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## Problem-based learning in higher education: a path towards training innovative and competent specialists

### Підготовка фахівців у вищій школі засобами проблемного навчання

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#### Abstract


This article explores the theoretical and practical aspects of problem-based learning (PBL) in higher education. It investigates the content, requirements, and methods for creating problem scenarios, outlining the criteria, stages, and forms of PBL. The study examines the role of key components in PBL and how to effectively integrate them into the educational process. It also analyzes the characteristics, principles, and structural elements of PBL in the context of specialist training. Additionally, the article proposes a classification of problem scenarios and highlights the differences between PBL and traditional learning approaches. The research emphasizes the importance of incorporating integrative technology, virtual reality, and digital educational resources into PBL. An experimental


#### Анотація


У статті розглянуто теоретичні та практичні аспекти проблемного навчання у вищій освіті. Досліджується зміст, вимоги та методи створення сценаріїв проблем, окреслюючи критерії, етапи та форми проблемного навчання. Дослідження розглядає роль ключових компонентів у проблемному навчанні та те, як їх ефективно інтегрувати в навчальний процес. У статті аналізується характеристики, принципи та структурні елементи проблемного навчання в контексті підготовки фахівців. Крім того, у статті пропонується класифікація проблемних сценаріїв і висвітлюються відмінності між проблемного навчання і традиційними підходами до навчання. Дослідження підкреслює важливість включення

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study was conducted to investigate educators' perspectives on the feasibility of implementing PBL in higher education and to examine the impact of a PBL program on students' knowledge acquisition. The findings suggest that PBL is a promising approach for enhancing the learning process and fostering the development of competent specialists.

**Keywords:** problem-based learning, higher education specialist training, problem scenarios, educational technology, virtual reality, digital educational resources.

інтегративних технологій, віртуальної реальності та цифрових освітніх ресурсів у проблемному навчанні. Було проведено експериментальне дослідження, щоб дослідити погляди педагогів на доцільність впровадження проблемного навчання у вищій освіті та вивчити вплив програми проблемного навчання на засвоєння знань студентами. Результати свідчать про те, що проблемне навчання є перспективним підходом для покращення процесу навчання та сприяння розвитку компетентних спеціалістів.

**Ключові слова:** проблемне навчання, підготовка спеціалістів вищої освіти, проблемні сценарії, освітні технології, віртуальна реальність, цифрові освітні ресурси.

## Introduction

Preparing qualified, competitive specialists is a key task of higher education. In the course of their professional activities, specialists must be able to critically evaluate information to use it to achieve professional goals, as well as specialists in the implementation of professional tasks must be able to quickly make correct and effective decisions in the process of creatively rethinking needs, strive for self-improvement and self-education, be able to personal and professional growth, to improve skills and abilities throughout life.

It is necessary to use effective pedagogical methods and techniques for training such specialists. Connection with the fact that traditional teaching methods are aimed at the reproductive assimilation of knowledge by students because we observe the acquisition of knowledge for its reproduction and not the application of knowledge in professional activities. In the context of obtaining a higher education, it is this trend that requires the search for more effective training in a higher education institution. Therefore, teachers of higher education institutions intensively implement innovative educational technologies, which more effectively influence the motivation to activate educational and cognitive processes, promote the development of critical and independent thinking in the process of educational activities of students, and also lead to the acquisition of skills and knowledge (Valentieva et al., 2022).

Therefore, training that takes place intending to increase the effectiveness of the educational activity of specialists, which prompts the student to make a certain decision, stimulates comparison, analysis, and comparison of new information, which is the most effective for achieving the set goal, becomes especially significant. It is this approach to the formation of the professional competence of future qualified, competitive specialists that is implemented in the context of the implementation of problem-based learning. Therefore, the training of specialists using problem-based learning is important and necessary on a global educational scale. The relevance of the research is determined by the definition of effective learning technologies, in particular, problem-based learning, in the process of obtaining higher education in the modern period of the formation of world society.

The application of problem-based learning in the training of specialists in higher education is currently a relevant issue of the theory and methodology of learning in the educational process. Based on this, we considered the following questions in the article:

1. Content, requirements, and methods of creating problem situations.
2. Criterion features, stages of implementation of problem-based learning, and forms of problem-based learning.
3. The main component of problem-based learning and compliance with the conditions of the organization of the educational process to implement problem-based learning
4. Traits, principles, elements, structural units, components, requirements of problem-based learning.
5. Classification of types of problem situations during the educational process to achieve didactic goals.

6. Peculiarities of problem-based learning compared to traditional learning.
7. Use of integrative technology, virtual reality, and informational materials in problem-based learning.
8. Experimentally verified problem-based learning in the Training of specialists in higher education.

### Literature Review

Modernization of the content and forms of organization of the educational process, constant improvement of the quality of education, and introduction and development of new educational innovations – is one of the priority directions of the state policy of all countries of the world to integrate higher education into the European educational space. Today, the formation of knowledge, skills, and traditional views on education do not satisfy the demands of modern society. That is why so much attention is paid to innovative teaching methods in the educational process of higher education.

S. Khursenko (2023) considers problem-based learning as a technology for developing education, aimed at the formation and methods of research activity, mental abilities of the individual, active assimilation of knowledge, development of creativity, and involvement in scientific research of students. In her research, the scientist clearly defined the purpose of problem-based learning, emphasized the development of human thinking; showed ways to improve the quality of education, ways to use innovative teaching methods that contribute to the development of the student's cognitive interests and contribute to better assimilation of educational material by students; highlights the advantages of problem-based learning; highlights the types and structure of problem-based learning, shows several advantages and features of problem-based learning compared to traditional learning.

