SCIENCE AND EDUCATION IN THE THIRD MILLENNIUM:

information technology, education, law, psychology, social sphere, management



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For scientists, educational staff, PhD candidates, masters of educational institutions, university facilities, stakeholders, managers and employees of management bodies at various hierarchical levels and for everyone, who is interested in current problems of Information Technology, Education, Law, Psychology, Social Sphere, Management through the prism of the possibilities of science and education in the third millennium.

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CHAPTER 3
THEORETICAL BASES OF FORMING STUDENTS' RESEARCH COMPETENCE IN SCIENCE LESSONS

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Abstract. The modern information society needs well-trained teachers, especially in the field of natural sciences. This requires teachers to be oriented in the rapidly changing world of information, to be aware of educational and scientific innovations, to be able to use their knowledge and skills creatively, to strive for professional and personal growth, to have critical thinking, to be ready to conduct research and collaboration, and to have an active research attitude.

The recent natural and man-made crises, such as Covid-19 and the full-scale Russian invasion, pose new challenges to education. That is why the training of future science teachers who can conduct research and organize students' research activities, interest them in research and encourage them to participate in it is extremely important. This trend emphasizes the need to modernize approaches to the professional training of future science teachers, in particular in the development of their research competence.

The article discusses different approaches to defining the concepts of «research competence», «research activity» and «research training». In the scientific literature, these terms are considered through the prism of other definitions related to the educational process. Terms such as «research training», «pedagogical research activity of students», «research activity», «technology of research training» are aimed at explaining how to develop research competencies and research skills.

Keywords. research competence, students, natural sciences, future teachers, digital technologies.

Introduction. In today's world, where everything is constantly changing, the ability to adapt is an extremely useful and necessary quality. The ability to adapt to change and keep up with the times - the ability to be a lifelong learner - is one of the most sought-after skills of our century. Modern science teachers are at the forefront of these changes. After all, it depends on them how the current generation will perceive these changes.

In order to respond quickly to changes in the world around us, it is necessary to possess the appropriate qualities that not only allow us to «keep up with the times» but also help us analyze changes and draw appropriate conclusions. This should be facilitated by the research qualities of a modern person, and these qualities are essential for a modern teacher, especially a science teacher.

According to the Law of Ukraine «On Education», the main purpose of education is to develop deep values of the individual and society, unleash their talents, intellectual and creative abilities, and form important skills and abilities. This contributes to the

self-realization of a person, the formation of responsible citizens who are able to consciously make social decisions and direct their activities for the benefit of society. This process contributes to raising the level of education, developing the intellectual, economic, creative and cultural potential of the country, and promotes sustainable development of Ukraine and its integration into European structures *(Pro osvitu, 2022).* The realization of this goal should be ensured through a competency-based approach, which should be used to train specialists in any field, especially in education.

In order to successfully conduct an effective educational process, a modern teacher needs to have a wide range of skills that help him or her to effectively transfer knowledge and develop students' skills. One of the key competencies is the ability to conduct research. That is why research competence has placed teachers as researchers and disseminators of scientific ideas above teachers who were merely disseminators of knowledge *(Kryvoruchko I., 2022).*

1. Research competence: basic definitions, forms and methods of formation.

The analysis of scientific data shows that the conceptual issues of «competencies», «key competencies» and «research competencies» were dealt with by the following scholars: M. Arkhipova, M. Yevtukh, O. Bilous, L. Burchak, T. Hodovanyuk, M. Holovan', M. Holubyeva, N. Rashevs'ka, I. P'yankovs'ka, O. Kobel'nyk, O. Kobernyk, L. Kozak, N. Lyubchak, T. Makhometa, O. Norkina, S. Sysoyeva, N. Sosnyts'ka, K. Stepanyuk, I. Tyahay, M. Frolova, S. Pryshchepa and others.

Based on the European Framework of Reference for Key Competences in Lifelong Learning, adopted in 2006 and adapted to the realities of modern life, an updated version was approved in 2018, which confirms the EU's position on understanding competence as a set of knowledge, skills and attitudes. Knowledge should consist of facts and figures, concepts, ideas and theories that contribute to the understanding of a particular field or topic. Skills are understood as the ability to apply the acquired knowledge to perform an activity in order to achieve a result. Attitude is explained as a way of thinking about actions and reactions to ideas, human behavior, or situations *(Lokshyna O., 2019)*.

The Law of Ukraine «On Education» defines competence as a dynamic combination of various aspects, such as knowledge, skills, abilities, styles of thinking, attitudes, values, and other personal qualities. It determines a person's ability to successfully adapt to the social environment, perform professional duties and/or work.

According to the European Reference Framework of Key Competences for Lifelong Learning (2018), key competences aim to promote personal development, employability, social integration, sustainable lifestyles, successful living in a peaceful society, the ability to manage, maintain a healthy lifestyle and take an active citizenship. They are acquired in terms of lifelong learning, from early childhood to adulthood, and through formal, non-formal and informal education in all settings, including family, school, workplace, social environment and other communities *(Lokshyna O., 2019)*. But, as in the 2006 reference system, the number of key competencies has not changed in 2018 – there are eight of them.

According to the Law of Ukraine «On Education», in order to ensure the comprehensive development, upbringing and socialization of a person who can live in

society and interact with nature, has a desire for self-improvement and lifelong learning, prepares himself/herself for conscious education, self-realization, takes responsibility and is ready for work and civic engagement, which are necessary for the formation of key competencies that are essential for every modern person to live a successful life *(Pro osvitu, 2022)*. Within the concept of the New Ukrainian School (NUS), key competencies are considered to be those that are necessary for each person for personal development, active participation in civic life, inclusion in society, professional activity and success in life *(Kontseptsiia Novoi ukrainskoi shkoly)*.

According to the NUS, students should master ten key competencies, namely: communication in the state (and native language in case of difference); communication in foreign languages; mathematical literacy; competence in natural sciences and technologies; information and digital competence; lifelong learning; social and civic competence; entrepreneurship; general cultural literacy; environmental literacy and healthy living.

Each competency is important, and they are all interconnected.

To ensure a comprehensive educational process, teachers must have the appropriate general and professional competencies necessary to perform all job functions. We believe that one of the main competencies is research competence.

The scientific literature explores the essence of research competence through various concepts related to the study of the educational process. Such terms as «research training», «pedagogical research activity of students», «research activity», «technology of research training» are intended to explain how research competencies can be developed.

In her research, M. Holovan describes research competence as a complex personality trait that includes knowledge, skills, research experience, values, and personal qualities. This competence is manifested in the willingness and ability to conduct research to obtain new knowledge using scientific methods, applying a creative approach to planning, analysis, decision-making and evaluation of results. It is worth noting that research competence does not simply stem from learning, but is the result of self-development, personal growth and the synthesis of cognitive, activity and personal experience *(Holovan M., 2012)*.

O. Antonova's scientific works on the history of experiential learning noted that the main content of research in education, unlike scientific research, is the educational aspect. Its main goal is the development of the student's personality, and not to obtain a new objective result, as is the case in «big» science.

E. Shashenkova and I. Zymova point out that research activity is a special type of human activity that is controlled by the consciousness and activity of the individual and is aimed at satisfying cognitive intellectual needs. Its result is new knowledge obtained in accordance with the goal and objective laws. The definition of specific methods and means of action, such as problem formulation, conducting an experiment, defining the object of research, analyzing and explaining the facts, formulating a hypothesis (theory), forecasting and testing the knowledge gained, determine the specifics and essence of this activity.

