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## Psychological and pedagogical problems of the methodology of computerization of gaming technologies in teaching chemistry

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### Abstract

**Relevance.** The relevance of the scientific subject is based on the search and solution of psychological and pedagogical problems of the methodology of computerization of gaming technologies in teaching chemistry. The process of committing experimental verification of the methodology of computerization of gaming technologies in teaching chemistry.

**Purpose.** The purpose of the article is to study the process of using computer gaming technologies in the educational process of a higher educational institution during chemistry classes.

**Methodology.** Such methods as analysis, synthesis, comparison, generalization of views belonging to Kazakh and European researchers in scientific and educational literature on the issue of researching methodology of teaching chemistry and technology of computerization of gaming technologies, graphic ones – for visual illustration and comparison of results obtained during research, are at the core of the methodological approach of research.

**Results.** The training course on the topic “Features of creating and using a STEAM-oriented educational environment of the higher education”, a special course for students in the Abai Kazakh National Pedagogical University on the topic “Technologies of the development of computer games”, are developed and implemented, the development of and the application for an international grant project aimed at improving investment of the implementation of gaming technologies in educational process oriented at learning chemistry are accomplished and proposed respectively.

**Conclusions.** The promising directions of improvements in the methodology of computerization of gaming technologies in teaching chemistry are formed. The practical value of the work is to determine the psychological and pedagogical problems of the methodology of computerization of gaming technologies in the process of teaching chemistry, namely: the development of a STEAM-oriented educational environment, the content of computerization of gaming technologies, the improvement of investment in the implementation of gaming technologies in the educational process of learning chemistry.

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**Keywords:** STEAM-technologies; computerization; gaming technologies; chemical engineering; graphic files; computer game; mobile applications.

## **Introduction**

The swift development of computer technologies and involvement of digital gadgets into the daily rhythm of the public life, the trend of psychological inclinations of youth to gaming activities and the desire for the realization in the virtual world require implementation of gaming technologies in educational process of universities, in particular, in Kazakhstan, during the process of teaching chemistry.

According to Kazakh scientists Z.M. Ozhybaeva and N.N. Nurmukhanbetova [1] the trend of impetuous raise of quality requirements for education is going on in the modern digital society. Nowadays the STEAM-oriented educational environment takes priority place in the educational systems of the leading countries of the world, in particular, of Kazakhstan. The concept of STEAM (S – science (natural sciences), T – technology (technology), E – engineering (engineering art), M – mathematics (mathematics)) is understood not only as integration of science, technologies, engineering and mathematics, but also as a modern trend of education designed to meet the requirements of the high-tech modern world. It finds its reflection in the State program for the development of education in the Republic of Kazakhstan for 2020-2025 [2]. The main task of the updated digital education of the Republic of Kazakhstan is to ensure the process of teaching students to have independent thinking based on digitalization.

Z.S. Wilson *et al.* [3] believe that the process of computerization and digitalization of education, which is a driving factor for the implementation of technical means of education in the educational process, gains more and more relevance. The specified problem in the educational system requires solutions in terms of psychological and pedagogical regarding computerization of education. There are numerous scientific writings by M. Devare [4] and N. Petersen [5] in which the analysis of psychological and pedagogical problems of the methodology of computerization of education, of technologies of using computer teaching programs and computer games, as well as methods of their use during classes has been carried out.

In conformity with the results of the applied research: STEAM-education in Kazakhstan: the current status and prospects for development implemented by authors N. Imanhaliyev *et al.* [6], it is found out that contemporary higher education focuses on the development of the so-called “skills of the 21st century” or “soft skills”. The need for such a vector of education is due to impetuous development of the fourth industrial revolution. The disappointing indicators, which are the result of the survey among Kazakh schoolchildren in international PISA, TIMSS studies.

