциплины в рамках проблемно-ориентированного обучения, определен начальный уровень готовности студентов к использованию курсов МООК. На втором этапе выявлялась эффективность использования курсов МООК при реализации проблемно-ориентированного обучения при изучении IT-дисциплин. На третьем этапе обобщены результаты и сформулированы выводы. *Результаты и научная новизна.* Определены подходы к организации проблемного обучения при подготовке студентов IT-направления. Обосновано использование МООК Coursera как наиболее удобной платформы для прохождения IT-курсов. Разработана и экспериментально проверена модель интеграции МООК в структуру учебной дисциплины при организации проблемно-ориентированного обучения. *Практическая значимость.* Результаты эмпирического исследования вовлечения студентов в использование МООК в условиях проблемного обучения доказывают функциональность курсов МООК Coursera и положительное влияние на учебный процесс. Обоснована целесообразность использования МООК в условиях реализации проблемно-ориентированного обучения для развития профессиональных IT-компетенций студентов.

Ключевые слова: массовые открытые онлайн-курсы, МООК, проблемное обучение, проблемно-ориентированное обучение, профессиональная подготовка студентов IT-направления

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Empleo de los MOOC en la organización del aprendizaje basado en problemas durante la formación profesional de los estudiantes con orientación en TI

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Abstracto. *Introducción*. La transformación digital de la educación juega un papel clave en la formación de especialistas con gran demanda en las tecnologías de información (TI). En las condiciones actuales, el método de aprendizaje basado en problemas se ha ido introduciendo activamente en el proceso formativo de la educación superior y contribuye a la formación de competencias profesionales, comunicativas y digitales de los estudiantes de Tecnologías de información. *Objetivo.* El objetivo del estudio es fundamentar el uso de los componentes de los cursos masivos abiertos en línea (MOOC) en la organización de la formación basada en problemas para estudiantes de Tecnologías de información con el fin de mejorar sus competencias profesionales. *Metodología, métodos y procesos de investigación*. En el estudio, que se llevó a cabo durante dos años académicos a partir de 2022 en la Universidad de Karagandá Académico E.A. Buketov, participaron 24 profesores que imparten formación especializada a estudiantes de Tecnologías de información y 86 estudiantes. En la primera etapa, se desarrolló un modelo para integrar los MOOC en la estructura de la disciplina especializada de Tecnologías de información en el marco del aprendizaje basado en problemas y se determinó el nivel inicial de preparación de los estudiantes para utilizar los cursos MOOC. En la segunda etapa, se reveló la eficacia del uso de cursos MOOC en la implementación del aprendizaje basado en problemas en el estudio de las disciplinas de las TI. En la tercera etapa, se resumen los resultados y se formulan conclusiones. *Resultados y novedad científica.* Se han identificado enfoques para organizar el aprendizaje basado en problemas en la preparación de estudiantes de Tecnologías de información. El uso de los cursos MOOC Coursera se justifica, ya que es la plataforma más conveniente para realizar cursos en TI. Se ha desarrollado y probado experimentalmente un modelo para integrar los MOOC a la estructura de la disciplina académica en la organización del aprendizaje basado en problemas. *Significado práctico.* Los resultados del estudio empírico sobre la participación de los estudiantes en el uso de los MOOC en entornos de aprendizaje basado en problemas, demuestran la funcionalidad de los cursos MOOC Coursera y el impacto positivo en el proceso de aprendizaje. Se fundamenta la viabilidad de utilizar los MOOC en el contexto de la implementación del aprendizaje basado en problemas para el desarrollo de competencias profesionales en TI de los estudiantes.

Palabras claves: cursos masivos abiertos en línea, MOOC, aprendizaje basado en problemas, formación profesional para estudiantes de Tecnologías de la información

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Introduction

In the modern world, the growth of digital technologies and automation leads to an increase in demand for qualified IT specialists [1, 2]. Digital technologies contribute to innovation and technological progress, allowing the creation of new

products and services that change people's lives and make it more comfortable and efficient [3, 4]. In the work of van E. Laar, van A. Deursen, van J. Dijk et al., it is emphasised that IT specialists play a key role in the processes of globalisation and digital transformation, ensuring the functioning and development of information systems, networks and platforms [5].