The study of T. Valentieva, Yu. Smolianko, & Yu. Semeniako (2022). The author's research consists of clarifying the concept of effective educational technology – problem-based learning; determining the specifics of conducting a lecture with problematic teaching; highlighting the peculiarities of problem-based learning; in the definition of problematic tasks and issues, the analysis of essential features of problem-based learning as educational technology, in the analysis of the structural components of problem-based teaching; in the peculiarities of creating a problematic situation as one of the main elements of technology; substantiation of the most effective means to achieve the goal in the educational process and the expediency of conducting a problem-based lecture.

R. Hernández, & S. Moreno (2021) describe a qualifying research experience with natural science teachers, which aimed to take appropriate school work strategy and thus consider alternatives that favor the development of skills, critical thinking, and construction of school scientific knowledge; in addition to recognizing the value of teamwork to favor the development of learning.

N. Myronchuk (2016), in the context-professional training of future teachers of a higher school, the functional and meaningful purpose of problematic professional-pedagogical situations is clarified, the criteria for the development and types of situations of self-organization of the teacher's activity are determined, the methods of creating problematic professional-pedagogical situations are substantiated.

L. Baranovska, & L. Morska (2022) in the system of continuing education highlighted the experience of scientists in the use of innovative educational technologies, in the training of specialists of various educational levels, they substantiated the theoretical, historical, and methodological foundations of the introduction of innovations, clarified the definitions of key concepts, showed the importance of introducing into scientific circulation new innovative – technological, innovative and educational terms, offered the experience of using innovative educational technologies in the professional training of future workers in the socio-economic sphere, teachers, military pilots, civil aviation specialists, engineers, developed methodical and practical recommendations regarding the development of critical thinking of students of higher education, in the conditions of educational information environment of a higher education institution – creation of a student's individual educational trajectory.

The relevance of the research topic is strengthened by the need to resolve a number of contradictions revealed in the research process between:

- The public demand for the training of specialists in higher education on the basis of the competence approach and the insufficient use of the potential of problem-based learning to achieve the programmatic results of training according to the relevant educational programs;
- Recognition of the role, importance, and functions of problem-based learning in the organization of the educational process in higher education institutions and the limited use of the theory and experience of problem-based learning in the practice of higher education;
- The existence of developed general didactic conceptual foundations of problem-based learning and the lack of a methodical system for its implementation in higher education.

Thus, the expediency of a comprehensive study of the organization of problem-based learning in institutions of higher education, as well as the absence of a holistic pedagogical study that would synthesize the evolution of the idea of problem-based learning, necessitate a comprehensive study of the problem of training specialists in higher education.

**The aim of the study.** With the aim of more effective training in a higher education institution, to prove the need for training specialists using problem-based learning and to clarify the respondents' positions on the feasibility of using problem-based learning in the educational process of higher education, to investigate the impact of problem-based learning on the effectiveness of learning program material.

### Methodology

In the study of the need to train specialists using problem-based learning and the influence of problem-based learning on the effectiveness of assimilation of program material, appropriate methods were used: a systematic analysis of scientific, pedagogical, and psychological literature on the research problem – for the further perspective of the research and identification and assessment of the state of study of the problem; combination and comparison, abstraction and concretization, induction and deduction, generalization and systematization of theoretical and methodological approaches in the process of revealing the essence of research concepts; analysis of the experience of implementing problem-based learning in the educational process of a higher school.

In the process of experimental work, we set the task of clarifying the position of the respondents regarding the feasibility of using problem-based learning in the educational process of a higher school.

During the experimental study, we created control and experimental groups and developed an experimental program that made it possible to create a favorable emotional climate in the experimental group, with the help of this program, the students felt that the group was a single team. During the educational process, the respondents of the experimental group learned to master the methods of problem-based learning, and the material of the classes contributed to the development of multiple competencies in them, in particular, key, psychosocial, subject-related.

During educational activities, EG students used integrative technology and virtual reality, informational materials in problem-based learning.

We organized and conducted a survey in which 17 teachers and 98 students participated.

After the introduction of the developed experimental program into the educational process of EG, we conducted a formal stage of the experiment to study the impact of problem-based learning on the effectiveness of knowledge acquisition by students. Traditional classes were held in the control group, problem situations were used in the experimental group, which were based on the active participation of the students themselves in the process of acquiring knowledge. EG students used integrative technology and virtual reality, informational materials in problem-based learning.

To establish the impact of problem situations on the completeness of students' knowledge and their depth, respondents were offered situations that helped to reproduce their knowledge in practice.

In the process of research, the respondents of the experimental group showed a significant interest (which increased noticeably) in learning and were actively involved in the proposed types of work.

Better assimilation of educational material and involvement of EG respondents in active search was facilitated by the use of problem situations. The results of the questionnaire data give reason to say that in most cases respondents (89.9%) have a positive attitude towards the implementation of the problem-based approach in classes and consider it necessary to use problem-based learning methods. The results of the study indicate positive changes in the experimental group – an increase in the number of respondents with a high level of knowledge acquisition and a decrease in the number of respondents with a low level of knowledge.