Due to the student’s oversaturation with information the role of gamers is growing swiftly in the educational process. A game is an activity, the meaning of which is not about results, but about the very process. The usage of computer games in the educational process provides psychological relaxation for students, stress resistance, involvement in cooperation, it gives physical, mental and moral upbringing of participants [7-10].

Nowadays the concept of “Edutainment”, which encompasses the education through entertainment, is quite common. The usage of computer games in the educational process will allow to form necessary skills while learning chemistry. The process of developing computer games needs to involve specialists in different industries: programmers, chemists, educators, psychologists who shall integrate results for the implementation of complex process of development and achieve the creation of the software product followed by introduction to gaming industry [11-14]. This process costs enough from a financial point of view. Thus, it is necessary to analyze and determine existing psychological and pedagogical problems of the methodology of computerization of gaming technologies in the process of teaching chemistry, find ways of their solutions.

## **Materials and Methods**

The presented research work was carried out in three main stages. The first stage of the scientific research consisted in preparing the theoretical base for further research. The analysis, synthesis, comparison, generalization of the scientific and educational literature on the problem of research, were carried out, this process enabled determining directions of the development of pedagogical ideas in the investigated area and methodological basics of research.

The main psychological and pedagogical problems of the methodology of computerization of gaming technologies, namely: the development of STEAM-oriented educational environment, the content of computerization of gaming technologies, the improvement of investment aimed at implementing gaming technologies in the educational process while learning chemistry are defined and the ways of their solution are outlined through the practical usage of contemporary methods of teaching chemistry. The choice of the methodology of computerization of gaming technologies in teaching chemistry for students studying at the Abai Kazakh National Pedagogical University is justified.

The second stage of research is devoted to the experimental study of the methodology of the computerization of gaming technologies during teaching chemistry. The process of designing a STEAM-oriented educational environment during the computerization of gaming technologies in teaching chemistry through the implementation of the training course on the topic “Features of building and using a STEAM-oriented educational environment of the higher education” was realized on this stage of the scientific research.

We propose to find a solution of the second problem “The content of the computerization of gaming technologies” through the developed special course on the topic “The technologies of developing computer games” for students studying in the Abai Kazakh National Pedagogical University. Considering that the process of development and implementation of computer games for learning costs enough from a financial point of view developed, an application for an international grant project to improve investment of the gaming technologies in

educational process while learning chemistry was proposed. Given the quality process of teaching chemistry should be carried out in a favorable STEAM-oriented educational environment, the students who study in the Abai Kazakh National Pedagogical University were proposed to have the training course on the topic “Features of creating educational environment of higher education”.

After passing the training course and study of the special course on the topic “Technology of creating computer games” students were offered to develop their own projects and present them, the acquired competencies were evaluated given these projects. Since the process of developing and implementing a computer game for education is quite costly in financial terms, the students of the research group developed and proposed an application for an international grant project to improve investment in the introduction of gaming technologies into the educational process in the study of chemistry. The survey and questioning were held among students and professors. Their aim was to find out peculiarities of the application of computer technologies in teaching chemistry, problems which exist with their use and outline ways of solutions of such problems.

The last stage of the research work allowed to formulate final conclusions of the scientific research carried out by us, which are the final reflection of received results and determine in general main trends in ways of improving the methods of computerization of gaming technologies in teaching chemistry and outline perspectives for further research.

## Results

The remote education experienced the evolution of four stages from electronic learning (e-learning) in the 80s–90s to mixed (blended learning) in the 2000s, and in the next decade the mobile learning (m-learning) was implemented. Since 2020 the comprehensive learning (ubiquitous learning) had place, but today the reasonable learning (SMART-learning) is spread. Numerous discussions are focused on the possibility of studying natural sciences, in particular chemistry, using means of electronic learning. But due to the emergence of circumstances of remote education the high school should ensure the study of chemistry at a high scientific and pedagogical level regardless of the circumstances. Since the requirement of the remote training is specific high quality electronic means of learning, the need for search effective computer technologies for teaching students arises [15; 16].

