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**Vira V. Liubchenko**<sup>1</sup>, Doctor of Technical Sciences, Professor, Professor of System Software Department, E-mail: lvv@opu.ua, ORCID: 0000-0002-4611-7832

**Oksana S. Saveleva**<sup>1</sup>, Doctor of Technical Sciences, Professor, Professor of Department of Oil and Gas and Chemical Engineering, E-mail: saveleva@opu.ua, ORCID: 0000-0002-0453-4777

**Eleonora N. Zabarna**<sup>1</sup>, Doctor of Economic Sciences, Professor, Head of Department of Economic Systems and Management of Innovation Development, E-mail: e.m.zabarna@opu.ua, ORCID: 0000-0002-2659-5909

<sup>1</sup>Odessa National Polytechnic University, Shevchenko Avenue, 1, Odessa, Ukraine, 65044

## IMPROVED PROJECT-BASED LEARNING AS THE METHOD OF KNOWLEDGE TRANSFER BETWEEN UNIVERSITY AND BUSINESS

**Annotation:** *The universities should provide for students the possibilities for gathering the actual applied knowledge and soft skills to prepare them for labor market needs. There are two pillars of success. The first pillar is learner-focused pedagogy and active learning. Recent publications have demonstrated the vast potential of project-based learning (PBL) through information and communications technologies (ICT). The second pillar is close University-Business collaboration during the study process. In the paper, we proposed the modification of PBL – improved PBL, which involves the students in real problems solving. The real problem means that the problem is actual for Company just in time of the course period. Improved PBL provides a competent approach in the teaching activities. The advantages and difficulties of improved PBL implementation for different stakeholders are generalized. It is shown that improved PBL supported by ICT means is attractive for the companies within the framework of their collaboration with higher educational institutions. Authors describe two alternatives of ICT infrastructure – based on learning management system Moodle and extended by social media tools Google Docs and Telegram. As well, authors provide a short description of IPBL implementation process. The examples of two courses demonstrate the effectiveness of University-Business collaboration for attracting students to solving the real problems under changing market conditions. The improved PBL supported by ICT means helps students to understand the course material better as well as to adapt for the realization of their own educational and professional potential in the labor market. The actualization of teachers' knowledge and enhancement cooperation in the frame of the knowledge triangle "Students-University-Business" are additional gains of IPBL. Also, in conclusion, there are generalized the main challenges of IPBL implementation.*

**Keywords:** *competence approach; professional education; project-based learning; case study; information and communication technologies*

### I. INTRODUCTION

Higher education is one of the leading state-forming units, which ensures the social cohesion of society, its economic growth, and political maturity. Under present conditions, the objective processes of globalization cover more and more areas of social activity, contributing to the international division of labor, migration across the planet of human and productive resources, standardization of legislation, economic and technical procedures. Higher education, research, and innovation play a crucial role in supporting social cohesion, economic growth, and global competitiveness. The labor market requires a graduate of a higher education institution to acquire not only a certain amount of knowledge, but also the ability to create and exploit new products, processes, and systems; communicate and work in a team; develop personal qualities.

The questions of personal development, ensuring the quality of education and vocational training, creating conditions for lifelong learning and

professional development, improving the efficiency of University-Business collaboration – today these are the critical issues.

Recently, the educational process as an intellectual, creative activity in the field of higher education and science is carried out at the university through a system of scientific, methodological and pedagogical activities. This activity is aimed at the transfer, mastering, multiplication, and use of knowledge, skills and other competencies of the learners, as well as the formation of a harmoniously developed personality [1].

The development of competences is the basis of curriculum development at all educational levels [2]. The dynamic development of the labor market, technology, and communications require the close collaboration of educators and employers in the creation and implementation of educational programs. Orientation on the competent model of a specialist should ensure the maximum suitability of the graduates for employment or support students in getting the first job in the labor market.