According to V. Yatsenko, research competence includes not only knowledge and skills, but also the ability to conduct independent research, the ability to generate new

ideas, conduct critical analysis of information and draw conclusions *(Holovan M., Yatsenko V., 2012).*

According to N. Liubchak, research competence is not only a complex but also an integrative characteristic of a personality, which includes knowledge, skills, experience of the researcher, values and personal qualities. This competence is manifested in the willingness and ability to carry out scientific work to obtain new knowledge using scientific methods, as well as in the use of a creative approach to goal setting, planning, decision making, analysis and evaluation of results. Research competence becomes a way of life for a future specialist, combining his or her cognitive and creative abilities. It has the potential for professional self-development and career growth, namely, it is manifested in self-confidence, self-realization and other aspects *(Liubchak N., 2013).*

In their studies, O. Budnyk and O. Dziabenko consider research-based learning as aimed at developing students' ability to analyze, synthesize and evaluate information, which contributes to the formation of a high level of critical thinking.

O. Hrybiuk explores the possibilities of using the dynamic mathematics system GeoGebra for research-based learning in mathematics. She defines research learning as a process associated with solving a creative, research problem with a known answer, which involves the main stages characteristic of scientific research: problem statement; study of the theory related to the chosen topic; choice of research methods and their practical use; collection of own educational material, its analysis and generalization; formulation of own conclusions. In the context of learning, the purpose of research activity is to develop students' research skills as a means of acquiring knowledge, to develop students' ability to research thinking and intelligence *(Hrybiuk O., 2020).*

Research competence as a complex personal and professional characteristic of a specialist, reflecting interest in scientific research, the level of mastering the methodology of pedagogical research and personally significant qualities of a researcher, such as the ability to innovative thinking and creative activity, is defined by the following scholars – S. Sysoieva and L. Kozak *(Sysoieva S., Kozak L., 2019).*

Y. Kryvenko argues that research competence is the ability of an individual to solve scientific problems that require an independent creative approach and mastery of methods of scientific knowledge in the process of activity. The essence of the research competence of high school students is manifested through the interconnection of its components: motivational, informational, cognitive, communicative and reflective.

Scientists I. Tiahai, T. Makhometa, and T. Godovaniuk consider research-based learning as an innovative teaching methodology that allows students to participate in a real scientific research. Among the main characteristics of this type of learning are the following: 1) emphasis on problems that may have several possible solutions; 2) special structuring of the educational process; 3) development of skills in formulating hypotheses and problems, as well as the ability to analyze them; 4) learning to work with different approaches by analyzing sources and comparing them; 5) using primary sources in formulating hypotheses; 6) improving information analysis skills and the ability to select one of the possible solutions that have been proposed earlier *(Hodovaniuk T., Makhometa T., Tiahai I., 2019; Hodovaniuk T., Makhometa T., Tiahai I., Medvedieva M., Pryshchepa S., 2024).*

Research-based learning is a teaching method that promotes students' independent learning activity, allowing them to acquire new knowledge, develop critical and creative thinking, organize the educational process based on teamwork, and increase their interest in the subject, emphasizes researcher O. Babkova.

T. Alnikova argues that research competence includes the ability to observe, measure, conduct experiments, develop empirical dependencies, draw inductive conclusions, and create models. Project and research competence includes knowledge in a specific field, understanding of the structure of project and research activities, skills (solving problems, formulating and substantiating hypotheses, formulating goals, planning actions, analyzing and experimenting) and the ability to apply this knowledge and skills in practice.

In the scientific works of I. Mushenyk, experiential learning is described as preparation for adulthood, where students form individual educational achievements and reproduce models of scientific or other fields of activity. The main technological unit of experiential learning is a learning situation that can be organized by the teacher or arise spontaneously. In this case, the teacher only accompanies the educational process, not predicting the result in advance *(Mushenyk I., 2021).*

In our opinion, research competence is one of the key qualities that a modern teacher, especially a science teacher, should possess.

Research competence makes it possible:

- Adapt effectively to changes: research and data analysis helps teachers keep up with the times, use new methods and technologies in teaching.
- Develop students' critical thinking: stimulate students to analyze information independently, formulate their own conclusions and reasoned points of view.
- Increase motivation to learn: research that has practical value and is interesting for students makes the learning process more exciting and effective.
- Develop independent work skills: planning work, setting goals, collecting and analyzing information, drawing conclusions and presenting results.
- Prepare students for life in society: independent search for information, problem solving and creative thinking.

In the modern educational environment, the emphasis on the development of research skills and competencies is becoming increasingly important. The growing need for the ability to analyze, think critically, and conduct research leads to the need to develop research competence as early as the general secondary education stage. School is a key place where these skills can be introduced and developed. In this section, we will look at various forms and methods of developing research competence at school.

Before looking at specific methods of developing research competence, it is important to understand its meaning. Research competence implies the ability to conduct research, analyze information, formulate hypotheses, draw conclusions, and use the knowledge gained for practical purposes. It is an important component not only for successful learning but also for success in further professional activities.

Let's analyze the following forms for developing research competence: project work, practical exercises, and role-playing games *(Medvedieva M., Titova L., 2022).*

Project work is one of the most effective methods of active learning that contribute to the development of students' research skills and competencies. Let's take a closer look at them:

The process of conducting design work:

1. Choosing a topic: students are encouraged to choose a topic for research within a particular subject or topic that interests them the most, which stimulates active participation in the learning process.

2. Problem statement: there is a clearly defined goal and objectives. Students formulate their research questions or hypotheses that they will test during the project.

3. Planning: a research plan is developed, where students determine the sequence of steps necessary to achieve the project goal, as well as determine research methods and collect the necessary data.

4. Research: students search for, collect and analyze information according to their plan. They may use a variety of sources of information, including books, articles, Internet resources, and interviews.

5. Project implementation: all the necessary tasks are performed as outlined in the research plan. This may include conducting experiments, creating presentations, writing reports, etc.

6. Presentation of results: presenting your results to an audience after completing the project. This can be in the form of an oral presentation, poster presentation, demonstration of project models, etc.

Important aspects of design work:

- Independence: students independently determine the areas and methods of research that contribute to the development of their creativity and initiative.
- Analysis: students learn to analyze information, draw conclusions, and formulate their own opinions.
- Communication: project work helps develop communication skills, as students often work in teams and communicate with other project participants.
- Creativity: students show their creativity by developing original approaches to solving problems.

Project work provides students with opportunities for self-expression and development, and helps prepare them for further scientific and professional activities.

Conducting practical exercises in research is an important element of developing students' research competencies. This approach allows students to gain practical experience in conducting research, as well as to develop their analysis and critical thinking skills. Below we will consider in more detail what specific types of practical exercises can be used for this purpose.

Data collection and analysis:

1. Experimentation: participating in experiments to investigate different phenomena or test different hypotheses. For example, studying physical or chemical processes by conducting your own experiments.

2. Polls and surveys: conducting surveys among your classmates, teachers, or other groups of people to gather information about their opinions, preferences, or experiences.

3. Observation: To observe certain phenomena or processes in a real or virtual environment. For example, studying animal behavior in nature or analyzing the dynamics of social networks.

Performing experiments:

1. Research on scientific regularities: creating experimental conditions for testing scientific hypotheses or laws in various subject areas such as physics, chemistry, biology, etc.

2. Technical projects: design and manufacture of various technical devices or mechanisms to solve certain tasks or solve practical problems.

3. Modeling: the use of various software tools or mathematical models to simulate complex systems or processes and study their properties.

Important aspects of practical exercises:

- Active participation: conducting research and experimentation, which promotes engagement and interest in learning.
- Hands-on experience: Practical exercises allow students to gain real-world experience with data and research, which enhances their practical training.
- Skill development: Developing practical skills in data collection, processing and analysis, as well as the ability to observe, analyze and draw conclusions from the results.

Practical exercises are an important element of the educational process, as they allow students to apply theoretical knowledge in practice and develop their own research skills.

Participation in role-playing games is an interesting and effective way to develop students' research competencies. This method allows students to be transported into virtual research environments where they can feel like real researchers and solve various problems. Let's take a closer look at what aspects of role-playing games contribute to the development of research skills.

