CURRENT RESEARCH JOURNAL OF PEDAGOGICS (ISSN: 2767-3278)

VOLUME: Vol.06 Issue05 2025
DOI: - 10.37547/pedagogics-crjp-06-05-06
Page: - 26-29
RESEARCH ARTICLE OPEN ACCESS

Opportunities for The Development of Professional Competence of Future Chemistry Teachers in A Digital Educational Environment

Yakubova Madina

Belarusian-Uzbek Institute of joint inter-sectoral practical technical qualifications base doctarant, Uzbekistan

Received: 24 March 2025 **Accepted:** 20 April 2025 **Published:** 22 May 2025

ABSTRAC

This scientific article is devoted to the study of the application of digital technologies in the teaching of chemistry in the modern educational process, their effectiveness and their impact on the level of knowledge of students. The article presents the results of the pedagogical study of innovative methods such as ChemDraw, ChemSketch, Jmol, Avogadro.

Keywords: ChemDraw, ChemSketch, Jmol, Avogadro, Gromacs, AMBER, CHARMM, ChemCaper, ChemBlaster, Bond Breaker, Molleculebuilder, MetaboLAB, Knewton, Alex, Seterra, immersive.

INTRODUCTION

The rapid development of Information Technology has a significant impact on all spheres of society, including the educational system. Traditional teaching methods are gradually paving the way for innovative approaches based on the use of Computer Technology, multimedia Tools, Internet resources [7]. Of particular importance in teaching subjects such as chemistry is the introduction in the digital educational environment. One of the most difficult topics for student perception, chemistry requires the use of visual and interactive learning tools that can be implemented using modern digital technologies [3].

One of the main problems in the study of chemistry is the high level of abstraction of educational material. It can be difficult for schoolchildren and students to imagine the mechanisms of chemical reactions, the spatial structure of molecules, the nature of chemical bonds and intermolecular interactions. The application of specialized software allows you to solve this problem by viewing chemical processes and objects at the micro level [2].

Programs such as ChemDraw, ChemSketch, Jmol, Avogadro allow you to create detailed 2D and 3D models of molecules, accurately demonstrate the formation of chemical bonds, conformational changes, reaction mechanisms. Students will have the opportunity to consider the structure of substances at the atomic-molecular level, to study the spatial configuration of complex organic compounds, which will contribute to a deeper understanding of fundamental chemical concepts. The interactivity of these models (the ability to rotate, scale, modify display modes) makes the process of studying chemistry interesting and memorable [1].

In addition, modern technologies make it possible to visualize not only static structures, but also the dynamics of chemical processes. Special applications of molecular dynamics (Gromacs, AMBER, CHARMM) allow modeling the movement of atoms and molecules, conformational transitions of proteins, folding processes of polymer chains, phase changes of substances [4]. Animated models clearly demonstrate kinetic and thermodynamic laws, mechanisms of catalysis, principles of self-organization of chemical systems. Students not only memorize abstract formulas and equations, but also see

"live" chemistry in practice.

Educational computer games, mobile applications, online platforms allow you to study chemistry in an interesting, interactive way. Examples of successful game resources are ChemCaper, ChemBlaster, Bond Breaker, Molleculebuilder VR. By completing tasks on building formulas and equations, designing molecules, performing virtual experiments, students receive points, badges, bonuses, and advance through game levels. The award system encourages schoolchildren to achieve educational goals, creating a state of success [5].

Adaptive learning platforms such as Knewton, Alex, Seterra implement a personalized learning concept based on large data analysis. Program algorithms track the individual trajectory of the student, his achievements and difficulties in mastering each topic of the chemistry course. Based on prognostic models, the system selects the sequence and level of complexity of training tasks, the speed of presentation of new material, the mode of training exercises [8].