In connection with the emergence of COVID-19 pandemic the global educational system faced significant changes that entailed the quick transition from offline to online learning. To date, the remote education physically divided teachers and students who use online technology to communicate. The world higher education is an industry most affected by the COVID-19 pandemic. The quarantine restrictions have increased the demand for the implementation of online education for higher education on the permanent basis [17].

The beginning of a new information millennium accompanied by active implementation of the contemporary digital technologies in the educational process, requires search for and solution of psychological and pedagogical problems of computer learning [18-21].

Today the game industry invests significant capital in the development, creation, development and modernization of computer games. The disadvantage of contemporary computer games used in the educational process in chemistry classes in the institutions of higher education of Kazakhstan, is primitiveness compared to network games. The main task faced by teachers is ensuring students' motivation to study chemistry and continuity of training [22; 23].

The specialists in gaming technologies propose the implementation of the following classification of computer games in the educational practice:

- by sphere of activities: physical, intellectual, labor, social, psychological;
- by the nature of pedagogical process: teaching, training, controlling, summarizing; cognitive, educational, developing; reproductive, productive, creative; communicative, diagnostic, vocational guidance, psychotechnical;
- by game methodology: subject, plot, role-playing, business, simulation, dramatization;
- by subject areas: mathematical, chemical, biological, physical, ecological; musical, theatrical, literary; labor, technical, production; physical culture, sports, military applied, tourist, folk; social science, management, economic, commercial;
- by game environment: without objects, with objects; desktop, room, street, on the ground; computer, television, technical ways learning; technical, with means helping to move.

Since any computer game is characterized by the multidimensionality, each her participant has the opportunity to find individual interest for himself. In chemistry classes students can implement their social functions remotely using gaming technologies because they prefer Internet communication [15].

J. Grubert *et al.* [24] noted that computer game scenarios that are used in the educational process can ensure the continuous development of user's experience and the achievement of many goals, in particular educational ones.

S.H. Lytvynova [25] substantiated the features of creating augmented reality content based on video examples and gave recommendations on the use of such content.

According to the results of a survey conducted by T. Olsson *et al.* [26] and other scientists from the University of Technology, computer technologies are necessary in the daily life of every modern person.

B. Dias *et al.* [27] are convinced that using augmented reality in education, it is possible to supplement existing teaching methodologies.

Chemistry is one of the sciences, which swiftly develops due to growing needs of humanity in new materials, products and devices. She is in demand in many areas such as environmental protection, sources of energy, recycling hydrocarbons, production of plastics, pharmaceutical drugs, products of nutrition or biomedical devices.

With a purpose to solve psychological and pedagogical problems of the methodology of computerization of gaming technologies, namely: the development of STEAM-oriented educational environment, content of

computerization of gaming technologies, improvement of the investment of implementation of gaming technologies in educational process in learning chemistry an experimental research was conducted in the Abai Kazakh National Pedagogical University.

The experimental study was conducted in the Abai Kazakh National Pedagogical University. The experiment involved 124 students and 56 teachers. The purpose of the educational program on which the study was conducted was to ensure students' mastery of chemical essence of processes and creation of new products and technologies. Since the educational program is closely related to industrial production, the educational process requires computerization. Due to the circumstances that have developed with the emergence of the COVID-19 pandemic, numerous items are taught online with the issuance of a paid certificate from leading world universities (via edx.org, coursera.com and others platforms).

At the beginning of the experiment students are offered the survey on feasibility of creating a STEAM-oriented educational environment, implementation of computer games in the educational process, prospects for the use of such technologies. In the course of conducted survey it was found out that 85% of the respondents consider the implementation of computer gaming technologies in the educational process in learning chemistry to be the requirement of modernity. The participants of the survey are sure that the gaming activity affects the development of individual abilities of students, the promotion of their motivation to study chemistry, the mastery of professional competencies takes place in an unobtrusive shape, stimulates mental activities, develops ability to think outside the box, increases intellectual activity, cognitive autonomy and initiative.