Elements of role-playing games:

1. Simulation of research situations: playing the role of researchers engaged in solving a particular problem or conducting a specific study. This can be a simulation of real scientific expeditions, laboratory research or scientific conferences.

2. Role-playing interactions: interacting in the roles of researchers, using communication and collaboration skills to achieve a common goal. This stimulates the development of communication and social skills.

3. Problem solving: solving various problems that arise in the course of their research activities. This helps to develop analytical thinking and creativity.

Advantages of role-playing games for the development of research competencies:

- Feeling like a researcher: feeling like a real researcher by solving real problems and performing scientific research in a virtual environment.
- Stimulating interest: Stimulating interest in learning science as they can apply theoretical knowledge to real-world practical situations.
- Fostering collaboration: Developing collaboration and teamwork skills as students must work together to solve research problems.
- Critical thinking: stimulating the development of critical thinking and analysis, as students must evaluate information and make informed decisions.

Examples of role-playing games:

1. Scientific expedition: the role of researchers who go on a virtual expedition to study a particular phenomenon or object.
2. Scientific conference: the presentation of the results of their research to an audience in the form of a scientific conference, where they act as scientists.
3. Laboratory experiment: the role of researchers who conduct experiments and analyze the results.

Role-playing games are an important tool for developing students' research competencies, as they provide an opportunity to immerse themselves in the world of science and feel part of it.

Let's consider the following forms and methods for developing research competence: problem-based learning, teamwork, and the use of Internet resources.

If we talk about the problem-based learning method, we understand that it is an approach to learning that focuses on the development of analytical thinking and the ability to search for and analyze information by students. Let's take a closer look at this method.

Basic principles of the problem-based learning method:

1. Problem statement: real or model problems are proposed that need to be solved. These problems can be complex, multidimensional, and require the application of research skills.
2. Active Participation: students play an active role in solving the problem. They use their knowledge, research skills and creativity to find a solution.
3. Collaborative learning: the problem-based learning method promotes collaboration among students. They work in groups, sharing ideas and resources to achieve a common goal.
4. Developing critical thinking: analyzing a problem from different perspectives so that students can draw logical conclusions and make informed decisions.

Regarding the stages of the problem-based learning method:

1. Problem statement: the teacher independently or with the help of a textbook poses a problem or situation that needs to be solved.
2. Problem analysis: students analyze the problem, identify key facts, aspects and potential solutions.
3. Search for information: students search for relevant information using a variety of sources such as books, articles, Internet resources, etc.
4. Problem solving: students develop strategies and methods to solve a problem, test different approaches and choose the most effective one.
5. Summarize: after solving the problem, students analyze their results, draw conclusions, and provide examples or arguments to support their decisions.

Let's consider the advantages of the problem-based learning method:

- Active learning: solving real-world problems that foster engagement and interest.
- Research skills development: developing students' research skills, such as analysis, synthesis, and critical thinking.
- Collaborative learning: promoting communication and developing collaborative skills.

• Practical application: applying knowledge to real-world situations and solving problems of practical relevance.

The problem-based learning method is an effective tool for developing students' research competencies, as it promotes active learning and involvement in solving real-world problems.

Collaborative learning is a method in which students work together on learning tasks, share experiences and knowledge, and solve problems together. This approach is actively used to develop students' research competencies. Let's take a closer look at the main aspects of collaborative learning.

Basic principles of collective learning:

1. Collaboration: working together on tasks, sharing ideas, and solving problems in a team.
2. Mutual assistance: mutual assistance, sharing of experience and knowledge to achieve a common goal.
3. Development of social skills: effective cooperation, ability to listen to others, express ideas and accept constructive criticism.
4. Mutual learning: sharing knowledge and experience that contributes to the overall development of the group.

Stages of collective learning:

1. Group formation: dividing into groups based on various criteria, such as interests, skills, level of training, etc.
2. Planning: discussing the task and assigning responsibilities to participants to ensure that the task is completed effectively.
3. Working on the task: collaborating on the task, sharing ideas, experiences and knowledge.
4. Analyzing and discussing the results: analyzing the results and discussing the knowledge and impressions gained.

The benefits of collective learning:

• Development of social skills: cooperation, communication and interaction with others.

• Effective problem-solving: different perspectives and experiences of participants allow for more comprehensive and effective solutions.

• Support and motivation: mutual support and joint work on solving problems stimulates motivation.

• Development of critical thinking: discussions and debates in the group contribute to the development of critical thinking and analytical skills.

Collaborative learning is an important tool for developing students' research competencies, as it promotes effective collaboration, experience exchange, and problem solving in a team.

The use of Internet resources in the educational process is an important element in the development of students' research competencies. This method provides many opportunities to conduct research, obtain information and develop critical thinking skills. Let's take a closer look at the main aspects of using Internet resources.

Basic principles of using Internet resources:

1. Wide access to information: access to a variety of information sources from different fields of knowledge, allowing students to familiarize themselves with relevant data and research.

2. Critical thinking: the ability to critically evaluate information, verify its accuracy and determine its relevance to their research.

3. Search skills: effective search for information on the Internet using a variety of search engines and tools.

4. Use of diverse sources: use a variety of information sources, such as websites, databases, scholarly journals, etc., to obtain diverse information.

Stages of using Internet resources:

1. Planning the research: defining the purpose of the research and drawing up an action plan, including searching for information on the Internet.

2. Finding information: using search engines and various sources to find information related to the research topic.

3. Evaluating the reliability of information: analyzing and evaluating information found on the Internet in terms of its reliability and credibility of the source.

4. Utilizing information: using the information gathered to analyze, draw conclusions and support your research.

Advantages of using Internet resources:

- Wide access to information: familiarization with up-to-date and diverse information on any topic and any subject area.
- Developing search and analysis skills: developing information search and analysis skills helps students through the use of the Internet.
- Research support: the Internet provides additional resources and sources to support students' research (virtual laboratories, experimental environments, etc.).
- Modern approach: online resources are in line with current trends and students' needs for access to information.

The use of Internet resources is an important component of developing students' research competencies, as it helps to develop skills in searching, analyzing and using information from various sources.

The development of students' research competence is a key goal of modern education, as it promotes the development of critical thinking, creativity and analytical skills that are important in students' future life and career. A variety of forms and methods contribute to the effective development of this competence in students.

Project work allows students to independently determine the purpose of research, use creativity and analytical thinking to solve problems. Practical exercises help students acquire practical skills in data collection and analysis, which is important in scientific and professional activities. Role-playing games allow students to experience the role of researchers and solve real-world problems through virtual scenarios.

The problem-based learning method promotes analytical thinking and the ability to search for and analyze information, which are important in learning and real life. Collaborative learning helps students learn how to cooperate, share experiences and knowledge, which contributes to the development of communication and collaboration skills. The use of Internet resources expands students' access to information and allows them to learn how to search for, evaluate, and use information from different sources.

It is important to emphasize that the combination of these methods and forms of teaching can provide the maximum effect in developing students' research competence. Each method has its own characteristics and advantages, and their use in combination can create a multifaceted educational environment that will inspire students to be active and creative.

Thus, developing students' research competencies is a process that requires a combination of different approaches and methods. The development of these competencies is a key task of education, as it prepares students for further scientific and professional activities, helping them to become active and creative members of society.

Let's look at science lessons using digital technologies and divide them into the following stages: preparing for the lesson, conducting the lesson, active part of the lesson, consolidating the material, and summarizing the lesson.