The main point taken into account while developing the new curricula and updating the

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existing ones is the elaboration of new knowledge and skills of students. It requires using active teaching methods that enhance the students' to work actively on mining new knowledge and training new skills. There are many well-known active teaching methods, which improve their usefulness to support the development of modern education, meet the demands of the changing labor market and hence contribute to social and economic growth in the country [3].

## II. Analysis of the Literature Data and Formulation of the Purpose

Due to current challenges of the labor market and with regard to students' satisfaction and perceived learning outcomes, teacher-focused pedagogy should make way for learner-focused pedagogy. In the research [4] authors demonstrated that amount different learner-focused methodologies only project-based learning (PBL) was perceived to have a significant impact on problem-solving and knowledge acquisition as compared to lecture. As well, students' satisfaction was significantly higher with PBL. The qualitative research [5] proved that a combination of project-based learning and the learning contract is sufficient to ensure a satisfactory skills level for the future generation of engineers.

Traditionally, the project-based course combines theoretical content from several subjects with a high-order learning approach (create, evaluate, analyze) to advance the engineering skills of university students [6]. Teams of four to five students complete the project collaboratively within an engineering competition framework. Individual students within each team are assigned specific engineering roles to create an interdependence that reflects a typically integrated product team in the industry and exposes students to real social dynamics.

In [7], there is highlighted that both disciplinary and interdisciplinary knowledge is needed for a student to succeed as a professional after graduation. Multidisciplinary knowledge, such as project management skills are essential in working life regardless of the competence area. For a student to gain competencies relevant for working life, both traditional and agile project management frameworks should be a part of their studies – in theory, and practice. As well, PBL can improve retention by introducing collaboration that spans

multiple courses in the same term. Such a result was demonstrated in [8].

Digital era requires education the using of appropriate technologies. Information and communications technologies (ICT) has the potential to enhance and transform higher education in many ways, and it is seen as a vital tool to enable and support the move from traditional 'teacher-centric' teaching styles to more 'learner-centric' methods [9]. Results of [10] showed that students prefer the courses with higher technological usage and that they are motivated to change their learning processes if ICT tools are involved. In terms of PBL, results show that technology promotes flexibility, autonomy, initiative, and active participation.

ICT involved in the study process strongly affect the participants. Authors of [11] showed the changes in activities based on PBL via cloud computing technology. In particularly in their research, students' roles were found as cooperation, coordination, communication, leadership, practice, effort provide in project-based activities. So ICT environment supports not only the teaching of knowledge but also the training of soft skills.

In [12] there was demonstrated that besides the communication, self-learning and interpersonal skills the blended-learning (b-learning) framework based on ICT supports the development of the following soft skills: active attendance, regular work, self-assessment, and peer review. Since soft skills largely contribute to the success of an organization, it considerably improves the students' position in the labor market.

Features of PBL through ICT was examined in [13]. The results showed the students' satisfaction and all of them agreed on the usefulness of the project itself. Collaborative learning and team working are the most positive aspects of the experience.

The changing of learning environment cases the changes of course characteristics dependencies. The study [14] investigated the effects of learning motivation on learning performance in b-learning. It showed that learning motivation positively influences social presence but does not directly influence learning performance in a b-learning setting. Even more interested that teaching presence was found to have direct positive impacts on the cognitive presence and social presence, and indirect positive effects on learning performance. These findings highlight the importance of course

design from the teaching perspective in a b-learning setting.

We should highlight that ICT opens additional possibilities for higher education stakeholders. For example, strategic integration between University and Industry can be achieved through the adoption of the e-collaboration approach as a new generation in the field of ICT. Notably, in [15] there was proposed a model based on the structural synergy between the components of e-collaboration has been designed by employing an electronic collaboration platform that enables the possibility of strategic integration through the combination of elements, tools, and techniques provided by this collaborative platform.

The purpose of our paper is to improve the supporting of the competence-oriented curriculum by involving the Business into a regular study process.