When determining the sample of subjects, the general specificity of the subject of the study was taken into account. The total sample size is 116 subjects. When forming the sample, the criteria of meaningfulness, representativeness, and equivalence were taken into account. The sample was formed by random selection using the technical procedure for calculating the selection step.

The reliability and validity of the obtained results, the objectivity of their assessment was ensured by the methodological soundness of the initial positions and the qualitative mechanism for evaluating the quality under study, the use of a complex of complementary research methods, and the involvement of a group of respondents from a higher educational institution in the analysis of its results.

To assess the homogeneity of experimental and control data, statistical processing was performed using MS Excel and SPSS (Statistical Package for Social Science).

Research relies heavily on the accuracy and reliability of the data. In the framework of research work, the quality of data collection and analysis not only adds weight to the research, but also contributes to the formation of sound conclusions, which is the key to academic success.

The following digital data collection tools were useful in the study:

- Google Forms - a simple tool for creating surveys that allows you to collect data from respondents, create different types of questions and collect answers in spreadsheets.
- SurveyMonkey - a modern survey tool that offers a wide range of customization options and analytical tools for analyzing the collected data.
- JSTOR, Google Scholar, and other academic search engines to provide access to scholarly articles, books, and other academic resources that may be useful for literature review and theoretical data collection.
- Zotero or Mendeley - bibliography management programs that help organize research materials, store references, and format bibliographies and citations according to different citation styles.
- Microsoft Excel or Google Sheets - spreadsheets are useful for organizing and analyzing collected data when working with quantitative data.
- SPSS, R or Python for more advanced data analysis, for statistical analysis and processing of volumes of data.

## Results and Discussion

### 1. Content, requirements, and methods of creating problem situations.

Formation of the methodology of creative reflection of world perception in future specialists is an important task of higher education. Human creativity contributes to discoveries in the global space, which in the process of development of society initiate innovation, which is a reflection of new methods, facts, and the formation of non-standard solutions. With this approach, problem-based learning technology is an important educational tool – the result of non-standard methods and approaches in decision-making, as a motivational and cognitive activity.

Scientists interpret problem-based learning as "a system of techniques that ensure purposeful actions of the teacher to organize the inclusion of the mechanisms of thinking and behavior of students with the help of problem situations" (Aleksiuk, 1998).

If students have intellectual capabilities to solve the problem and there is a cognitive need, then a problematic situation arises when there is a difficulty, a contradiction between new and old knowledge,

unknown and known, requirements and conditions. At the same time, the previous experience, which would be useful, does not contain a ready-made algorithm. It is necessary to develop a new strategy of action, different from the previous one, to overcome these difficulties.

Let's highlight the requirements that the teacher should be guided by when formulating and identifying problem situations:

- Focus on maximum independence of cognitive activity;
- Not to present the truth in a finished form, but to demonstrate the revealed contradictions in the development of this or that phenomenon;
- Take into account the main didactic principles (scientific, accessible, clear, systematic, etc.).

A problematic situation arises with such content that contains unknown and known elements. A problematic situation occurs most often with limited information when there are several options for solving the problem and there is a lack of initial data. The teacher must teach the educational material in such a way that it involves the problem situation, promotes the emergence of a special type of thinking interaction, and causes the students to have a cognitive need. Informational and cognitive contradiction is one of the structural psychological elements of a problem situation, without which the problem situation is impossible.

There are different ways to create problematic situations:

- Detection of contradictions in practical activities;
- A conflict of contradictions, which involves the urge to make an independent decision;
- Proposal to consider the problematic situation from different positions;
- Resolution of the issue and presentation of various ways of implementation;
- Encouragement to carry out one's own generalization, comparison, and conclusions.

First of all, a problematic situation is a state that arises as a result of meaningful interaction of a student of higher education with educational material. The basis for creating any problem situations is the need: cognitive-communicative, problem-communicative, professional.

Addressing problem situations requires compliance with certain requirements in the educational process:

- 1) Taking into account the psychophysiological characteristics of the student;
- 2) Definition of the goal – the task will contribute to the formation of skills and abilities, assimilation of new knowledge;
- 3) Compliance with the intellectual development of the student of higher education;
- 4) Adaptability to the demands of society, and real problems;
- 5) Presence of an interdisciplinary nature;
- 6) Availability as a result of the analysis of a complex solution and generalization of the studied material;
- 7) Establishment of partnership relations between the student and the teacher;
- 8) Motivation for self-improvement and self-education;
- 9) Stimulation of students' cognitive activity, giving them independence and freedom of choice (Dmitrenko, 2016).

The emergence of a pedagogical problem stimulates interest in learning, which to make an effective decision encourages creative rethinking and, as a result, forms problematic tasks in the process of mental activity to solve the corresponding problem. In solving the problem, there is an intrinsic interest based on such a concept. Internal interest is a factor in effective learning and the intensity of the educational process. Each student, in achieving the results of his interest, strives to surpass himself and, as a result, the cognitive motivation of the individual is formed as a driving factor in the educational field of new educational approaches.

## **2. Criterion features, stages of implementation of problem-based learning, and forms of problem-based learning.**

Problem-based learning involves several ways:

- Awareness of the existing problem;

- Solving the problem with the help of well-founded hypotheses;
- Verification and decision-making.