In the process of preparing IT students, the main difficulty is created by the dynamism of the development of digital technologies and the IT industry, changing requirements for the professional competencies of graduates from employers and the global labour market. This aspect requires the academic environment to apply effective approaches to training specialists. One of the most widely used teaching and learning strategies in engineering and IT education are problem-based learning (PBL) and project-based learning, which have been studied in sufficient detail in traditional learning environments by scientists J. E. Mills, D. F. Treagust [6], J. Chen, A. Kolmos and X. Du [7], and V. N. Petrova [8] and others. Students studying PBL technology face real-world challenges that require an integrated approach and analytical thinking.

However, aspects of the implementation of PBL with the parallel introduction of massive open online courses (MOOCs) into the educational process, especially in the context of professional training of IT students, require additional attention, according to E. M. Dzyuba, V. T. Zakharova, A. L. Latukhina et al. [9], I. V. Afanasiev, N. V. Vysotskaya, V. N. Alferov et al. [10].

Digital technologies influence the content and quality of education, but also determine the choice of methods, means and forms of educational organisation [11]. According to M. N. Wagner, M. Kupriyanova, U. Ovezova et al. [12], the use of MOOC platforms can significantly enrich the educational process, provide students with access to the best resources, experts and technologies, as well as contribute to the development of critical skills for a successful career in the IT field.

The purpose of this study is to substantiate the possibility of using MOOC components in the organisation of problem-oriented training of IT students to improve the professional competencies of IT students, gain skills in collective problem solving and software development close to real participation in production.

To determine how problem-oriented learning using MOOC platforms expands the professional competencies of IT students, the following research questions will be considered:

1. Which MOOC platforms can be used in the study of IT profile disciplines?
2. How can MOOC courses be integrated in the organisation of problem-oriented training within the framework of IT profile discipline?
3. What factors increase and/or hinder the success of problem-based learning in the study of specialised IT disciplines using MOOCs from the point of view of students?
4. How does problem-based learning using MOOCs affect personal professional competencies (communication skills, teamwork, group decision-making) when performing an IT project?

Literature Review

MOOCs have become an increasingly popular online learning environment in higher education in recent years. MOOC courses offer content developed by leading universities and corporations, including short video lectures, digital text, interactive assignments, discussion forums and quizzes [12]. This allows students to access up-to-date information and study the latest technologies and methods used in the industry. According to P. Rodríguez, A. Armellini, V. C. Villalba, MOOC platforms and courses provide people with different points of view, different religions and different nationalities with the opportunity to receive the same education [13].

According to D. Santandreu Calonge and M. Aman Shah, MOOCs are used to identify gaps in the competence of university graduates when working at work, professional development and career growth [14].

I. Irwanto, D. Wahyudiati, A. Saputro et al. [15] emphasise that as a special type of digital education, MOOCs can be considered as a combination of elements of education (implementation and training) and interaction with the public (additional education). A typical MOOC has learning objectives and a clear course fellowship structure based on academic experience and instructional learning objectives (learning features). Many MOOC projects have the support of an educational institution, which can be important when developing a course.

A. A. Al-Imarah & R. Shields [16], N. F. Sa'don, R. A. Alias, N. Ohshima [17] summarised the results of the analysis of scientific articles devoted to the problems of using MOOCs. The research works by Y.-P. O. Eyitayo & O. D. Bolaji [18], N. K. Annan & C. Jnr. Asiedu [19] are devoted to the transformation of e-courses into MOOC courses.

K. F. Hew & W. S. Cheung identified some problems of MOOC teaching, namely: difficulties in evaluating studentsə work, lack of immediate feedback from students, time and financial difficulties, as well as insufficient student participation in online forums for collective discussion of issues [20].