For the purpose, such objectives should be reached:

- to modify PBL, which enhances the collaboration between students, teachers, and industry due to solving real problems;
- to develop ICT based infrastructure for supporting the modification of PBL;
- to examine the effectiveness of the implementation of the proposed modification of PBL.

### III. Improved Project-Based Learning

As we have mentioned above, one of the ways of forming the professional competencies of future specialists is PBL. The faculty are faced with the task of actively involving the PBL into the study process, which realizes the modern methodology of the practice-oriented educational model.

One of the tools for such an approach is a case study in the context of interdisciplinary problem solving, which arise in the practice of specific companies (business structures/enterprises). The grave disadvantage of the case study is the lack of industry representatives in the study process. Technically, the method composed of two stages: definition and description of the real situation from the past of the company and working on and discuss the results between students and teachers.

The experience of some European universities, such as Instituto Politécnico de Bragança (Portugal) or Erhvervsakademiet Lillebælt (Denmark), demonstrates the possibility to break the gap. They used the “real case study” while the case is actual, but not pressing, for the company. Therefore, the

company is interested in the participation of its representatives in the study process.

Therefore, the improved PBL (IPBL) is a system of educational and cognitive techniques that allow students to solve applied tasks due to the individual or collective work with or without teachers. The results have to be presented in the companies of the real sector of the economy. The teachers are involved in the design and implementation of the study so that they support commonly accepted didactic principles (see Fig.1).

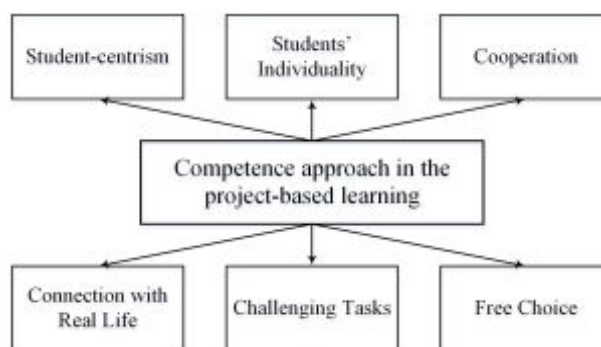


Fig. 1. The guiding principles of IPBL

The purpose of IPBL based on the real case study is to create the conditions under which students and teachers:

- independently and willingly acquire missing knowledge from the various source;
- learn to use gathered knowledge to solve educational and practical problems;
- improve communication skills by working in teams;
- develop research skills such as problems identifying, collecting information, observing, conducting experiments, building hypotheses, generalizing);
- elaborate on the capabilities of design and analytical thinking (see Table 1).

It is essential for students to understand that they have a personal interest in the acquired knowledge. This knowledge can and should be useful for their further professional activities and facilitation their first steps in the professional field.

In this regard, the possibility of working on the real problem takes on special significance [16]. The problem solution should demonstrate the feasibility of applying previously acquired knowledge from various academic courses.

Table 1. Advantages and Difficulties of IPBL

Stakeholder	Advantages	Difficulties
Student	Personal interest in practical-oriented knowledge Increased learning motivation The ability to adapt to rapidly changing economic and technological conditions Formation of the competences of a modern specialist	Free creativity Involvement in the process of lifelong learning Insufficient level of knowledge about different aspects of the particular business structure Inadequate level of professional skills and lack of practical experience
Teacher	An indicator of high qualification of the teacher Improvement of personal knowledge and skills during the regular study process	Lack of time Insufficient level of teacher's qualification for working with multidisciplinary problems Difficulties with the involvement of weak students
Company	Free transfer of knowledge in the system University-Company The opportunity to get qualified assistance in solving complex practical problems	"Trade secret" issue Flexibility in real problems solving and the ability to work in a team Professional-Student Unwillingness to bear the social responsibility about the training of personnel not only for own company

The teacher should provide students new sources of information. He can only recommend the direction to look for a solution. As a result, the tandem Teacher-Student should solve the problem and get real results. The process of working on a real case acquires the characteristics of the project.