Methods of using digital technologies in science lessons:

1. Preparing for the lesson:

- Selecting digital tools and programs. Analyze the topic and purpose of the lesson and select the appropriate digital tools and programs. For example, virtual laboratories, interactive simulations, or videos may be appropriate for biology lessons.
- Check the availability of equipment and Internet connection. Before the lesson, make sure that the equipment, such as computers, projectors, or tablets, is working properly and that there is Internet access (if necessary).
- Developing digital materials (presentations, videos, interactive activities, etc.). Prepare digital materials that help support the educational process. This can be a presentation with key concepts, a video demonstrating the concepts, interactive tasks, or web resources for additional study.

These steps will help prepare the teacher to successfully use digital technologies in science lessons, providing effective support for the educational process and engaging students in active learning.

2. Introduction of the lesson:

- Use a digital presentation or video. Introduce the lesson with a digital presentation or video that will get students interested in the topic and introduce the key material. For example, for physics lessons, you can show videos of experiments that illustrate the laws of nature or how devices work.
- Use digital tools to demonstrate phenomena or experiments. It is suggested to use digital tools, such as virtual laboratories or simulations, to demonstrate phenomena or experiments that are difficult to reproduce in a regular classroom setting. This allows students to see and learn concepts through hands-on examples without the need for high equipment costs or safety risks.

Introducing a lesson using digital technology helps to create an engaging and interactive environment that stimulates students' interest in learning science.

3. Active part of the lesson:

- Use of interactive digital tasks: engage students in active learning through interactive digital activities such as interactive exercises, graphs, virtual experiments, etc. For example, the use of virtual simulations allows students to experiment with different parameters safely and effectively.

• Use digital platforms for students to work together in groups or to discuss results. It is suggested that digital platforms such as Google Classroom, Microsoft Teams, Moodle, or specialized education services be used to allow students to work together in groups or to discuss results. Students can communicate, share ideas, and solve problems together, which helps to develop communication skills and collaboration.

The active part of the lesson, supported by digital technologies, creates a dynamic and engaging learning environment where every student has the opportunity to actively participate in the learning process.

4. Consolidation of the material:

• Use of interactive digital tests or quizzes. Using interactive digital tests or quizzes to check students' learning. These can be open-ended or closed-ended tests that help students test their understanding and memory of the lesson topic.

• Providing additional materials for self-study. Provide students with additional materials for self-study: links to video lessons, interactive exercises, web resources, or additional reading. Such materials help students to consolidate their knowledge and can also be useful for those who want to explore the topic in more detail.

Reviewing the material through interactive digital tests and providing additional self-study materials helps learners to strengthen their understanding and confidence in the material they have learned.

5. Summarize the lesson:

• Discuss the key points of the lesson and highlight the main conclusions. Discuss the key points that were learned during the lesson. The teacher should emphasize the most important concepts and ideas that the students should learn. You can also note questions that remain open or need further study.

• Use a digital summative test or survey. A digital summative test or quiz is a small quiz with key questions or tasks to help check for understanding and retention of the material.

The final part of the lesson allows students to consolidate their knowledge and helps the teacher evaluate learning outcomes and identify additional areas of development. The use of digital assessment tools provides a quick and convenient way to collect data on student performance.

6. Homework:

• Provide additional digital resources for self-study and deepening of knowledge. Learners can be assigned to study additional materials using digital resources such as video tutorials, interactive exercises, online courses, or web resources. This will allow students to explore a topic in more depth and address individual questions that interest them.

• Assignments to create digital projects or reports using specialized programs. There are assignments to create digital projects or reports using specialized programs (PowerPoint, video, website, digital book, or other creative forms of knowledge display).

This approach to homework helps to engage students in independent learning, develops their skills in working with digital resources, and stimulates creativity in learning.

This proposed methodology allows for the effective use of digital technologies to create an interactive and engaging learning environment in science lessons, which contributes to improving the quality of learning and student engagement.

2. Selection of digital tools for the development of research competence.

Digital technologies play an important role in the modern educational process and in the formation of students' research competence in general. Digital tools not only expand access to information, but also promote active learning, critical thinking and creative skills.

Digital tools allow students to search, analyze and process large amounts of information, which stimulates their research activity. Moreover, these tools provide opportunities to interact with other participants in the educational process, co-create materials, and share experiences.

In addition, digital tools can stimulate creativity in research activities, for example, by creating digital presentations, interactive websites, animations, etc. This allows students not only to consume information but also to actively create and present their own research projects.

The right choice of digital tools is an important aspect for the successful development of students' research competence. It is necessary to take into account their needs, level of training, and learning style. In addition, it is important to choose tools that promote the development of a wide range of skills, including information retrieval, critical thinking, collaboration, and creativity.

The best interactive digital science curricula turn complex concepts into engaging ways to engage students. Through these technologies, students can explore science in an engaging way. These include real-time physical simulations, detailed virtual images of insects, interactive microscopes, and other exciting features. Modern interactive equipment together with such applications make online lessons exciting and classroom lessons unforgettable.

New educational and scientific programs are constantly being developed that can be used on interactive whiteboards or tablets, which is very important, especially during distance learning. These services cover a wide range of natural sciences, from geography and chemistry to biology and physics.

Let's take a look at the services that can be useful for studying natural sciences.

Mozaik Education is a professional education system that contains school course materials for specific subjects and is a useful tool for teachers in their practical work. Among the various tools offered by Mozaik Education, including those that help in teaching science, math, technology, history, music, and art, are the following:

- mozaBook is a smartphone or tablet application that allows teachers to create digital notebooks based on existing textbooks in the application's database or create their own digital textbooks. It provides access to an extensive media library containing interactive 3D scenes, video and audio elements (Fig. 1);
- mozaWeb Browser – a web browser developed on the basis of Google Chrome and designed to view interactive content on the platform;
- Euklides – a design program for building flat geometric shapes;
- Euler3D – a design program for displaying spatial geometric shapes, etc.

MozaWeb (https://ua.mozaweb.com/) is an online platform that provides access to a variety of digital materials such as lessons, 3D-scenes, books, videos, audio, games, and other interactive resources. The platform offers Ukrainian-language content and is currently available for free to users from Ukraine *(Titova L., 2022)*.

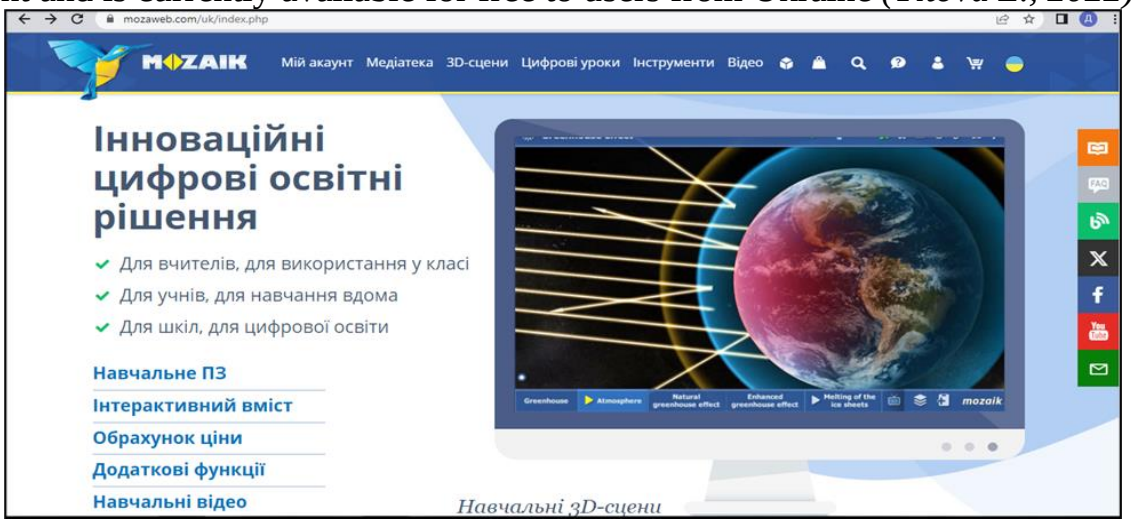


Fig. 1. Educational system mozaBook

To use mozaWeb, you need to create a personal account and confirm it using the email address provided during registration. The platform has conditionally free access, which means that there are both paid subscriptions that allow full access to all interactive resources and free ones with limited functionality (for example, a limited number of available educational tools or games, 3D-scenes or videos per week, as well as the possibility of using mozaBook for free for 30 days).