The development of MOOC platforms occurs as a result of the spread of new technologies, the use of Web 2.0 and 3.0 tools, and cloud technologies, therefore, the peculiarity of using MOOCs in training is the condition of independence and high motivation of students to successfully complete the course. T. A. Ivashkina, V. N. Sidorenko and E. I. Sukhova [21], C. Alario-Hoyos, I. Estévez-Ayres, M. Pérez-Sanagustín et al. [22] considered issues related to the influence of MOOC courses on the development of interest and motivation in the educational process. T. Bystrova, V. Larionova, E. Sinitsyn et al. identified a number of opportunities for MOOCs to assess students' academic achievements [23].

Due to the increased popularity of MOOCs, the researchers N. K. Annan & C. Jnr. Asiedu [19], A. Bressler, R. M. Quintana and M. Zint [24], M. S. Al-Aghbari, M. E. Osman and A. S. Al-Musawi [25], S. Bulfin, L. Pangrazio and N. Selwyn [26], H. Sebbaq & N. El Faddouli [27] paid serious attention to the analysis and improvement of the quality of MOOC platforms and courses.

Of particular interest are studies that offer recommendations for integrating MOOC courses into the learning process. For example, J. R.Tayag & M. R. Tayag describe the experience of using MOOCs in college in addition to academic assignments [28]. Many researchers suggest using MOOC courses in the context of blended or distance learning [10, 12, 21].

Depending on the areas of students' training, specific requirements for the structure and content of MOOC courses and the methodology of their use are highlighted. Thus, P. de Jong, J. D. Pickering, R. A. Hendriks et al. summarised the experience of using MOOC medical courses and offered a number of tips on integrating MOOCs into the educational process [29].

The research by A. A. Beloglazov & L. B. Beloglazova revealed a number of problems and tasks that may arise when integrating MOOCs into the educational process when teaching computer disciplines [30]. At the same time, the authors recommend using various teaching methods, including problem-oriented learning. Other researchers agree with this and consider problem-oriented learning as one of the effective methods of student-centred learning [31, 32].

Researchers in the field of problem-based learning offer different approaches to the definition of the concept (Table 1).

Table 1

Approaches to the concept of "problem-based learning"

Resource	An approach to defining the concept of "problem-based learning"
A. M. Matyushkin, E. V. Kovalevskaya et al. [32]	*Problem-based learning in the context of developmental learning:* Problem-based learning is aimed at developing students' ability to formulate problems independently, search for and find ways to solve them, which contributes to the development of their intellectual and creative abilities.
V. A. Sitarov [33]	*Problem-based method as a means of increasing the effectiveness of learning:* Problem-based learning is based on students gaining new knowledge by solving theoretical and practical problems, tasks in problematic situations created for this purpose.
C. C. Bonwell, J. A. Eison [34]	*Problem-based learning within the framework of an interactive approach:* Problem-based learning is considered as one of the forms of an interactive approach in which students actively participate in the learning process, solving real or simulated tasks, which contributes to a deeper assimilation of the material.
A. Aslan [35]	*Problem-based learning as a way to increase student motivation:* Problem-based learning helps to increase students' motivation by involving them in the process of actively searching and solving problems, which makes learning more interesting and meaningful for them.
K. H. Tseng, C. C. Chang, S. J. Lou, W. P. Chen [36]	*Problem-based learning in the context of STEM education:* Problem-based learning in STEAM disciplines (science, technology, engineering, mathematics) is aimed at developing students' ability to think interdisciplinary and apply knowledge in practice.
A. Kolmos, E. de Graaff [37]	*Problem-based learning as a means of developing professional competencies:* Problem-based learning contributes to the development of professional competencies among students by performing practice-oriented tasks that are close to real professional situations.

Problem-based learning allows us to combine modern computer technologies [38], web services [39, 40], artificial intelligence and chatbots [41], cloud technologies [42], MOOC platforms [43]. In the context of digitalisation of the educational space and the need to adapt to changing learning conditions, digital technologies are becoming not just a convenient tool, but also an integral part of the educational process.