IPBL should be logically integrated into the study process to demonstrate the application of the gained knowledge and the practical implementation of the student's abilities to cope with a non-trivial task in his cognitive activity.

#### IV. ICT in IPBL Support

The research [17] demonstrated that ICT use causes not only a change in student learning and improvement in their grades but a profound change in the behaviors and attitudes of students in the role they should have played in the development of assigned projects. Additionally, ICT, in particular, multimedia resources, gives the possibility to realize flipped learning methodology to optimize the ability of teacher and mentor to respond to the significant number of student queries and to ensure positive outcomes in terms of students' mid-term assessment [18].

Based on these reasons, we developed ICT support for IPBL. The process of building the ICT

infrastructure for course support was iterative and based on lean principles [19].

At the first iteration, we used the learning management system (LMS) Moodle as a supporting tool. For the long term, Moodle is one of the most popular LMS in the World, and it is the best free LMS for Do-It-Yourselfers [20]. Moreover, for a long time e-learning platform of Odessa National Polytechnic University is realized on Moodle.

While we were working on the e-course, we tried to take into account the modern trend to digitalization realized by the knowledge economy, on-line learning, lifelong learning, etc. The main differences in this culture are:

- Light educational content: webinars, white papers, user guides, video clips for different categories of specialists.

- The priority of standards: the basis of education should be the best practices and international standards.

- Compliance with the current audience: modern youth is free with the Internet; they are active in social networks, messengers and online services.

- Natural involvement and rapid reaction of the audience: Internet and social networks allow to quickly reaching the target audience.

- Creativity: agile culture is open for experiments with the creation of new types of educational materials and interactions.

– Collaboration: easy ways for interactions without the need to formalize planning too much, or to map communication mechanisms.

– Positioning, ideological leadership: the market is always looking for experts and leaders in the field.

The central principle in e-course development was microlearning, which has already become a strong trend, as realize a new way of delivering targeted and objective-specific learning bytes. Microlearning works best when it is just in time and addresses a specific question that the learner may have about their job.

As it was mentioned above, the real case drives the course. We used the organization of e-course as a series of topics. The process of working on the case was discussed between the teacher and supervisor from the company; as a result, the main stages of the process were defined. Each of the stages corresponded the particular topic in e-course. The tasks of the topics were formulated as topic descriptions; they were available for the student during all time. When the student had passed on to the next stage, they got access to all materials of the corresponded topic. We provided three types of learning materials:

- PDF files with teaching notes on theoretical knowledge;
- Video content with expert tips, best practice demos and bad practice demos offered by the company;
- Lists of additional resources from the Internet useful for task explaining.

Even though there was the recommended bibliography for the course, lists of additional resources as a kind of content curation highlighted

content that students have never seen in a way that adds value to the case study.

To support active learning, we used different communication tools such as the asynchronous forum for all students and separated teams and synchronous chat for communication with the supervisor from the company. Unfortunately, our communication strategy fault, we did not pay attention to the fact our student belongs to the millennials.

Generation X was the first to embrace a complete social adoption, and the growing desire for social learning mimics that. Open forums, chat boxes, note sharing are the natural collaborative environment for them. They ignored communication tools provided by Moodle, used Google Docs with comments and the messenger Telegram for working together.

“If you can’t beat them, lead them.” At the second iteration, we used Google Docs for collaborative working on the result documents and the group chats in Telegram for different kinds of discussions. “Static” teaching materials are situated in the e-course at Moodle platform, because of University’s rules and privacy restrictions of the company.

In IPBL context, ICT provides additional benefit making the company closer to the students. ICT supports Professional-Student collaboration in the different ways, for example, the video for a demonstration of the processes in the company, video-conferences with the company representatives for discussion the intermediate results, messengers for operative solving various issues concerned the current tasks.

Finally, let us describe the general process of IPBL implementation (see Fig. 2).