A survey was also conducted among teachers on the relevance of the introduction of gaming computer technologies in the educational process. According to the results of the survey, it was found out that teachers encounter significant difficulties in the way of using gaming computer technologies in the educational process when teaching chemistry, namely: insufficient knowledge of computer technologies, low level of awareness about computer technologies, insufficient knowledge regarding the requirements for creating a computer-game environment, lack of forward planning skills, use of computer games, presentation materials.

During the research for students who obtain education in the Abai Kazakh National Pedagogical University it was proposed the study of special course on the topic "Technologies of the development of computer games". Subject of the discipline represents the familiarization of students with design aspects of computer games, technologies of their development, research of infological, datalogical and physical models of computer games and other technical systems.

The tasks of studying the subject "Technologies of the development of computer games" are the ability to develop, implement and adapt applied software security; the design of computer games according to profile of training by types of support; the application programming and creation of program prototypes of solving applied tasks; conducting testing of components of software for

ensuring computer games; performance of testing components of computer games according to given scenarios.

During the study of a discipline after mastering the content of lecture course students are offered to develop the computer game during laboratory works following next stages [28-30]:

1. The first stage is the preparation for producing games. Students are given the task to develop the concept of a game, characters, to determine means to implement a project, come up with a prototype of the game, come up with a plan according to which a game will be created and agree this plan with a professor.

2. The second stage is the production. It is the main stage in the process of creating computer games. The student should implement the plan created in advance and get results of the development.

3. The third stage is release. It is final and consists in carrying out testing of a game and its release.

Computer games that have been created by students during the experimental studies consisted of two major parts: gaming resources and software code.

We propose using such graphic files used for the storage of images and creation of elements of design of games and as textures to be overlayed on 3D Models [28]:

- JPEG (a standard for storing digital photos);
- PNG (Portable network graphics);
- TGA (Truevision Graphic Adapter),
- TARGA – Truevision Advanced Raster Graphics Adapter (is a graphic format for storing game textures);
- DDS (Direct Draw Surface) (graphic format intended mainly for storing textures, including gaming ones);
- BMP (Bitmap) (a graphic format intended for storing images in compressed form);
- FBX (Autodesk FBX) (universal format for storing 3D models and related information);
- SPRITEFONT (font settings editor, namely, of its visualization in the game window);
- XAP XNA (special sound editor that allows to create files in XAP format);
- FX files (files of effects applied when rendering three-dimensional images).

We offer the following mobile applications for self-progression; they help a student to master topics for personal study.

1. "Mozaic Education" is an Internet service that serves to provide interactive learning. It will diversify tools of university studies by numerous illustrative, animation and creative presentation opportunities. The spectacular interactive elements and built-in applications contribute to the development of skills, facilitate conducting of experiments, awaken interest of students and help with easy assimilation of educational material.

2. Mobile application "Chemical substances: organic and inorganic" will allow to master easily the formulas and properties almost 200 chemical substances. The application allows to arrange competition between students through solutions of test tasks in a game format.

3. "MEL Chemistry" is a mobile application used for the visualization of molecules, which can be examined under any angle at normal screen or with using glasses of virtual reality. It is recommended to be used to understand



the essence of chemical experiments and the structure of a substance.

Since the qualitative chemistry study should be carried out in a favorable STEAM-oriented educational environment, we proposed for students who receive education in the Abai Kazakh National Pedagogical University the training course on the topic "Features of creating educational environment of higher education".

After passing the training course and study the special course on the topic "Technology of creating computer games" students were offered develop and deliver a presentation of their own projects, and the assessment of acquired competences was carried out in accordance with them.

Since the process of developing and implementing a computer game for education is quite costly in financial terms, the students of the research group developed and proposed an application for an international grant project to improve the investment of the implementation of gaming technologies into the educational process in the study of chemistry.