Immersive virtual and augmented reality technologies:

Examples of successful VR applications in Chemical Education include MEL Chemistry VR, HoloLAB Champions, Nanome. MEL Chemistry VR allows you to visualize the structure of atoms in immersive 3D space, the types of chemical bonds, the structural formulas of organic molecules. Users can take, rotate, zoom in and remove virtual models for a detailed review of spatial configuration, electronic structure, molecular conformation [14].

VR technologies allow modeling processes and phenomena that are not available to school experience due to their scope, risk, or high cost. For example, a VR simulation of chemical productions that introduces students to the device of reactors, the principles of process control. Virtual trips to enterprises in the chemical industry provide an opportunity to communicate with the real world of professions related to chemistry [11].

Unlike VR, augmented reality (AR) technologies do not replace the physical environment with a virtual environment, but complement it with digital objects. With smartphones and tablets, students can see animated 3D models embedded in a real-world image. AR apps recognize textbook pages, lab equipment, custom markers on the periodic table, and "animate" them by filling them with interactive digital content [12].

An example of a chemistry education (AR) resource is the Elements 4D application. each chemical element corresponds to a physical wooden cube with a marker. When you take the camera of the mobile device over the cube, the augmented reality shows a 3D model of the atom with animation of electronic shells. By tying the cubes together, students can observe the chemical reactions between the ARda elements and the properties of the resulting substances.

Finally, the success of innovations is determined by the development of the material and technical base and information infrastructure of educational institutions. It is necessary to invest in the purchase of computer and multimedia equipment, the provision of schools with high-speed Internet, the creation of a single safe digital environment. The network connections of educational organizations, science and business contribute to the transfer of advanced educational technologies and the improvement of the quality of chemistry education at the national level.

Systematic work in all these areas is a prerequisite for the realization of the potential of modern information technologies as a catalyst for the modernization of Chemical Education. The synergy of pedagogical and technological innovations makes it possible to prepare students for life in a high-tech society, to increase the prestige of professions related to chemistry, to form the human resources potential for the development of high-tech sectors of the economy.

A significant place in the development of professional competence of future chemistry teachers is occupied by the digital educational environment. Digital technologies provide a wide range of opportunities to make the educational process interactive, interesting and effective, update teachers ' knowledge, form practical skills and improve their professional skills. Below is a review of the main opportunities for the development of professional competence of future chemistry teachers in the digital education environment:

I. Strengthening and expanding theoretical knowledge:

Online courses and webinars: prospective teachers can take online courses in chemistry recent achievements, teaching

methodology, pedagogy and psychology, and follow webinars. This will help update and expand their theoretical knowledge.

Electronic textbooks and teaching aids: electronic textbooks and teaching aids help students to conveniently Master educational materials, receive additional information and develop independent learning skills.

Scientific electronic libraries: scientific electronic libraries provide future teachers with access to scientific articles, research and other scientific materials. This will help expand their scientific worldview and develop their ability to think critically.

II. Formation of practical skills:

Virtual laboratories: virtual laboratories provide prospective teachers with the opportunity to conduct chemical experiments in a safe and interactive way. It helps to form their practical skills, learn the methodology of conducting experiments and develop the ability to analyze results.

Simulations: computer simulations of chemical processes help prospective teachers to visually study complex processes, change their parameters, and monitor their effects on results.

Interactive assignments and exercises: interactive assignments and exercises are aimed at developing students ' knowledge application, problem-solving and decision-making skills.

III. Improving pedagogical skills:

Teaching resources: the digital learning environment provides future teachers with teaching resources (presentations, lesson developments, tests, interactive games). This will help develop their skills in lesson planning, selection of teaching methods and creation of educational materials.

Online communities and forums: online communities and forums give prospective teachers the opportunity to share experiences, seek advice, communicate with colleagues, and build professional contacts.

Videoconferences: videoconferences help prospective teachers track the lessons of experienced teachers, get advice from them, and discuss their own lessons [13].

Portfolio: the digital portfolio provides an opportunity for prospective teachers to concentrate and demonstrate their achievements, work patterns and reflexes. This will help monitor their professional growth and show their abilities to employers.