The use of this platform in the educational process contributes to the development of creative thinking and the formation of students' information and digital competence.

The interactive resource «PhET» (Physics Education Technology – https://phet.colorado.edu/uk/) is designed for virtual modeling in the process of studying natural sciences. The PhET project was originally created to study educational technologies in physics, but was later expanded to other subjects. The website offers more than 200 models in physics, chemistry, biology, mathematics, and other natural sciences (Fig. 2).

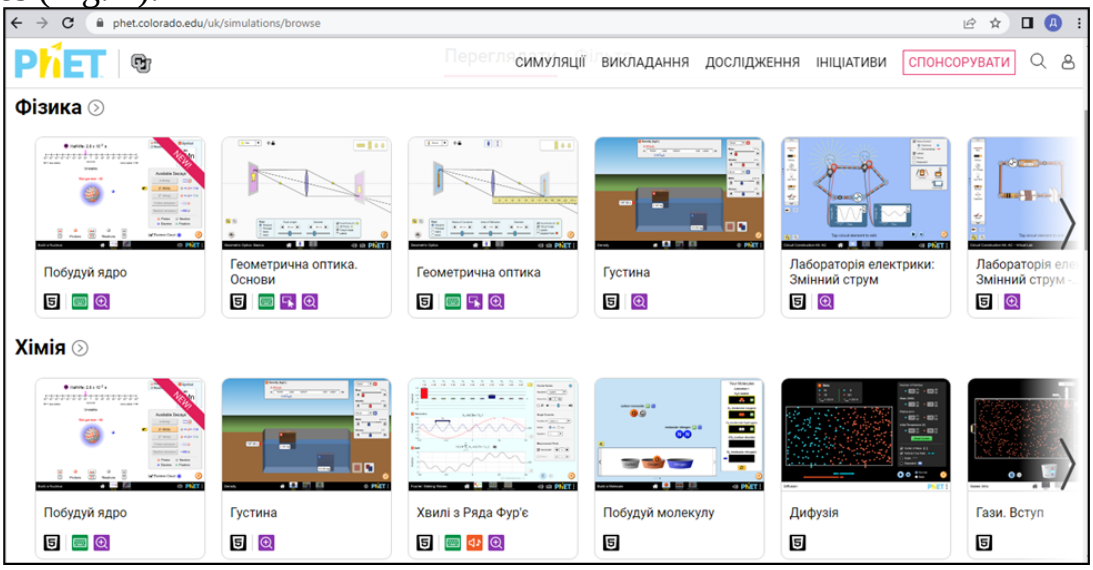


Fig. 2. Physics and chemistry simulations in the PhET service

Studies have confirmed the effectiveness of PhET simulations for conceptual learning in various contexts. A special feature of this resource is the active international community of researchers and practicing teachers who jointly develop, implement, and evaluate various models. The website also provides general guidelines and recommendations on how to use each model.

All PhET models are available free of charge on their website and can be easily used with a standard web browser.

The PhET website has been translated into 75 languages. For example, the Chinese version includes 119 models, and the Ukrainian version includes 50. Volunteer teachers from all over the world participate in the translation process. The site is free to use and is the most popular among similar resources. It is referenced in more than 170 thousand articles and other web resources related to the study of natural sciences.

PhET, with its models, brings invisible processes and phenomena to life through animation and graphics. It allows for intuitive control of processes through actions such as click and drag, as well as a variety of sliders and switches.

Models have unique features, such as interactive elements, animation, and dynamic feedback, which makes them different from other learning tools. They allow you to effectively study phenomena and processes that are not available for direct experimentation.

Although students may be interested in playing with models at home, this does not always mean they learn better. Most students lack the motivation and skills to learn independently, so it is important that teachers provide incentives in the classroom. This is one of the reasons why scientists and educators in the PhET community are conducting research on the effective use of simulations in the classroom.

In addition to simulating phenomena that can be directly observed on real equipment or in nature, many PhET models reflect expert models of invisible processes. For example, the Gas Properties model reproduces the microscopic behavior of molecules in a gas. Such expert models are especially useful in complex topics, such as molecular physics, where it is necessary to visualize atoms, molecules, states of matter, and other molecular phenomena that cannot be directly observed.

Some PhET models, such as gas property simulations, have great potential for teaching entire branches of science, as they can be used to demonstrate different aspects of physics. Other simulations focus on specific physical phenomena or concepts.

PhET simulations are designed with fun and curiosity in mind, with fun images and out-of-the-box features. For example, you can add a dog, a hand, or a fire dog to the model that cools a ramp, or a laser that explodes when too many photons are added.

Solar System Scope (https://www.solarsystemscope.com/) is a virtual model of the solar system available online and as a mobile application. The inconvenience is that this resource does not have a Ukrainian translation, but the interface is very simple and easy to understand, which makes it useful for use in the educational process. The service offers high-quality 3D-models of planets, comets, asteroids, and other objects that can be studied at different scales and time intervals (Fig. 3).

The main feature of Solar System Scope is that the user can control the movement of planets and other objects with the mouse or by touching the screen. In addition, the

service has many features that allow users to recreate the movement of objects in different historical periods, explore the surface of the planets, and observe various atmospheric phenomena such as storms and thunderstorms.

In addition, Solar System Scope contains an interactive catalog that provides information about each solar system object, including characteristics, sizes, and other interesting facts.

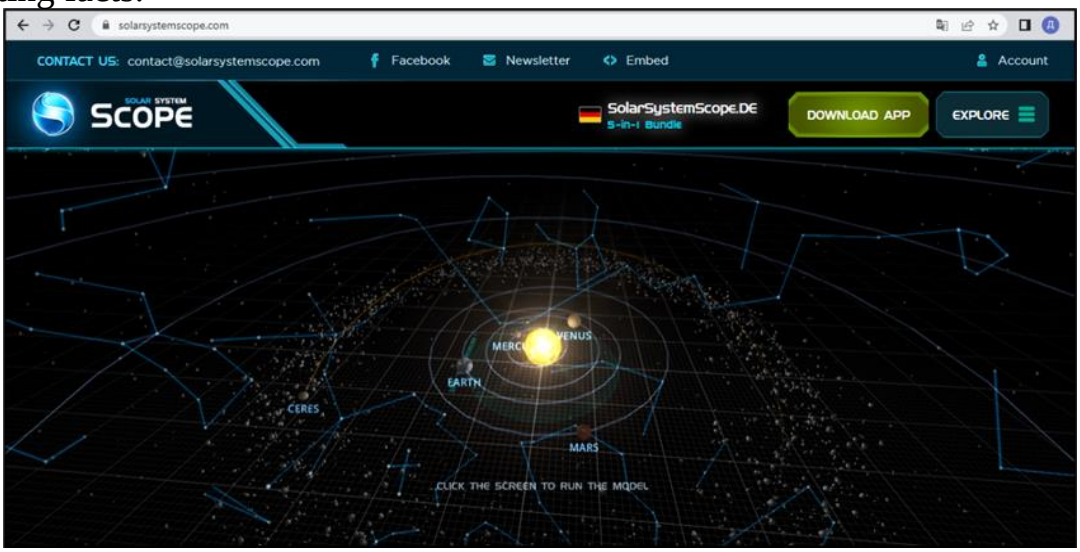


Fig. 3. Virtual model of the solar system

My physics lab (https://www.myphysicslab.com/) is a free web service that allows users to feel like experimenters in various physical phenomena and models. It was created to teach physics through interactive experiments and virtual simulations. Among its features is a wide range of interactive demonstrations that help to understand various physical concepts such as motion, mechanics, electricity, and magnetism. In addition, users can create their own experiments and models (Fig. 4).