The scientific research described above partially addresses the issues of MOOC implementation in the higher education system and explores some aspects of problem-based learning. However, the specifics of integrating MOOCs into the structure of training IT specialists in the organisation of problem-based training are not sufficiently considered. The hypothesis of this study: the components of MOOC courses can be used at different stages of studying specialised IT disciplines (in practical work, when performing individual and team tasks, in the process of independent work of students), which will improve the professional competence of IT students.

Limitations of the study: the approbation of the pedagogical model of MOOC integration into the structure of the academic discipline within the framework of problem-based learning was carried out on a limited sample consisting of students from one university (Academician E. A. Buketov Karaganda University, Kazakhstan).

Materials and Methods

The study took place in three stages during the 2022–2023 and 2023–2024 academic years.

Stage 1. Tasks of the 1st stage: 1) identification of MOOC platforms and courses in the study of specialised IT disciplines, which are used by teachers in the study of IT disciplines of the curriculum of IT specialities of Academician E. A. Buketov Karaganda University (Karaganda Buketov University, KBU): “Information Systems”, “Software Engineering”, “Mathematical and Computer Modelling”; 2) selection and justification of ways to integrate MOOC courses into the educational process; 3) selection of actual problem tasks in the field of disciplines.

Stage 2. Conducting experimental work, identifying the effectiveness of using MOOC courses in the implementation of problem-based learning within the framework of studying specialised IT disciplines;

Stage 3. Control – summing up the results of the experiment, summarising the results and formulating conclusions.

This study involved 24 teachers of the Department of Applied Mathematics and Computer Science of KBU, who carry out specialised training of IT students, and 86 students (42 students – the control group (CG), 44 students – the experimental group (EG)).

The study uses theoretical methods (literature analysis, comparison of researchers’ opinions on the use of MOOC in student education, generalisation and systematisation of theoretical material on the studied problem) and empirical research methods (student survey, conversations with students and teachers, analysis of the results of experimental research).

Results

Stage 1 (ascertaining). An online survey of teachers of Academician E. A. Buketov Karaganda University was conducted in order to find out the preferences of choosing and using the MOOC platform in the framework of studying specialised IT disciplines using the Google Forms tool. The choice of a specific platform depends on the specifics of the discipline, the objectives of the problem task, the specifics of the tasks and the preferences of teachers and students.

The following MOOC platforms are most popular in IT education: Coursera, edX, Udacity. FutureLearn and Udemy platforms are not so popular, so certificates are not very appreciated among IT employers.

The results of comparing the characteristics of MOOC platforms and the results of teacher preferences are presented in Table 2. The teacher survey included a multiple choice option.

Table 2

Comparative characteristics of global MOOC platforms

Basic characteristics of the platform	Coursera	EdX	Udacity	Udemy	FutureLearn
The choice of teachers, (%)	87%	37%	8,6%	4,2%	4,2%
Registration	Mandatory				
Language support	English + subtitles	English	English	English, Russian	English
Certificate	from $29 for a certificate or subscription to a block of courses: $59 per month with the receipt of a certificate	from $49 per certificate, subscription with certificate receipt – $516.60 per month	from $80 per certificate, subscription with a certificate is $399 per month	from $64.99 per course with a certificate	from $350, a subscription with a certificate – from $14.58 per month
The average duration of the course	from 2 weeks to 6 months	from 4 weeks to 6 months	from 2 hours to 6 months	from 2 to 180 hours	4–6 weeks

The results of a survey of teachers revealed that the Coursera MOOC platform is the most preferable for studying IT courses. As the results of a comparative analysis of the platforms have shown, most of the world's MOOC platforms conduct their courses in English, do not provide an opportunity to study for free and receive a free certificate, the duration of the courses offered varies from several weeks to several months. However, for IT students, proficiency in English is one of the modern requirements of the industry, special attention is paid to the study of English in the preparation of IT students, so this is not a significant obstacle to studying the MOOC course (this issue will not be considered in the article).