IV. Development of digital literacy:

Using digital tools: the digital learning environment helps prospective teachers develop skills to use various digital tools (computers, projectors, interactive whiteboards, software).

Online resource assessment: prospective teachers must develop skills to select, evaluate, and use online resources effectively in the learning process.

Digital content creation: prospective teachers must develop a skillful routine to create digital content (presentations, video tutorials, interactive exercises) and use it in the learning process.

V. Basic principles of organizing a digital educational environment:

Convenience: the digital learning environment should be comfortable and easy to use.

Interactivity: the digital learning environment should ensure the active participation of students.

Flexibility: the digital learning environment must be able to adapt to the individual needs of students.

Collaboration: the digital learning environment should encourage collaboration between students.

Assessment: the digital learning environment should provide an opportunity to assess students ' knowledge and skills.

CONCLUSION

As a conclusion, it can be said - the digital educational environment provides ample opportunities for the development of professional competence of future chemistry teachers. The active use of digital technologies helps to update the knowledge of teachers, form practical skills, improve pedagogical skills and develop digital literacy. This allows them to be trained as highly qualified

professionals to meet modern educational requirements.

REFERENCES

Dobrotin D.Yu., Zhurin A.A. Integration of digital resources into the system of methodical training of chemistry teachers // Izvestiya RSPU named after A. I. Herzen. – 2019. – No. 194. – pp. 168-179.

Pustovit S.O. Digitalization of chemical education: realities and prospects // Modern natural science education: achievements and innovations. Collection of articles. Moscow: Publishing house "Pero", 2020. pp. 105-110.

Zagorsky V.V. Information technologies in teaching chemistry // Chemistry at school. - 2021. – No. 4. – pp. 12-18.

Nechitailova E.V. Digital technologies in chemical education: opportunities and prospects // Natural science education: a look into the future. Proceedings. 2020. pp. 450-458.

Eremin V.V. Computer modeling in chemistry teaching // Natural science education: information technologies in higher and secondary schools. Moscow: MSU Publishing House, 2018. pp. 159-178.

Volkova S.A., Pustovit S.O. Augmented reality in chemistry education//Actual problems of chemical and oral science education. Materials of the 67th All-Russian Scientific and Practical Conference, 2019, pp. 13-17.

Titov I.V., Evstigneev A.A. Virtual chemical laboratories in chemistry teaching // Modern technologies in science and education. – 2020. – Vol. 1. – pp. 149-152.

Gavronskaya Yu.Yu., Alekseev V.V. Virtual laboratory work in chemistry education // Izvestiya RSPU named after A. I. Herzen. 2020. No. 198. pp. 142-148.

Belyaeva E.A. Independent work of students with virtual chemical laboratories // Problems and prospects of chemical and environmental education. Collection of works, 2019, pp. 110-116.

Abdukodirov A., Pardaev A. Methodology for using modern pedagogical technologies in education and education: Tashkent. Talent, 2014. 5-105 b.

Abdullaev A.X., Sattarov Z.M., Rakhmatov B. Methodological recommendation for professors and teachers of engineers and educators on the rating system of control over the level of knowledge, skills and abilities of students in academic lyceums and professional colleges. Tashkent. O'MCKHTRY, 2000. – 17 b. 1

Apatova N.V. The influence of information technology on the content and methods of teaching: Dis. ... Doctor of Pedagogical Sciences, Moscow, 1994– 354 p.

Begimqulov U.Sh.scientific-theoretical foundations of the introduction of modern information technologies in pedagogical education. - Tashkent. Science, 2007.-164 b.

Lutfillaev M.H. Theory and practice of integrating information technology in improving the educational process of Higher Education (on the example of Informatics and Natural Sciences): Ped .fan. doct. dis. - Samarkand, 2004. -211 b.Добротин Д.Ю., Журин А.А. Интеграция цифровых ресурсов в систему методической подготовки учителя химии // Известия РГПУ им. А. И. Герцена. – 2019. – № 194. – С. 168-179.