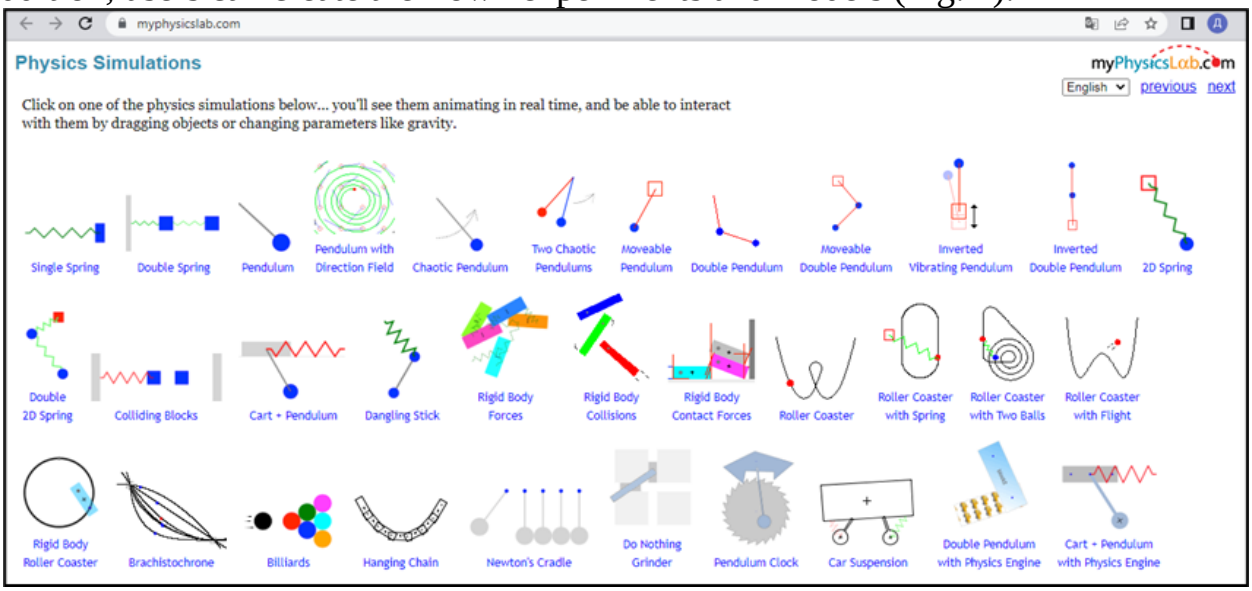


Fig. 4. Interactive demonstrations in the My physics lab service

The service has an intuitive and clear interface that simplifies interaction with various demonstrations and models. Each demonstration includes detailed instructions on how to use and explanations, which facilitates understanding of the physical concepts it presents.

Anatomy Explorer by Innerbody (https://www.innerbody.com/htm/body.html) is an online resource that allows you to explore in detail the structure and function of various organs and systems in the human body. The site contains a large amount of information, illustrations and animations that help to better understand the workings of the human body. The Innerbody website consists of several sections covering different systems in the human body. Each section contains detailed pages with information about the structure and function of each system. These sections include the bone, muscle, nervous, circulatory, digestive, respiratory, urinary, endocrine, immune, and reproductive systems. In each section, the user can select the organ or system they wish to study and view detailed information, including illustrations, animations, and photographs (Fig. 5).

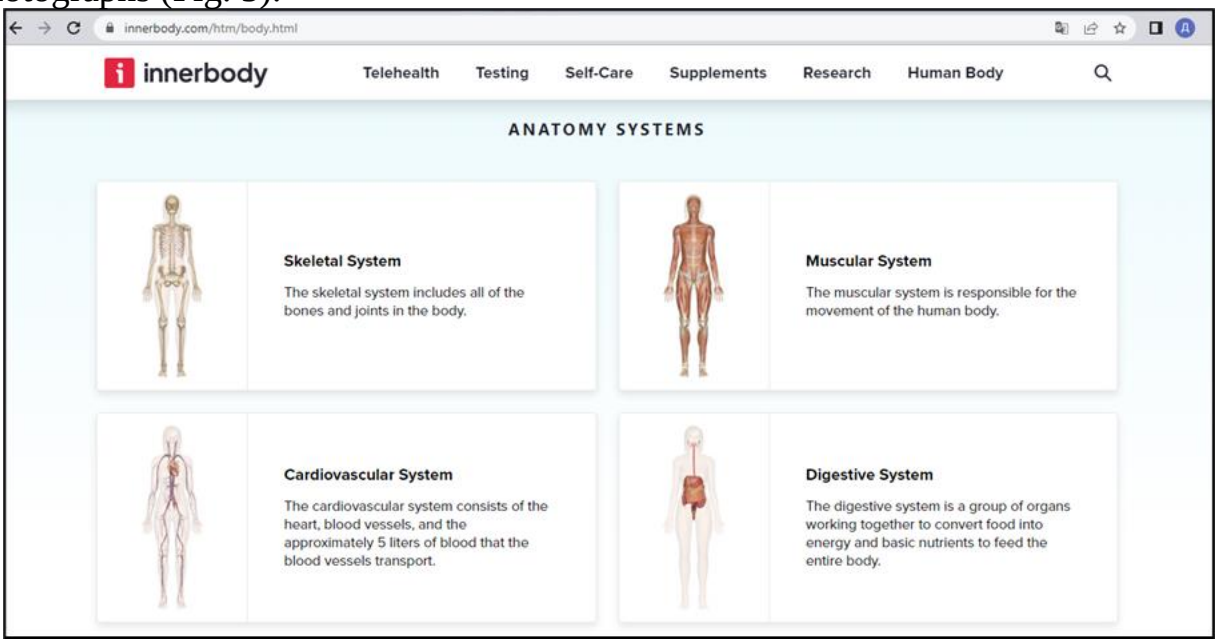


Fig. 5. Online resource Anatomy Explorer by Innerbody

The free Innerbody Anatomy Atlas is also available, allowing users to explore the structure of various organs and systems in the human body. This atlas includes high quality illustrations that can be zoomed in and rotated for a closer look. Overall, The Human Body is an important resource for students studying human anatomy and physiology, as well as for anyone interested in the health and functioning of the human body.

Periodic Table Live! (https://ptable.com/) is an online resource that provides an opportunity to get acquainted with the periodic table of chemical elements. The site contains a large amount of information about each element, including its atomic mass, electronic configuration, electronegativity, melting and boiling points, information about isotopes, and other characteristics. One of the key features of Periodic Table Live! is its interactive periodic table. Users can choose from a variety of periodic table options, including tables displaying elements by their chemical and physical properties, electronic configurations, and other parameters. In addition, users can search for elements by their names, create formulas for chemical compounds, and apply various filters to find the information they need (Fig. 6).