Problem-based learning is carried out in stages:

- Encouragement to accumulate knowledge and thinking operations;
- Creating a situation that is a study of student behavior and problems;
- Actualization of necessary knowledge, hypothesis analysis;
- To solve a problem situation – designing an action plan;
- To create conditions for the realization of their goals – determination of organizational and pedagogical conditions (Maksymenko, 2013).

In the context of problem-based learning, the organization of learning involves criterion features. Important is the knowledge that forms the topics of sections and courses, is the structure of the educational subject. This is the importance of content. The availability of educational material is also necessary (Budnyk et al., 2022).

The communication of facts and ways of presenting them, which the teacher systematically creates and describes by creating problem situations, is an essential feature of the problem-based approach in education. problem-based approach provides an opportunity to independently solve any issue in the process of educational activity.

There are three most important forms of problem-based learning in institutions of higher education:

- Problem-based learning during a lecture session, where students only accompany the teacher's solution to the problem, which is presented by the teacher as the formation of a problematic issue and the solution of this issue by him;
- Problem-based learning during a seminar, practical, lecture session, or heuristic conversation, where the work involves the definition of a previous problem, which is solved based on the knowledge of the students themselves and in the context of a purposeful solution to the task creates conditions for intellectual search, which is a sign of partial search activity;
- Problem-based learning during the student's research activity, which involves solving the problem and putting forward the student's own formulation of the problem.

### **3. The main component of problem-based learning and compliance with the conditions of the organization of the educational process to implement problem-based learning**

A problem situation has been created that requires the search for new methods of action or knowledge to achieve tasks and solve certain issues that arise when a problem situation arises, which is the main component of problem-based learning (Rojas Bahamón et al., 2019).

Problem situations are formed in different ways:

- Emergence in the process of analysis of various phenomena, facts, and perceptions, which must be theoretically substantiated;
- Arising in the process of conflicting situations, in the process of learning or life;
- Arising in the process of creating research goals;
- Arising when determining certain phenomena or facts in the process of stimulating analytical thinking.

The creation of a problem situation involves the comparison of facts, juxtaposition, and application and when solving the specified problem encourages logical thinking.

Thus, in the form of a problem statement, educational and cognitive activity encourages future specialists:

- To the formation of own pedagogical beliefs based on generalization, systematization, analysis results, and creative interpretation of existing knowledge;
- To creative and creative combination of theories, pedagogical ideas, and concepts;

- To the creative formation of the ability to determine the truth in the process of discussion (justification, assumptions, determination of one's own position, unbiased listening to the opinion of others, etc.).

We claim that problem-based learning is an educational technology; the most important component of problem-based learning is a "problem situation" with its specific functional characteristics, which, when organizing specific actions of students, combines the systematized actions of the teacher and exists when conducting classes in the context of creating a problem situation (Valentieva et al., 2022).

The implementation of problem-based learning in education requires compliance with the conditions of the organization of the educational process of a higher school:

- 1) A high level of education and the level of professional training of the teacher (mastery of problem-based learning methods and fluency in the educational material of the subject);
- 2) Preparedness of the audience: mastery of techniques of analytical activity; the presence of interest in the proposed problem, motivation; preliminary theoretical training to find an unknown result or a way to solve a problem;
- 3) To create problem situations – scientific and methodological support of the educational process;
- 4) Taking into account the topic, the specifics of the academic discipline, and the time allocated for the study of a certain topic (Baranovska, 2013).

#### **4. Traits, principles, elements, structural units, components, requirements of problem-based learning.**

Characteristic features of problem-based learning are:

- Activation of cognitive activity;
- Creative approach to information and activities;
- Formation of independence;
- Dialogue as a form of joint research work;
- Justification and proof of approaches and personal opinions to activities;
- Reflection on the part of students and the teacher (Correa Cruz et al., 2017).

The principles of problem-based learning are:

- 1) *Permutation of stages (inversion of stages)* – students are given a problem situation and they look for material to solve it;
- 2) *The principle of motivated activity of students* – to calculate the interests and desires of students – the teacher must propose problem situations;
- 3) *Research principle* – when solving a problem, students use mental operations: synthesis, analysis, comparison, abstraction, etc.;
- 4) *The principle of problem visualization* – when solving problems, use tables, diagrams, drawings, plans, etc.;
- 5) *The principle of independence, self-management, and creativity* – the student himself discovers new things for himself, and seeks knowledge that helps solve a problem.

The main element of the problem situation is what must be open for the correct performance of the assigned tasks, the unknown, and the new (Fitsula, 2006).

Three main components contain problem situations:

- 1) The unknown, which must be revealed in a problematic situation;
- 2) The need to perform such an action by a student of higher education, which creates a cognitive need for something new;
- 3) The task should be neither too difficult nor too easy.

The teacher must be guided by the following requirements when identifying and formulating problem situations:

- Focus on the maximum independence of the student's cognitive activity;



- To demonstrate and reveal contradictions in the development of any phenomenon, and not to present the truth in its finished form;
- Take into account the main didactic principles (systematicity, scientificity, accessibility, visibility, etc.).

When there are several options for solving a problem, a problematic situation often arises with insufficient initial data and limited information (Restrepo-Millán & Candela-Rodríguez, 2020).

##### **5. Classification of types of problem situations during the educational process to achieve didactic goals.**

Problem situations are divided into:

According to the method of submitting information to:

- *Textless* (created by demonstration, orally, with the help of a natural phenomenon or device);
- *Textual* (arising during the comprehension of information contained in graphic material or text).