In the course of holding surveys and questionnaires among teachers and students, we found that the application of computer technologies in teaching chemistry is explained by the following factors: various forms of filing material, high degree of visibility, opportunity to simulate digital objects and processes using computers, computer technology, opportunities to organize collective and individual work, differentiation of work of students depending on the level of their readiness, organization of computer control by professor.

The application of contemporary computer technologies in educational process in learning chemistry raises student's activity, is the key to the restructuring of educational process based on independence.

Thus, after the experimental study of ways to solve the psychological and pedagogical problems of the methodology of computerization of gaming technologies in the course of teaching chemistry, there is a positive trend in increasing the acquired competencies among students studying in the Abai Kazakh National Pedagogical University by attracting students to gaming activities during the classes of chemistry.

## Discussion

Modern gaming technologies proposed by developers in the market of game industry, are developed in quite convenient format, available to use, bright and have the high relaxation ability. The usage of gaming technologies allows teacher and student to communicate remotely if necessary and receive from this not only productive work, but also emotional pleasure.

Nowadays, there are a large number of theories of game activity, which are known in the field of scientific and pedagogical education. The analysis of the key ones was carried out by psychologist M.M. Marko [31] in the work "Formation of the readiness of future teachers of the first classes to the establishment of primary and gaming technologies in the professional activity":

1. The game theory by Gross. K. Gross considers the essence of the game to be the ability to prepare its participants for further serious activity and improve the acquired abilities. The advantage of the theory is the

connection of the game with the development of an individual's personality and his professionalism. The disadvantage is the insufficient disclosure of the motives that encourage the game.

2. The game theory by Spencer consists in the implementation of excess forces in the game.

3. The game theory by Freud. Z. Freud brings the hypothesis that there is a realization of desires in the game that could not be brought into reality in real life.

4. The game theory by Vygotsky is that students have the opportunity to create an imaginary situation in the game instead of a real one.

5. The game theory by Elkonin. D. Elkonin revealed the content of the game as an instrument of relationships between people. In the content of their play, children reproduce the relationships of adults in labor activity and social life and penetrate into the genuine social meaning of human labor.

However, despite the large number of theories of game activity, the game remains a "mystery" for most scientists to this day and at the same time it is "a vital component of activity for any person" [31; 32].

The concept of "gamification" refers to the application of gaming techniques in non-gaming situations. Students involved in the game process master the subject and material by gradually gaining points gradually. The rapid computerization of the educational process has accelerated the development and implementation of the didactic gaming industry.

Today, the Internet offers numerous sites where it is possible to choose a game and use it to master the lesson material [7].

According to O.V. Anichkina [15], the gamification in the educational process of training specialists in teaching chemistry will make it possible to achieve significant success in learning. Due to the nature of chemical science, its diversity, the possibility of transformations, changes in aggregate states, the emergence of new substances with different properties that can be proven, makes it possible to create computer games that are interesting for the student.

Currently, the Internet offers a fairly large number of computer games based on chemical knowledge and skills. However, the conducted studies give grounds to assert that today there are no such chemistry games on the Internet that would provide students with high-quality theoretical knowledge and practical skills, and allow them to explore the features of a chemical experiment [33-35].

The gaming activities for students are voluntariness, satisfaction of needs, self-realization, development of creative thinking. The key purpose of usage of games while learning chemistry is the development of cognitive interest through the diversity of games. Computer games on chemistry should be developed with taking into account the principle of individualization and nature conformity, where every student can express himself, his creative potential [8; 36].

But we have determined that there are virtual simulators, which are simulators with which it is possible to work out certain parts of a chemical experiment in the laboratory. Such simulators provide initial elementary knowledge about substances, utensils, equipment. However, unfortunately, there are certain comments on the

technological features of using such simulators, namely, the low level of graphics and animation, which does not require detailing. For example, the majority of virtual laboratories have insufficiently high-quality reproduction of the color of substances, there is no image of the features of the appearance of substances (dramuristic, crystalline sediment, homo- and heterogeneous systems, etc.), and this knowledge forms the basis of analytical skills to recognize substances [37-39].