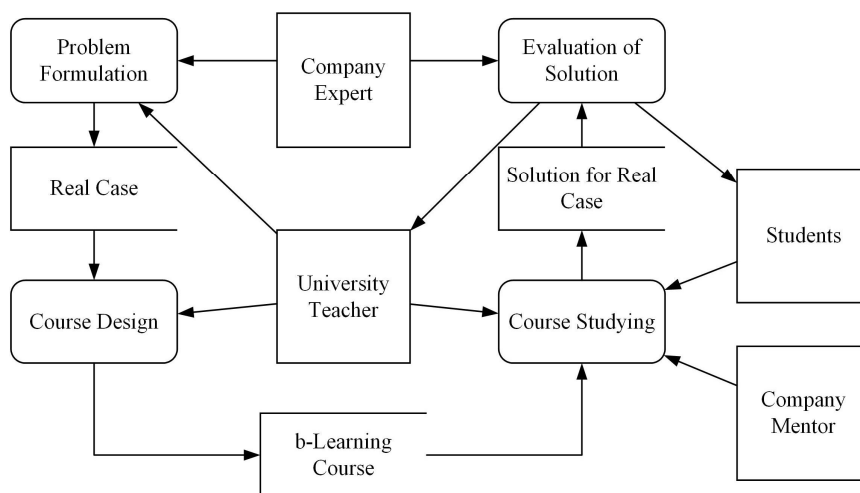


Fig. 2. DFD-diagram of IPBL implementation process

At the first stage company expert with help from teacher formulate the problem for solving in the course. It should be small enough to be resolved during one semester with involvement students' knowledge gained before and during the studying of the course. The resulted real case becomes the input for the second stage.

Next, the teacher or teachers define the steps that lead to problem-solving. The sequence of steps forms the base for course scheduling and resource selection, which are finalized by creation b-learning course with ICT support.

Then the course is taught for the students. As it was mention above the specific characteristic of IPBL is involvement the representatives of the company in the regular study process. As a result of learning in the course, the students solve the real case.

Finally, the expert from the company evaluates the solution and provides feedback for students and teacher.

## V. Discussion of Experimental Evaluation

Let us describe the implementation of IPBL at Odessa National Polytechnic University. We used it to enhance the interest in economic courses of the students who took the non-economic curricula. Below we do not point the names of the companies because of ethical reason.

The first attempt was realized in the framework of the course “Strategical Analysis and Innovation Entrepreneurship in IT” taught for master degree students of Computer Science curriculum. Small-size outsourcing IT-company collaborated with us. In the mid-term perspective, the company wants to develop its software service on green engineering and promote it at the global market. The company wanted to make a strategic analysis of its potential, which means SWOT analysis, competitor analysis, and internal environment assessment and analysis.

Because of the pilot implementation of the method, there were competing only two teams with seven members in each. Rest of the group traditionally studied the course. Both teams solved the problem successfully, provided two analysis reports for the company. The supervisor from the company was satisfied with the results of the analysis.

We propose to look at the quality of the learning outcomes. Because of the average grade of all team members was 83 and higher, we analyzed the final evaluation not for all 72 students, who took the course, but only for 42 students, who have

average grade 83 and higher. The following Table 2 gives a summary of the evaluation used such grading scale:

- perfect is defined as 90-100;
- good is defined as 75-89;
- satisfactory is defined as 60-74;
- unsatisfactory is defined as below 60.

Table 2. The results of the evaluation

Grade	In sub-group who studied	
	in a traditional way	with IPBL
Perfect	35,7 %	57,1 %
Good	50,0 %	42,9 %
Satisfactory	14,3 %	0,0 %

Table 2 shows the students who use IPBL demonstrated better learning outcomes.

The second implementation of IPBL was realized in the framework of the course “Economic Studios” taught for 3-rd year students of Mechanical Engineering curriculum. Mid-size Product Company asked for forming the effective logistics for delivery of new goods, which means the implementation of price analysis, research on methods of transportation, the choice for cargo insurance, evaluation of transport charges, the definition of handling operations.