According to the solution time, there are:

- *Long-term* (resolved during several classes);
- *Short-term* (used for prompt activation of students' activities) (Romaniuk & Bohaichuk, 2011).

Problem situations can be classified according to the following characteristics:

- By academic discipline or branch of scientific knowledge (mathematics, physics, etc.);
- Based on the search for something new (methods of action, new knowledge, identifying the possibility of using known methods and knowledge in new conditions);
- By the level of difficulty (medium severity, significant, implicitly expressed, or weakly expressed contradictions);
- By the nature and type of the content side of the contradictions (between scientific knowledge, life circumstances, an unexpected fact, and the inability to explain it, etc.).

It is most expedient to classify types of problem-based learning in different spheres of activity according to the features of the creative process. On this basis, the following types of problem-based learning are distinguished:

- *"Scientific" creativity* – the discovery and search by students of a new law, rule, theorem, etc. – theoretical research, which includes setting up and solving theoretical problems of education;
- *Practical creativity* – search for a method of construction, application of known knowledge in a new situation, invention – search for a practical solution based on setting and solving practical problems in the field of education;
- *Artistic creativity is carried out based on creative imagination* – an artistic reflection of reality (drawing, game, literary works, writing a musical piece, etc.).

All types of problem-based learning are characterized by the presence of finding and solving a problem, and the presence of productive, reproductive, and creative activity of the student. During the organization of the pedagogical process, they can be implemented in various forms (Ortiz Ortiz & Hernández Yomayuya, 2023).

The creation of problematic situations pursues the achievement of didactic goals in the educational process:

- 1) To put the student in front of such a cognitive problem, which would quickly activate his mental activity;
- 2) Draw the student's attention to the educational material, task, question, arouse his cognitive interest, etc.;
- 3) Help the student indicate the way out of a difficult situation find the most rational way and determine the limits of application of previously acquired knowledge;

- 4) Help the student identify the main problem in a cognitive question or task and, to solve it, outline a plan for finding ways to implement it;
- 5) Encourage the student to search actively. Solving any educational problem begins with a clear and correct formulation, in the process of which the student to some extent sees the way to its solution and already understands the task set before him, that is, evaluates the results of his activity, having previously drawn up a solution plan and implemented it (Knysh et al., 2023).

#### **6. Peculiarities of problem-based learning compared to traditional learning.**

Let's highlight the features of problem-based learning compared to traditional learning:

- 1) Specific intellectual activity of higher education seekers by solving educational problems while independently mastering new concepts, which ensures the formation of intuitive and logical-theoretical thinking and conscious, solid, and deep assimilation of knowledge;
- 2) Problem-based learning – the most effective way of forming a worldview, independent problem solving, which is the main condition for turning knowledge into beliefs; because in the process of problem-based learning, the features of creative dialectical and critical thinking are formed;
- 3) For the interrelation of theoretical and practical material, the connection with the life of problematic situations is especially effective;
- 4) Systematic application by the teacher of effective combinations of various types of independent work and types, during the execution of which the assimilation of new knowledge and methods of activity is actualized, earlier acquisition of knowledge;
- 5) Each student perceives the problem differently, which leads to finding different ways to solve the problem and various hypotheses;
- 6) The active mental activity of each student, the independent mental activity of a searching nature is inextricably linked with the sensory-emotional sphere of mental activity, and the high emotional activity of students depends on this (Khursenko, 2023).

#### **7. Use of integrative technology, virtual reality, and informational materials in problem-based learning.**

In problem-based learning, it is important to use integrative technology with the help of various technical devices of virtual reality and with the help of software tools. Teachers have the opportunity to transfer informational materials to students through their direct communication with the studied phenomena and objects. In the educational process, situations are created that change the role and place of the student in the organization of a problem situation, when the student must independently apply research experiments and make decisions. The use of integrative technology, virtual reality, and information materials in problem-based learning makes it possible to use such situations in problem-based learning when the student changes the situation by his actions and becomes an active participant in it – solving such situations is possible when "immersing" in a certain environment. This also applies to solving situations that students of higher education solve based on the rules they have created and create them independently. This approach to solving a problem situation expands the opportunities of students who can independently interact with a group of students, changing either the parameters of the process or the conditions of the situation and ways of solving it (Polishchuk et al., 2022). This is because, in our opinion, information and technical means stimulate the dialogue between the student and the teacher and have inexhaustible possibilities of visualizing not only various objects but also the possibility of their implementation in a problem situation. Interactive educational systems make it possible to find out how correctly the student distinguishes the essential features of the concept, make it possible to create a dialogue in the learning process between the student and the teacher at any time, to check whether the student understands the way of communicating in the form of a dialogue. In this case, we see that the possibilities of information and technical means are almost the same as in the conditions of individual training carried out by the teacher.

Information and technical means stimulate the introduction of fundamentally new forms of organization into the educational process, and not only significantly enrich the theory of education. During such an educational process, the student acts as a subject of educational activity, who independently, using heuristic methods, solves various problem situations. First of all, it concerns the process of assimilation of educational information.

By solving a problem situation in the learning process, the student forms the necessary skills and abilities, which ensures an individual approach to educational activities, changing the status of a student who is aware of himself as a person who can provide a solution to any situation and make decisions independently. This reveals new possibilities in the practical implementation of the principle of humanization of education and ensures the formation of a full-fledged personality.