The number of actions and operations in a chemical experiment is very limited in the presented simulators, there is no possibility of an alternative, which makes it impossible to form the ability to freely operate with substances, independently choose ways to solve problems. A fairly schematic animated image of dishes and equipment that is used in such laboratories, which is quite different from the real one. In our opinion, the possibility of using such laboratories is appropriate for developing general skills, but does not contribute to the interest and motivation to study chemistry [3; 40].

To ensure high motivation of students to increase interest in the study of the subject "Chemistry", computer technologies for the study of chemical phenomena, innovative projects, and extensive data obtained as a result of the study of chemical components and compounds should be inspired in the educational process. Digital technologies are designed for the visual content of the educational component of the subject "Chemistry", which will allow students to become more familiar with the processes of organic and inorganic chemistry and observe experiments from the pages of the textbook using augmented reality (AR) technology.

Thus, the analysis of numerous works on the topic of the study made it possible to identify the following psychological and pedagogical problems of the method of computerization of gaming technologies during the study of chemistry in the Abai Kazakh National Pedagogical University:

- the development of STEAM-oriented educational environment;
- the content of computerization of gaming technologies;
- the improvement of investment in the implementation of gaming technologies in the educational process in the study of chemistry.

It is worth noting one of the first models of a STEAM-oriented educational environment of a general education institution, proposed by G. Yakman [41] as a "Pyramid of a STEAM-oriented educational environment".

The essence of the model is that "science cannot be understood without technology", which is associated with most of its research and development of engineering, which cannot be carried out without an understanding of art and mathematics, and the study of technology and technology is impossible without studying the natural sciences.

The core of the model encompasses the content of five disciplines [42-44]:

- natural sciences;
- technology;
- engineering;
- maths;
- art.

S. Akaygun & F. Aslan-Tutak [45] believe that the citizens of the 21st century need skills for successful work and life – these are communication, critical thinking, creativity and cooperation. The need for these skills requires the creation of an environment that will facilitate their assimilation. As the study of science and mathematics gains importance in a digital world, 21st century citizens need meaningful knowledge of science, chemistry and mathematics to apply it in creating technology and innovation.

The functionality of a STEAM-oriented educational environment consists of a computer-oriented, mobile-oriented, open to learning through practice-oriented, interdisciplinary and project-based approaches in the study of robotics by students and contribute to the development of information and digital competence, increasing motivation [46; 47].

Under the conditions pandemics coronavirus disease COVID-19 state Kazakhstan felt need for professionals capable of critically think and create digital solutions and products. To date, STEAM- based education based on digitalization and computerization is priority in the education of the leading countries of the world [48-50].

Given the emergence of the COVID-19 pandemic, the use of digital gadgets and smartphones has been actively introduced, allowing the reproduction of objects of augmented reality and the use of computer games, which will allow to increase significantly the level of memorization of information by visualizing objects and processes and reproducing them in 3D format.

The motivation and level of knowledge of students in memorizing the properties of objects that cannot be demonstrated in class depends on the quality of using computer games. The use of computer games can be applied as an additional means of forming students' ideas about a chemical experiment.

## Conclusions

In the course of the study, we defined the concepts of "STEAM-technologies", "computerization" and "game technologies"; which are the most important psychological and pedagogical problems of the method of computerization of gaming technologies in teaching chemistry. These include:

- the development of a STEAM-oriented educational environment;
- the content of the computerization of gaming technologies;
- the improvement of investment in the introduction of gaming technologies in the educational process in the study of chemistry.

Promising directions for improving the methodology of computerization of gaming technologies in teaching chemistry have been formed.