In this study, the Coursera platform was used to implement problem-based learning for IT students for several reasons. Firstly, due to the fact that Coursera is the largest training resource, Coursera certificates are appreciated by IT employ-

ers. Secondly, Academician E. A. Buketov Karaganda University participates in the financing programme of the Ministry of Science and Higher Education of the Republic of Kazakhstan for the implementation of the project "Coursera Education" by institutions of higher and (or) postgraduate education; therefore, the university has been providing free tuition for university students on the global online learning platform Coursera since 2022. The training of students in streams has been organised, at the moment 1800 university students of all specialties have been trained with a certificate. Therefore, all students of KBU IT specialities had the opportunity to study at the selected profile course on the Coursera platform – as a separate online course, upon completion of which students received certificates. The students used the received certificate later in their personal portfolio to choose a place of work practice and employment.

At this stage of the study, the disciplines within which it is permissible to implement problem-based learning according to the curriculum of the disciplines are identified. Two disciplines have been selected: "Programming in Python", "Web Technologies", which are studied in different semesters of the third year. The choice of disciplines is justified by the necessary basic professional competencies already formed in the 1st and 2nd courses; in addition, third-year students already have experience in implementing collaborative IT projects.

Further, the teachers, together with representatives of IT companies in the region, defined the requirements for the subject and content of student problem tasks, and developed criteria for their assessment.

Based on the results of theoretical research, we have developed a model for integrating MOOC into the structure of an academic profile discipline in the organisation of problem-based learning for IT students (Fig. 1).

Academic discipline

Lectures	Practical (laboratory) work	Independent work under the guidance of a teacher		Control
Conducting lectures without using MOOCs	Students complete a module of the MOOC course with an intermediate assessment, instead of certain practical work (one or more)	Group project work on a problem task	Individual work on a problem task	The opportunity to prepare for the border control by completing test tasks in the MOOC

Fig. 1. Model of MOOC integration into the structure of an academic discipline within the framework of problem-based learning

Based on this model, recommendations have been developed for teachers to plan the educational process with the integration of MOOCs, while it is assumed that some part of the MOOC course chosen by the teacher for a specific profile discipline will be used in training. During the planning of the training course, the teacher must:

- Select the topics of the discipline that need to be supplemented and expanded with external MOOC resources, including topics on which problematic tasks will be performed.

- Choose a course or several MOOC courses suitable for the purposes of the discipline within the framework of problem-based learning. It is advisable for the teacher to take the selected course in advance in order to clarify the entry points of students into the content to solve problematic problems, as well as to find out the possibilities of the course for online compilation of IT tasks, means of communication and discussion.

- Identify the types of online activities that students will engage in when using the MOOC course: watching videos, completing tasks, independently researching a resource or completing assignments, discussing and collaborating with team members.

When integrating the MOOC course into a discipline, it is necessary to coordinate the objectives of the discipline, the results of the discipline, teaching activities and assessments. The MOOC course most often provides for student assessment by topic or module, this can also be taken into account or left as part of the student self-training. We agree with A. Margaryan, M. Bianco and A. Littlejohn [44] that the evaluation criteria should be designed so that they correspond to the expected learning outcomes. When conducting practical classes, teachers need to follow the developed plan-scenario for the use of MOOC content in the classroom.

An online survey was conducted to determine the initial level of students' readiness to use MOOC courses and to find out the students' attitudes, which made it possible to identify the initial level of students' readiness to use online MOOC courses in the learning process, to perform complex IT tasks, and their readiness to work in a team. The results of the survey are presented in Table 3.