The most important goal of using integrative technology, virtual reality, and information materials as a certain system in problem-based learning is to achieve a high level of formation of the problem situation, which will enable the student to apply intelligence and research skills. In other words, it is necessary to turn the educational process into an interesting experiment, when the student, performing all the functions of managing his activity, solves a problem situation with the help of a teacher or by himself.

Therefore, when using integrative technology, virtual reality, and informational materials in problem-based learning to solve and create a problem situation, the student should be able to:

- 1) Choose the style of educational influences, level, and complexity;
- 2) Determine the nature of educational auxiliary influences;
- 3) Be able to create problem situations independently;
- 4) Choose the sequence of studying the material;
- 5) To make the right decision on one's own initiative and initiate interaction to solve a problem situation.

Computer control of a problem situation depends to a large extent on the selected control mode.

Let's highlight the main management modes:

- 1) Computer-mediated management of educational activities – the student is presented with a problem, which he formulates in the form of a problem situation, situations are used that allow for many decisions regarding the modeling of various social and industrial directions, as well as situations for the search for imperfection. Students receive educational influences in the form of generalized evaluations of actions and heuristic recommendations;
- 2) Direct, on the part of the computer, management of educational activities, when the computer creates a problematic situation for the student; the nature of the help is determined by the computer, and the student may have questions that relate only to solving this problematic situation;
- 3) Dynamic, on the part of the computer and the student, management – the solution of the problem situation appears externally as a joint solution of the task with the computer; the degree of help from a hint to the computer's execution of a fragment of the solution to any problem situation can vary, but the nature and degree of help can be determined by both the computer and the student.

Summarizing the analysis of the psychological mechanism of the distribution of management functions between the student and the computer, we note that in the conditions of problem-based learning using integrative technology, virtual reality, and information materials, the student always performs the functions of managing his educational, and later, professional activities.

In the process of using integrative technology, virtual reality, and information materials in problem-based learning, the student not only acquires certain skills, abilities, and knowledge of educational subjects but also masters his professional activity and begins to perform the functions of managing it, which accelerates the process of forming skills for getting out of problematic situations. situations and general education skills and makes it possible to strengthen the student's independence. It is this approach that determines the specificity of such a psychological mechanism.

In the modes of computer management of students of higher education through problem-based learning, we will single out the main trends:

- An increase in the number of management functions, which are transferred to a higher education applicant during dynamic management;
- Strengthening the positions of indirect control, which involves implicit control from the computer;
- Decline in the popularity of direct management, which depends on the traditions of programmed learning.

Therefore, in the preparation of future specialists, the use of integrative technology, virtual reality, and information materials in problem-based learning opens up opportunities for the student to practically transfer the function of management in the process of solving problem situations. This contributes to increasing the efficiency of the process of applying the skills and abilities formed in one's activity. After all, here you can implement methods of transferring control functions to the student and various forms, clearly dosing the boundaries.

In the process of analyzing and using integrative technology, virtual reality, and information materials to intensify the process of forming students' abilities and skills in problem-based learning, we paid attention to the following aspects:

- 1) *Pedagogical* – to what extent the tool contributes to the development of correct ideas of students and corresponds to the general direction of a specific course;
- 2) *Methodological* – what skills and abilities are formed as a result of using the tool and whether this tool contributes to better learning of the material;
- 3) *Psychological* – how, during the mastering of the relevant educational discipline, this tool affects the solution of a problem situation;
- 4) *Organizational* – is the organizational point of using integrative technology, virtual reality, information materials, and for implementing solutions to problem situations rationally planned in problem-based learning – is enough machine time provided?

Considering modern integrative technologies, virtual reality, and informational materials for training by these provisions, we identified promising directions for the implementation of educational tasks:

- 1) Computer telecommunications equipment;
- 2) Universal information technologies (graphic packages, text editors, database management systems, modeling systems, spreadsheet processors, expert systems, etc.);
- 3) Electronic textbooks, monitoring and training programs;
- 4) Multimedia software products.

The effectiveness of the use of integrative technology, virtual reality, and information materials in problem-based learning is achieved by connecting the student's auditory and visual analyzers to the process of perceiving the proposed educational material.

Computer educational hypermedia systems occupy a special place among them. They make it possible to shorten the period of study, deepen knowledge, and increase the number of students per teacher. Compared to courses on traditional media, hypermedia systems, on which information is presented sequentially, allow students of higher education to directly engage in a topic that interests them and have fairly flexible branching opportunities. In addition, such systems, as a rule, are provided with effective means of monitoring skills and knowledge.

An important condition for the use of integrative technology, virtual reality, and information materials in problem-based learning is the availability of software with an aesthetic, psychologically adequate, intuitive, simple user interface. This is because the human-machine system remains a weak point in the way they interact with the significant increase in the power of computer technology. Modern educational systems require interfaces that are more natural for humans, in particular, such as speech and gesture recognition systems (Plakhotnik et al., 2022). Therefore, the introduction of integrative technology, virtual reality, and informational materials in problem-based learning contribute to the creation of visual images in classes, significantly changes traditional teaching methods, and promotes the development of students' creative thinking and the activation of their educational and cognitive activities. Today, the use of integrative technology, virtual reality, and information materials in problem-based learning is a working tool for the student and teacher in the educational process, and not only popular pedagogical technologies in the professional training of future specialists (Kravchenko et al., 2022).