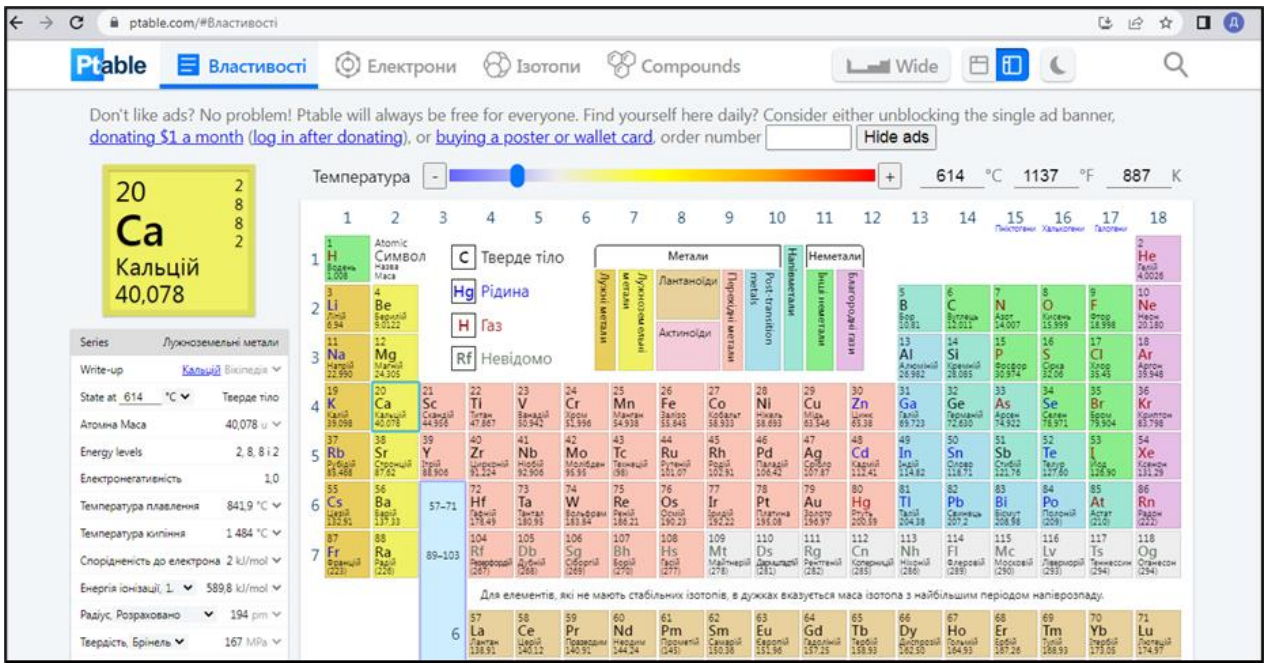


Fig. 6. Periodic table of chemical elements in the Periodic Table Live service!

Go-Lab (Global Online Science Labs for Inquiry Learning at School, https://www.golabz.eu/) is an online platform designed for teachers and students who want to learn science using virtual interactive laboratories and educational tools. The main goal of the platform is to improve the quality of science education *(Kryvoruchko I., 2022)*.

Go-Lab offers more than 600 virtual laboratories and interactive exercises in various subjects, such as physics, chemistry, biology, geology, astronomy, and others. Each lab has a short description that helps teachers and students understand what they will be learning, what questions they can explore, and what tasks they can perform.

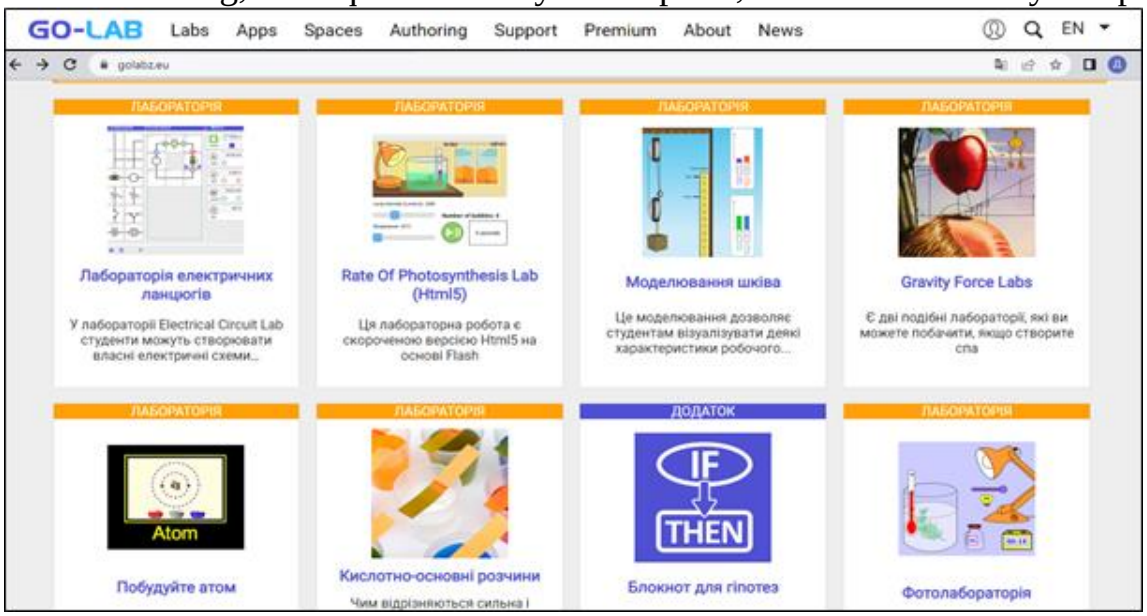


Fig. 7. Online platform Go-Lab

In addition, the platform has a variety of pedagogical tools, such as tools for creating dialogues, interactive lesson plans, knowledge models, etc., that promote a better understanding of science and make the learning process more engaging and effective.

eBird (https://ebird.org/home) is a global online database of birds from around the world that anyone can join by entering the results of their bird observations. This project was launched by Cornell University in 2012 and covers 27 languages, including Ukrainian (Fig.8).

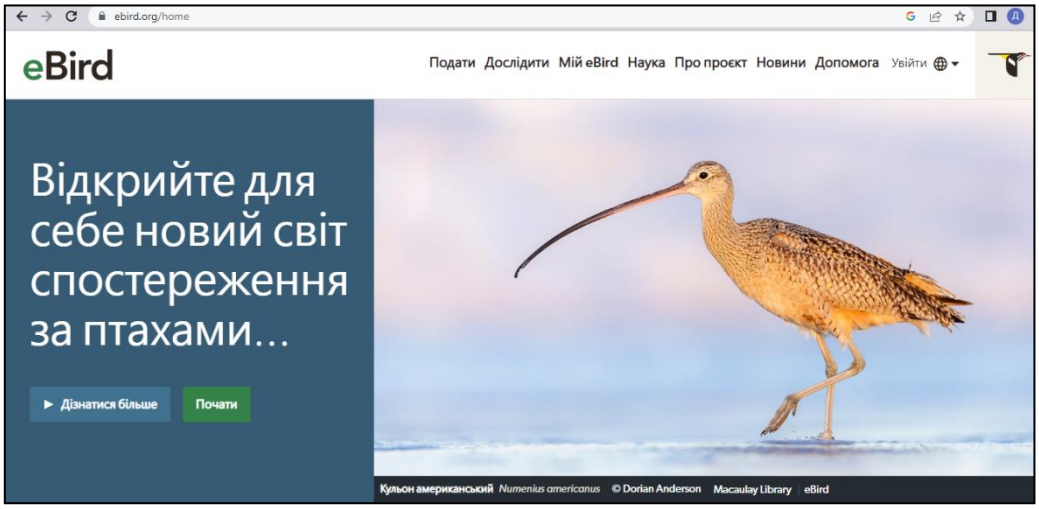


Fig. 8. Online database of bird observations

Participation in eBird is open to all, and every year more than 100 million bird sightings are recorded by experts and amateur birders from around the world. Currently, the database has over 500 million observations.

The eBird app is an important tool for those interested in ornithology. You can find a lot of useful information here: a large number of photos and videos of birds, encyclopedic data about them, audio recordings of singing, map information about habitats and migration routes.

You can also search for the best places to watch birds, view checklists of species that can be seen in certain regions during a certain period. You can refine the search for photos of specific species using special filters.