Table 3

Results of determining the initial level of students' readiness to use MOOC courses in the study of specialised IT disciplines

Questions	Control group, sud.	Experimental group, sud.
Q1: Do you use MOOC courses for training, hobbies, personal interests?		
Yes, often	0	0
Yes, but rarely	2	4
I know about them, but I do not use them	6	5
No	34	35
Q2: Do you use MOOC courses in the process of studying specialised disciplines? When preparing for classes?		
Yes, often	3	2
Yes, but rarely	3	5
I know about them, but I do not use them	12	11

No	24	26
Q3: Do MOOC courses make learning more flexible, accessible and adaptive for students?		
Yes	16	13
No	14	18
I do not know	12	13
Q4: Does the use of MOOC courses contribute to the development of self-education skills, which is an important aspect for future IT professionals?		
Yes	4	6
Possible	29	26
No	9	12
Q5: Can the content of the MOOC course by profile be useful for solving an IT problem or task?		
Yes	6	7
No	36	37
Q6: Do you think the certificate of completion of the MOOC course indicates the level of professional competence?		
Yes	8	10
No	13	10
I do not know	21	24

As a result of the ascertaining experiment, it was found out that students in the control and experimental groups have a weak understanding of MOOC platforms, but have heard about them, rarely use them both for personal interests and for educational purposes. Students do not know the possibilities of MOOC courses, do not realise their importance for professional training and the importance of having a MOOC profile certificate for successful employment.

Stage 2 (formative). At the second stage, experimental work was organised and carried out. Problem-based learning in the study of the IT discipline was implemented throughout the semester. The learning process was organised around a series of problematic situations that students solved during classes. The teacher gave out the assignment and the distribution of students into groups in practical classes.

A problematic task involves solving a specific problem that requires the application of knowledge and skills to find the optimal solution. Each problem is analysed in a short time (from several classes to a week), which requires students to quickly search for information and make decisions. Similar assignments were given to different subgroups of students, which allowed for communication between groups. The tasks offered were real: for the development of software or a module and aimed at solving specific problems, such as optimising algorithms, correcting errors in code or analysing data, i.e. those tasks that best allowed the implementation of problematic learning methods.

Then the students conducted research on the problem during independent work under the guidance of a teacher, developed and tested hypotheses, mainly worked in groups to discuss the problem, exchange ideas and methods of solution.

The end result was a solution to a specific problem or a set of solutions that could be tested and evaluated. The assessment focuses on the students' thinking process, their ability to analyse problems and offer informed solutions.

The study used the following techniques for implementing problem-based learning for IT students using MOOC content:

- Case method (group work, individual work): analysis of specific program codes, finding errors and bugs; analysis and improvement of existing code; search for the optimal algorithm for a specific task contained in the MOOC course.

- Group work: joint solution of tasks proposed by the MOOC, as well as by employers of IT companies. Since the discipline is limited to a semester, the tasks were solved with average labour intensity, or modules of a large-scale project were studied.

- Reverse engineering: students study and analyse existing software solutions, trying to understand how they work, i.e. there is an analysis of the code of open projects on GitHub.

- Interdisciplinary mini-projects that combine knowledge from academic disciplines, in particular, the disciplines selected in this study: "Programming in Python", "Web Technologies". Problematic tasks were set for the development of web applications using Python frameworks.

Within the framework of the selected disciplines in the control groups, students performed the implementation of problematic tasks using standard tools and required programming languages. In experimental groups, students additionally used MOOC courses recommended by teachers, depending on the tasks and type of project.

The criteria for evaluating the solution of a problematic IT task are: compliance with the deadlines for solving the problem, effectiveness of implementation, individualisation or team decision, originality (creativity), reasonableness of decision-making. When evaluating the solution of problematic tasks proposed by IT employers, an IT company expert was invited to the commission.

Stage 3 (control). At the third stage, the results of the experiment were summed up and conclusions were made. Table 4 presents the generalised results of the implementation of problematic tasks on a 100-point scale in control and experimental groups.

Table 4

Generalised results of the assessment of the solution of the problem of IT tasks

Criteria for evaluating the solution of problematic IT tasks	Control group	Experimental group
Deadline, efficiency of task implementation	76 (B-)	88 (B+)
Reasonableness of decision-making, originality	82 (B)	94 (A-)
Average score	79 (B+)	91 (A-)

These results confirm the effectiveness of using MOOC courses in problem-based teaching of IT students. The results of the control group students (average score – 79, B+), who used traditional instruments, are lower than those of the experimental group students, who used MOOC courses (average score – 91, A+).