## 8. Experiment.

During the experimental study, we created control and experimental groups and developed an experimental program that made it possible to create a favorable emotional climate in the experimental group, with the help of this program, the students felt that the group was a single team. During the educational process, the

respondents of the experimental group learned to master the methods of problem-based learning, and the material of the classes contributed to the development of multiple competencies in them, in particular, key, psychosocial, subject-related.

The peculiarity of the developed experimental program is its focus on the adequate use by the higher school teacher of various active learning methods, to take into account the strategy of problem-based learning and the individual style of perception of each student. We offered the students of the experimental group the following forms of work: work in groups, projects, brainstorming, role-playing games, case studies using integrative technologies, virtual reality, informational materials, etc.

The educational process in the experimental group was designed by maximally approaching the capabilities and requests of each student. The main task of the teacher in the experimental group is to create such conditions in the class that the student, performing a problematic task, unexpectedly makes certain generalizations for herself. For this, in the educational process of the higher school, we used various methods of stimulating educational activity and innovative methods to organize effective educational work. The students of the control group (CG) studied according to the usual scenario of the higher school, and the students of the experimental group (EG) studied according to the scenario of the developed experimental program.

In particular, EG students were aware of the content, requirements, and methods of creating problem situations, distinguished criteria features, stages of implementation of problem-based learning, and forms of problem-based learning. During training, the main component of problem-based learning was used and the terms of the organization of the educational process were followed to implement problem-based learning. EG students independently created problem situations that required finding new methods of action or knowledge to achieve tasks and solve certain issues that arose when problem situations arose, which is the main component of problem-based learning.

When implementing problem-based learning in education, EG students, under the guidance of teachers, followed clear innovative conditions for the organization of the educational process of the higher school and took into account the features, principles, elements, structural units, components, and requirements of problem-based learning.

To achieve the didactic goals, the students of EG used the types of problem situations we identified during the educational process.

During the study, the respondents compared and used the features of problem-based learning compared to traditional learning.

During educational activities, EG students used integrative technology and virtual reality, informational materials in problem-based learning.

During the experimental work, we set the task of clarifying the position of the respondents regarding the feasibility of using problem-based learning in the educational process of a higher school.

We organized and conducted a survey in which 17 teachers and 98 students participated.

It was found that not all respondents constantly use problematic methods, guided by the attitudes that were in the answers (the confirmatory stage of the experiment):

- "Special training of the student involves the use of problem situations" – 13.4%;
- "Students do not understand the problematic issue" – 22.4%;
- "Time is not spent rationally at class" – 21.4%;
- "Students do not know how to construct problematic learning situations" – 15.5%, etc.

Among the answers were the following:

- Insufficient educational and methodological support of the higher school – 12.5%;
- Ignoring professional incompetence by problem-based learning technology – 46%.

However, among the respondents there were those who constantly use problematic situations in the educational process – 36.4%.

In the course of the experimental study, the answers of the respondents convincingly proved that the use of problem-based learning technology in classes in higher education contributes to the development of creative thinking, the formation of positive motivation of students, and the formation of their professional competencies.

Most of the teachers we interviewed confirmed the fact that problematic situations are the main basis for creating comfortable conditions for the development of students' critical thinking, cooperation skills, initiative, etc.

Thus, the results of the ascertainment experiment indicate the existence of a contradiction between the real practical situation and the effectiveness of using problem-based learning methods. The majority of respondents are reluctant to use it in pedagogical practice but have a positive attitude toward the concept of a problem-based approach.

After the introduction of the developed experimental program into the educational process of EG, we conducted a formal stage of the experiment to study the impact of problem-based learning on the effectiveness of knowledge acquisition by students. Traditional classes were held in the control group, problem situations were used in the experimental group, which were based on the active participation of the students themselves in the process of acquiring knowledge. EG students used integrative technology and virtual reality, informational materials in problem-based learning.

To establish the impact of problem situations on the completeness of students' knowledge and their depth, respondents were offered situations that helped to reproduce their knowledge in practice.

In the process of research, the respondents of the experimental group showed a significant interest (which increased noticeably) in learning and were actively involved in the proposed types of work.

Better assimilation of educational material and involvement of EG respondents in active search was facilitated by the use of problem situations. In the process of learning according to the developed experimental program, students practiced the ability to work in pairs, express their own opinions, think logically, actively engage in work, and use integrative technology and virtual reality, informational materials in problem-based learning.

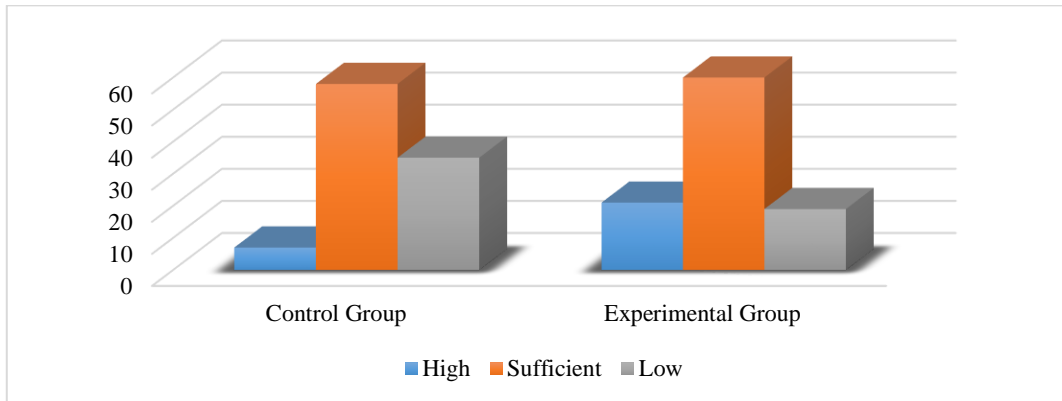
The problem situations offered to the respondents provided for the solution of educational problems and, as a result, new skills, abilities, and knowledge were formed.