The course was provided for 87 students who studied two different programs (49 and 38 students respectively). The grade distributions in the group were statistical equivalent. The learning process for the first group used IPBL; the second group traditionally studied the course. Table 3 shows a summary of the final evaluation.

Table 3. The results of the evaluation

Grade	In sub-group who studied	
	in a traditional way	with IPBL
Perfect	21,1 %	28,6 %
Good	44,7 %	49,0 %
Satisfactory	26,3 %	20,4 %
Unsatisfactory	7,9 %	2,0 %

As we can see in Table 3, in this case, IPBL also leads to the improvement of the quality of learning outcomes.

The quality in use model defined in the standard ISO/IEC 2510 recommend to evaluate such characteristics as

- effectiveness: accuracy and completeness with which users achieve specified goals;

– efficiency: resources expended in relation to the accuracy and completeness with which users achieve goals.

In the context of IPBL, the users are the students. As we can see in Table 2 and 3, the effectiveness of learning increased because the learning outcomes became better. At the same time, the efficiency remained the same because time and efforts for studying the course were not changed.

## VI. Conclusions

The generation of millennials grown in digital society requires new didactic and methodological approaches. Universities have to support the gathering of actual knowledge and developing crucial skills to facilitate the adaptation of graduates to their professional fields. In particular, students should be involved in solving real problems during their study.

To fit the requirements of the labor market universities should form the competencies applied in real life conditions. Especially graduates should flexibly respond to the demands of a changing market environment and make appropriate, efficient management decisions. This challenge requires close cooperation in the frame of the knowledge triangle “Students-University-Business.” Traditionally the links Student-Business and University-Business are weak or absent at the study process. Involving the students in solving real problems under supervising not only university teachers but also representatives of the company enhances creative thinking and bring Teacher-Student collaboration at a qualitatively new level. As well, it forms students’ new leadership qualities and teaches them teamwork.

IPBL inherits all the advantages of PBL, such as interdisciplinary and soft skills training. The real case study increases the students’ motivation to learn since new knowledge is needed to solve not simulated, but actual tasks. Participation of the company representatives in the course not only allows students to consult with practicing professionals but also creates motivating challenges. We also note an additional gain in the actualization of teachers' knowledge.

Of course, it should be emphasized that without the use of ICT such results would not have been possible. Traditional class-lesson organization of study process significantly limits the ability to organize project teamwork. Also, without ICT it would be impossible to support such involvement of the company's representatives in the course.

It must be admitted that it is challenging to organize a course based on IPBL. Companies are reluctant to start work in this format due to several factors. Real tasks can be associated with a trade secret. Students' ability to solve such problems often causes doubts. Employees are loaded with the current routine, and it is difficult to find mentors for students.

In addition, there are difficulties on the side of the university. The time the teacher has to spend on the course increases, as course content should be changed, and the collaboration with students requires more involvement. Students do not always believe that active work in the course is beneficial to them and try to do with minimal efforts.

Nevertheless, the examples of IPBL implementation demonstrated that the use of real case study supported by ICT means contributes to a better quality of learning outcomes.

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<sup>1</sup>Любченко, Віра Вікторівна, доктор технічних наук, професор, професор кафедри системного програмного забезпечення, E-mail: lvv@oru.ua, ORCID: 0000-0002-4611-7832

<sup>1</sup>Савельєва, Оксана Степанівна, доктор технічних наук, професор, професор кафедри нафтогазового та хімічного машинобудування, E-mail: saveleva@oru.ua, ORCID: 0000-0002-0453-4777

<sup>1</sup>Забарна, Елеонора Миколаївна, доктор економічних наук, професор, зав. каф. економічних систем і управління інноваційним розвитком, E-mail: e.m.zabarna@oru.ua, ORCID: 0000-0002-2659-5909

<sup>1</sup>Одеський національний політехнічний університет, пр. Шевченка, 1, Одеса, Україна, 65044