In addition to academic assessments in the disciplines, the analysis of the results of satisfaction of KBU IT students participating in the experiment confirmed the effectiveness of using MOOC courses in problem-based learning in IT disciplines. The most significant results of this survey are shown in Table 5.

Table 5

Results of IT student satisfaction when using MOOC courses

Questions	Control group (CG), students (%)	Experimental group (EG), students (%)
Q1: Do you use MOOC courses in the process of studying specialised disciplines?		
Yes, often	2 (4.76%)	39 (88.64%)
Yes, but rarely	3 (7.14%)	5 (11.36%)
I know about them, but I do not use them	27 (64.3%)	0
No	10 (23.8%)	0
Q2: In your opinion, do MOOC courses improve professional competencies in the discipline?		
Yes	7 (16.67%)	40 (90.9%)
No	21 (50%)	4 (9.1%)
Do not know / find it difficult to answer	14 (33.33%)	0
Q3: Do you know how to choose a MOOC course to enhance professional IT competence?		
Yes	6 (14.3%)	42 (95.45%)
No	36 (85.7%)	2 (4.55%)
Q4: Does the use of MOOC courses simplify teamwork on an IT project or in developing a solution to a problematic task?		
Yes	5 (11.9%)	38 (86.36%)
No	24 (57.14%)	6 (13.64%)
Do not know / find it difficult to answer	13 (30.96%)	0
Q5: Do you think problem-based learning allows you to gain practical work experience in solving emerging professional problems?		
Yes	27 (64.29%)	42 (95.45%)
No	8 (19.03%)	0
Do not know / find it difficult to answer	7 (16.67%)	2 (4.55%)
Q6: Will you use MOOC courses in your professional activities?		
Yes	16 (38.1%)	37 (84.1%)
No	3 (7.14%)	3 (6.8%)
Do not know / find it difficult to answer	23 (54.76%)	4 (9.1%)

The final survey showed that EG students have significantly increased their interest in using MOOCs (88.64%) compared to CG (4.76%) and students are ready to continue using MOOC professional IT courses when studying other specialised disciplines.

Students participating in the experiment gained an understanding of the possibilities and diversity of MOOCs, 90.9% of EG and 16.66% of CG students are confident that MOOC courses can improve professional competencies in the discipline, gain additional knowledge and skills; 95.45% of students know how to choose a MOOC course for study.

The majority of EG students (86.36%) are satisfied with the use of MOOCs, because MOOC content is convenient to use when solving problem tasks both in a team and individually.

EG students (95.49%) are confident that problem-based learning and the use of IT professional MOOC courses allows them to gain experience useful for solving emerging professional problems.

MOOC courses are planned to be used in further professional activities by 84.1% of EG students and 38.1% of CG students. Students believe that the certificate they receive after completing the MOOC course will allow them to choose a more

interesting place of professional practice. Nevertheless, 6.8% of EG students and 38.1% of CG students answered negatively and consider it inappropriate to receive a MOOC certificate.

During the experiment, it was possible to assemble three teams of students who successfully participated in IT hackathons in both the region and the Republic of Kazakhstan.

Discussion

The relevance of this article is confirmed by insufficient consideration in the scientific community of issues related to the integration of MOOC platforms into the process of problem-based training of future IT specialists. Problem-based learning promotes the development of professionally important qualities: practical skills and teamwork, allowing students to work on real projects and tasks, integrate knowledge from various disciplines, which is especially important in IT, where project implementation often requires an interdisciplinary approach. This contributes to the formation of a comprehensive understanding and deeper development of educational material [45].

The use of MOOC courses in the process of training and retraining of specialists is primarily due to the global processes of globalisation, digitalisation, as well as the availability of education [43].