Respondents showed special creativity, activity, interest, and independence. In the process of solving problem situations and modeling, the respondents faced the need for practical and theoretical immersion in the problem and felt an intellectual difficulty, which prompted them to independently compare, analyze phenomena, statements, external contradictory facts, formulate hypotheses, compare, conclude and verify them, etc.

The results of the questionnaire data give reason to say that in most cases respondents (89.9%) have a positive attitude towards the implementation of the problem-based approach in classes and consider it necessary to use problem-based learning methods.

As a result of the study, it was proved that the use of problem situations, the use of integrative technology and virtual reality, and informational materials in problem-based learning contributed to an increase in the quality of students' mastery of educational material.

The results of the study indicate positive changes in the experimental group – an increase in the number of respondents with a high level of knowledge acquisition and a decrease in the number of respondents with a low level of knowledge. We present the results as a percentage in Fig. 1.



**Fig. 1.** Levels of mastering the content of the educational material.

Having carried out research and experimental work to identify the expediency and effectiveness of using a problem-based approach in higher education, we state that it is very necessary and important to apply elements of problem-based learning in higher education, because it is the use of problem situations in classes in higher education institutions that contributes to the formation natural competences, general personality development, formation of motivation, interest in learning, increasing the quality of knowledge, development of life skills, mental development of students, increases the level of critical reflection of the student.

By creating problematic situations, the teacher encourages students to learn and understand the material more deeply and better, to think actively, which significantly expands the range of skills, abilities, and knowledge of students, promotes the development of critical thinking, and motivation for learning.

Based on our research, we claim that the organization of problem-based learning in classes in higher education contributes to a more productive and active assimilation of the most important professional knowledge by students, improves relationships and regularities of the educational process.

The theoretical significance of the study is to reveal the theoretical and methodological aspects of problem-based learning of future specialists in the process of professional training at a higher educational institution, including: theoretical prerequisites of problem-based learning; in the selection and disclosure of various aspects related to problem-based learning in the process of professional training of future specialists, on the basis of which educational and methodological support for problem-based learning in a higher educational institution was developed.

The practical significance of the research lies in the development of the structure and content of the educational and methodological complex, which includes a system of problem tasks, during the study of various disciplines in a higher educational institution; methodological instructions for teachers in the educational process.

The developed materials can be used in the process of professional training of future specialists of a higher educational institution, as well as their retraining and professional development.

## Conclusions

The content, requirements and methods of creating problem situations are considered, and criterion features, stages of implementation of problem-based learning and forms of problem-based learning are highlighted.

The implementation of problem-based learning in education requires compliance with the conditions of the organization of the educational process of the higher school. The main component of problem-based learning is revealed and the ways of observing the conditions of the organization of the educational process for the purpose of implementing problem-based learning are shown. A problem situation has been created that requires the search for new methods of action or knowledge in order to

achieve tasks and solve certain issues that arise when a problem situation arises, which is the main component of problem-based learning.

Features, principles, elements, structural units, components, requirements of problem-based learning are justified. A classification of types of problem situations during the educational process with the aim of achieving didactic goals is proposed. Peculiarities of problem-based learning compared to traditional learning are highlighted.

The importance of using integrative technology and virtual reality, informational materials in problem-based learning is proven.

During the experimental study, we created control and experimental groups and developed an experimental program that made it possible to create a favorable emotional climate in the experimental group, and with the help of this program, the students felt that the group was a single team.

During the experimental work, we set the task of clarifying the position of the respondents regarding the feasibility of using problem-based learning in the educational process of a higher school.

After the introduction of the developed experimental program into the educational process of EG, we conducted a formal stage of the experiment in order to study the impact of problem-based learning on the effectiveness of knowledge acquisition by students. Traditional classes were held in the control group, problem situations were used in the experimental group, which were based on the active participation of the students themselves in the process of acquiring knowledge. EG students used integrative technology and virtual reality, informational materials in problem-based learning.

In order to establish the impact of problem situations on the completeness of students' knowledge and their depth, respondents were offered situations that helped to reproduce their knowledge in practice.

In the process of research, the respondents of the experimental group showed a significant interest (which increased noticeably) in learning, and were actively involved in the proposed types of work.

Better assimilation of educational material, involvement of EG respondents in active search was facilitated by the use of problem situations. The results of the questionnaire data give reason to say that in most cases respondents (89.9%) have a positive attitude towards the implementation of the problem-based approach in classes and consider it necessary to use problem-based learning methods. The results of the study indicate positive changes in the experimental group – an increase in the number of respondents with a high level of knowledge acquisition and a decrease in the number of respondents with a low level of knowledge.

Noting the thoroughness of the conducted scientific research, it is worth noting that some issues of problem-based learning require further scientific study, namely: psychological and pedagogical aspects of the application of problem-based learning methods during students' learning of various disciplines. There is no doubt that today problem-based learning is the most promising in the practice of higher educational institutions, which meets modern requirements.

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