The study was conducted basing in the Al-Farabi Kazakh National University. The ways outlined by us to implement the psychological and pedagogical problems of computerization of gaming technologies in teaching chemistry have been carried out.

We carried out the design and implementation of a STEAM-oriented educational environment during the computerization of gaming technologies in teaching chemistry through the introduction of a training course on

the topic “Features of creating and using a STEAM-oriented educational environment of the higher education”.

We offer the solution of the second problem “The content of computerization of gaming technologies” through the developed special course for students studying in the educational program “Chemical Engineering” of the Faculty of Chemistry and Chemical Technologies of the Kazakh National University named after Al-Farabi on the topic “Technologies of the development of computer games”.

An application for an international grant project has been developed and proposed to improve investment in the introduction of gaming technologies in the educational process in the study of chemistry.

As a result of the study, it was found out that the newest direction for improving the process of teaching chemistry is to create a high-quality STEAM-oriented educational environment to increase students' motivation to study chemistry, teach students the latest technologies in the field of chemistry, at the digital level, we propose to involve students in the development of teaching computer games for the study of chemical elements and phenomena, the creation of virtual laboratories for the study of chemical processes, conducting chemical experiments. Using computer game technologies in teaching chemistry,

students really comprehend the results of decision-making depending on the chosen roles, taking into account previous actions. The process of the game shows students' professional maturity, socio-economic activity, which undoubtedly contributes to the improvement of the study of chemistry.

A promising direction for further research is the consideration of modern programs, including remote ones, and the improvement of professional competence of both teachers and students. The results of the scientific research, as well as the conclusions and prospects for further research formulated on their basis, can be used in the future as an effective scientific basis for improving the preparation of students studying chemical technology, participation in international grants and projects for the development and implementation of gaming technologies at the international level.

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## Conflict of Interest

None.

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## **Психолого-педагогічні проблеми методики комп'ютеризації ігрових технологій у навчанні хімії**

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### **Анотація**

**Актуальність.** Актуальність теми дослідження зумовлена пошуком і розв'язанням психолого-педагогічних проблем методики комп'ютеризації ігрових технологій у навчанні хімії. У процесі дослідження здійснено експериментальну перевірку методики комп'ютеризації ігрових технологій навчання хімії.

**Мета.** Мета статті – дослідити процес використання комп'ютерних ігрових технологій у навчальному процесі вищого навчального закладу на заняттях з хімії.

**Методологія.** В основу методологічного підходу дослідження покладено такі методи, як аналіз, синтез, порівняння, узагальнення поглядів казахстанських і європейських дослідників у науковій і навчальній літературі з проблеми дослідження методики навчання хімії та технології комп'ютеризації ігрових технологій, графічний – для наочної ілюстрації та порівняння результатів, отриманих у ході дослідження.

**Результати.** Розроблено та впроваджено навчальний курс на тему «Особливості створення та використання STEAM-орієнтованого освітнього середовища вищого навчального закладу», спецкурс для студентів Казахського національного педагогічного університету імені Абая на тему «Технології розробки комп'ютерних ігор», виконано розробку та подано заявку на міжнародний грантовий проект, спрямований на підвищення інвестиційної привабливості впровадження ігрових технологій в освітній процес з вивчення хімії.

**Висновки.** Сформовано перспективні напрями вдосконалення методики комп'ютеризації ігрових технологій у навчанні хімії. Практичне значення роботи полягає у визначенні психолого-педагогічних проблем методики комп'ютеризації ігрових технологій у процесі навчання хімії, а саме: розробка STEAM-орієнтованого освітнього середовища, зміст комп'ютеризації ігрових технологій, удосконалення інвестування впровадження ігрових технологій в освітній процес навчання хімії.

**Ключові слова:** STEAM-технології; комп'ютеризація; ігрові технології; хімічна інженерія; графічні файли; комп'ютерна гра; мобільні додатки.