The main result of the research was the scientific substantiation and testing of the MOOC integration model into the structure of the profile discipline in the organisation of problem-based learning for IT students.

According to the results of the study, we recommend their partial implementation in the study of specialised IT disciplines: in practical work, when performing individual and team tasks, in the process of independent work of students. It is when performing problematic tasks in practical and independent classes that students develop their professional and personal competencies [21]. The results of the study showed that the use of MOOC courses in the study of certain topics of the profile discipline provides additional study of specific issues.

The results of the survey of students and teachers showed that students were particularly interested in using MOOCs when solving and discussing problematic tasks during a practical lesson [46]. The results of the survey of students and teachers showed that students were particularly interested in using MOOCs when solving and discussing problematic tasks during a practical lesson. Interaction and communication between students using MOOC tools, such as discussion platforms, is extremely effective due to an interesting audience consisting of peers [47].

The study revealed several interrelated problems, such as the preliminary selection of MOOC courses suitable for specific topics and the interaction of students with the teacher. E. Forcael, V. González, F. Orozco et al. determined that the role of a teacher in problem-based learning is to regularly give feedback to students, guide and coordinate group members in obtaining and using the necessary knowledge to solve a problem and not deviate from the desired learning path [48]. The answers of

the students indicated that sometimes the time for discussion and development of a team solution was delayed, since students could not always quickly choose a better solution and the teacher did not provide support. In addition, psychological problems may arise when communicating with students as was noted by O. N. Bryzgalova [49], C. L. Chiang, H. Lee [50], O. F. Derindag, B. Cizmeci [51].

Thus, the results of the study are consistent with the conclusions of E. V. Balakireva, E. I. Brazhnik, who concluded that the use of problem-based learning contributes to improving the quality of vocational training based on the use of information and communication technologies [52]. The experience of solving problematic tasks at the university, knowledge of the capabilities and features of MOOC platforms allows IT students to gain practical work experience, which makes them more competitive in the labour market after graduation.

Conclusion

The results of the study show that the use of MOOC courses in the study of specialised IT disciplines is an effective approach that encourages students to self-study through collaboration, communication and reflection within the framework of real professional tasks. Regular completion of IT courses on the Coursera platform allows students to increase their self-esteem, improve their independent problem solving skills, and strengthen students' professional motivation.

Taking MOOC courses requires students to have a high degree of self-organisation, responsibility and the ability to plan their time. These skills are extremely important for a successful career in the IT field.

The study confirms the hypothesis that MOOC courses can be effectively used in the implementation of problem-based IT training for students at different stages of studying specialised IT disciplines and different types of training sessions: in practical work, in the process of independent work of students, their preparation for intermediate and final tests.

The results prove the expediency of using MOOCs in the educational process, since the survey results show that a most of students are interested in taking MOOCs to improve professional IT competencies. According to the students, studying IT specialised MOOC courses allows IT specialists to remain competitive in the labour market.

However, despite the undoubted potential of online courses and the advantages of using MOOCs, the study revealed a number of features when applying the proposed model of integrating MOOCs into the structure of the profile IT discipline of the traditional university educational process:

- It is necessary to take into account that the degree of integration of MOOC courses into the structure of the academic discipline should be monitored and pedagogically substantiated; the planned learning outcomes of students in the discipline and selected topics should be achievable when using the MOOC course.

- Due to the huge number of MOOC courses offered, for each specific discipline or topic, the preliminary work of a teacher is required to pre-select the MOOC platform and courses suitable for the specifics and tasks of the profile discipline.

- It is recommended to take into account the level of students' proficiency in English, therefore, it is proposed to introduce MOOCs in the educational process at senior courses.

The data obtained are of pedagogical importance for teachers of specialised IT disciplines and employers, since the effective integration of MOOC courses into the teaching of specialised IT disciplines should be provided with pedagogical support. The directions of the IT industry are changing rapidly, so a sufficient number of qualified teaching staff is required. The undisclosed aspects of using MOOCs to improve the skills of teaching staff may become a prospect for further research.

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