Together with eBird, we recommend using the Merlin Bird app, which will help you recognize more than 3,000 species of birds common in America and Europe. To do this, you need to upload a photo of the bird taken with your smartphone camera or answer just 5 hint questions offered by the app to more accurately identify the species of bird you are interested in.

iNaturalist (https://www.inaturalist.org/) is the world's largest public educational project for the study of natural objects, which was created by students at the University of Berkeley in 2008. It currently has more than 1 million 200 thousand users from all over the world (Fig. 9).

iNaturalist contains more than 16 million observations of 200 thousand species of plants and animals, which are available to everyone. Anyone can join the global community of naturalists and add their observations. The platform is available in 20 languages and has been cooperating with National Geographic since 2014. You can find a lot of useful information here, including photos and information about different species and individual representatives, maps of observation sites, and specialized projects for activist researchers. Anyone who has registered on the platform via email or Facebook profile can add observation results.

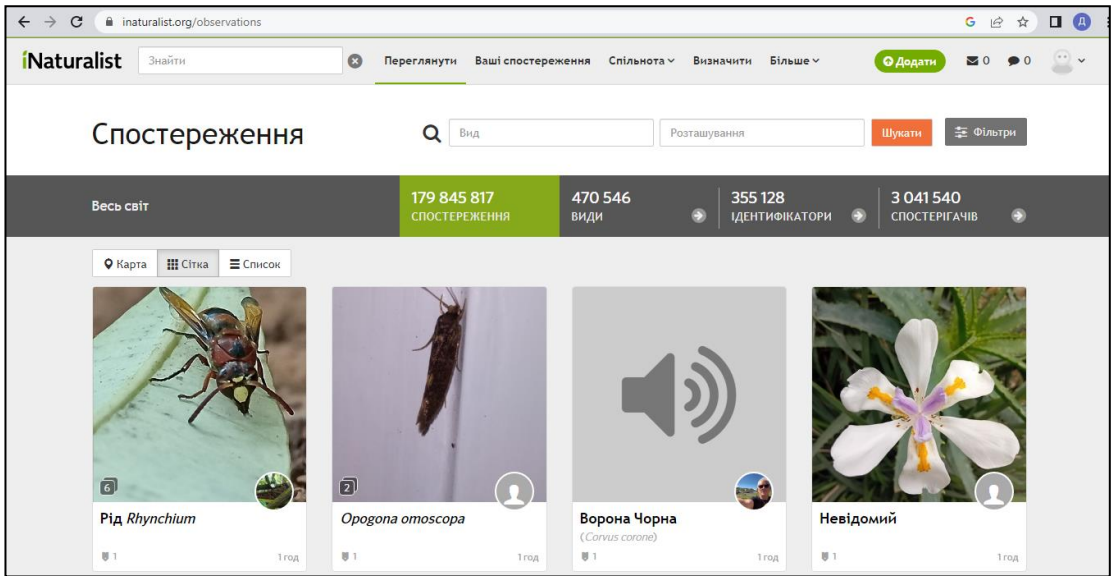


Fig. 9. An educational project to study natural objects

By joining a virtual community of naturalists, you can create your own research project or join existing ones that specialize in, for example, bat observations.

Anatomy Learning (https://anatomylearning.com/) – 3D-Anatomy is a mobile application for Android smartphones and tablets that allows users to study the anatomy of the body in three dimensions (Fig. 10).

The application contains a detailed high-resolution model of the human body, which allows users to explore each organ of the body separately. Users can explore the skeleton, muscles, nervous and circulatory systems, digestive and respiratory organs, cardiovascular system, and other body systems.

The app provides the ability to zoom in and out to better understand the organs' structure. It also contains detailed descriptions of each body organ, its functions, and how it interacts with other systems, allowing you to understand the body's anatomy on a deeper level.

The app also has interactive features, such as quizzes and recalling anatomical names. It allows users to use the cross-section function to see the internal structure of an organ in detail.

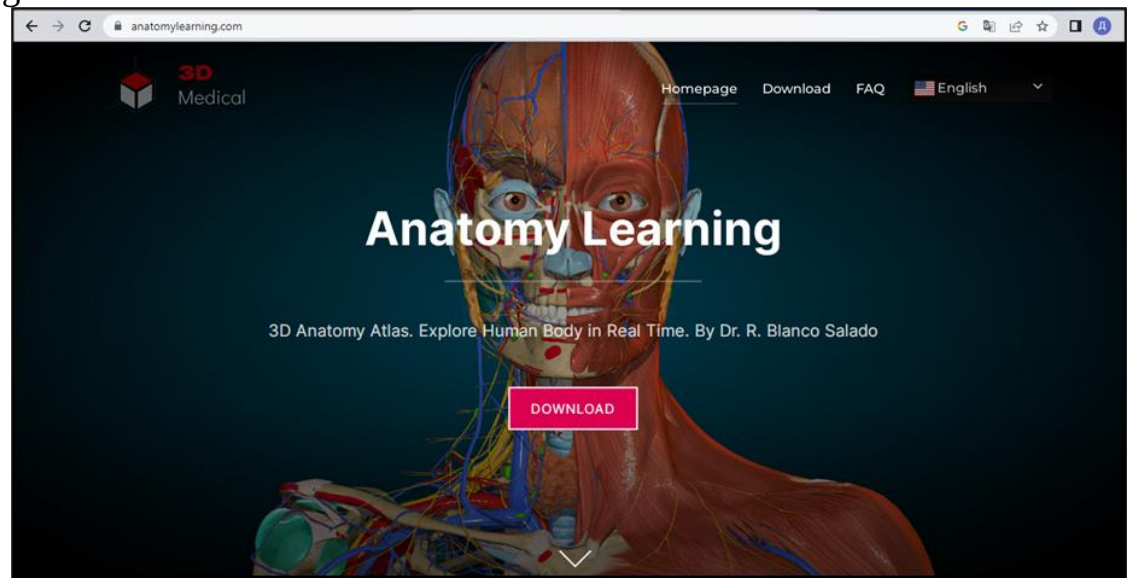


Fig. 10. 3D-Atlas of Anatomy.

Having analyzed various digital tools, we note that not all digital tools are equally useful. When choosing learning tools, it is necessary to take into account the age of the learners, their level of training, learning characteristics and goals. It is also important to use digital technologies in combination with traditional teaching methods, such as lectures, discussions, and labs.

The above examples of digital resources and platforms can be valuable tools for learning science. It is important to use them effectively and purposefully to promote the comprehensive development of students' research competence.

We would also like to emphasize the role of the teacher in the use of digital technologies, as teachers should have the necessary knowledge and skills to choose and use digital tools in the educational process. They should also be able to stimulate students to research, guide their learning and provide them with the necessary support.

Overall, digital technologies have great potential to improve science learning. Their effective use can make learning more interesting, engaging, and effective for students.

Conclusions. Thus, research competence includes knowledge, skills and research experience, as well as values and personal qualities. It is the result of self-development and synthesis of cognitive, activity and personal experience. Research activity is aimed at satisfying cognitive intellectual needs and is reflected in new knowledge obtained through the application of scientific methods and creativity.

Given the growing need for these skills in the modern educational environment, it is important to actively introduce various forms and methods of developing research competence in general secondary education institutions. Methods such as project work, practical exercises, and role-playing games can be effective tools in this process.

Digital technologies play a key role in modern education, in particular in developing students' research competence. They not only provide access to information, but also promote active learning, critical thinking, and creative skills. It is important not only to have digital tools, but also to choose the right ones, taking into account the needs and characteristics of students, and to focus on the development of a wide range of skills. Interactive digital curricula, particularly in the sciences, create engaging ways to learn, making lessons interesting and memorable. Together with the constant development of new educational and scientific programs, these technologies have the potential to significantly improve the quality of education, especially in the context of distance learning.

Analyzing each stage of the proposed methodology, we see that preparing for a lesson includes selecting appropriate digital tools, checking equipment, and developing digital materials, which allows teachers to effectively structure and support the learning process.

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