## УДОСКОНАЛЕНЕ ПРОЕКТНЕ НАВЧАННЯ ЯК МЕТОД ПЕРЕНЕСЕННЯ ЗНАТЬ МІЖ УНІВЕРСИТЕТАМИ ТА БІЗНЕСОМ

**Анотація.** Природна адаптація студентів до майбутньої професійної сфери вимагає від університету забезпечення прикладних знань і навичок. Популярні методи викладання надають обмежену підтримку для навчання, орієнтованого на студента. У роботі ми запропонували модифікацію проектного навчання, яке залучає студентів до розв'язання реальних проблем, і його тематичне дослідження. Показано, що підтримка засобами ІКТ удосконаленого проектного навчання є привабливим для компаній у рамках співпраці з вищими навчальними закладами. Удосконалене проектне навчання забезпечує компетентнісний підхід у навчальній діяльності. Узагальнено переваги та труднощі впровадження удосконаленого проектного навчання для різних зацікавлених сторін. Приклади двох курсів свідчать про ефективність співпраці університет-бізнес для залучення студентів до вирішення реальних проблем в умовах зміни ринку. Удосконалене проектне навчання, що підтримується засобами ІКТ, допомагає студентам краще зрозуміти навчальний матеріал, а також пристосуватися до реалізації власного освітнього та професійного потенціалу на ринку праці.

**Ключові слова:** компетентнісний підхід; професійна освіта; проектне навчання; навчання на прикладах; інформаційно-комунікаційні технології

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<sup>1</sup>Любченко, Вера Викторовна, доктор технических наук, профессор, профессор кафедры системного программного обеспечения, E-mail: [lvv@opu.ua](mailto:lvv@opu.ua), ORCID: 0000-0002-4611-7832

<sup>1</sup>Савельева, Оксана Степановна, доктор технических наук, профессор, профессор кафедры нефтегазового и химического машиностроения, E-mail: [saveleva@opu.ua](mailto:saveleva@opu.ua), ORCID: 0000-0002-0453-4777

<sup>1</sup>Забарна, Элеонора Николаевна, доктор экономических наук, профессор, зав. каф. экономических систем и управления инновационным развитием, E-mail: [e.m.zabarna@opu.ua](mailto:e.m.zabarna@opu.ua), ORCID: 0000-0002-2659-5909

<sup>1</sup>Одесский национальный политехнический университет, пр. Шевченко, 1, Одесса, Украина, 65044

## УСОВЕРШЕНСТВОВАННОЕ ПРОЕКТНОЕ ОБУЧЕНИЕ КАК МЕТОД ПЕРЕНОСА ЗНАНИЙ МЕЖДУ УНИВЕРСИТЕТАМИ И БИЗНЕСОМ

**Аннотация.** Естественная адаптация студентов к будущей профессиональной сфере требует от университета обеспечения прикладных знаний и навыков. Популярные методы преподавания предоставляют ограниченную поддержку для обучения, ориентированного на студента. В работе мы предложили модификацию проектного обучения, которая привлекает студентов к решению реальных проблем, и ее тематическое исследование. Показано, что поддержка средствами ИКТ усовершенствованного проектного обучения является привлекательной для компаний в рамках сотрудничества с высшими учебными заведениями. Усовершенствованное проектное обучение обеспечивает компетентностный подход в учебной деятельности. Выполнен обзор преимуществ и трудностей внедрения усовершенствованного проектного обучения для различных заинтересованных сторон. Примеры двух курсов свидетельствуют об эффективности сотрудничества университет-бизнес для привлечения студентов к решению реальных проблем в условиях изменения рынка. Усовершенствованное проектное обучение, поддерживаемое средствами ИКТ, помогает студентам лучше понять учебный материал, а также приспособиться к реализации собственного образовательного и профессионального потенциала на рынке труда.

**Ключевые слова:** компетентностный подход; профессиональное образование; проектное обучение; обучение на примерах; информационно-коммуникационные технологии