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КВЕСТ ЯК ЗАСІБ РЕФЛЕКСІЇ ПІД ЧАС ПРОВЕДЕННЯ STEM-ЕКСКУРСІЇ

Анотація. Сьогодні в освітній процес активно впроваджуються новітні педагогічні технології, серед яких особливе місце посідають особистісно-орієнтовані, інтерактивні, інформаційно-комунікативні, технології розвитку критичного мислення. Навчальні технології спрямовані на формування мобільної особистості, здатної критично осмислювати інформаційні потоки, адаптуватися в сучасному соціумі й навчатися впродовж життя. Біологія як навчальний предмет має великі потенційні можливості для реалізації різних форм організації навчання. Різноманітні інтерактивні технології навчання біології дають змогу активізувати можливості школярів та учителів, продемонструвати сфери практичного застосування засвоєних знань, умінь і навичок. Однак без володіння базовими знаннями з основних розділів біології (ботаніки, зоології, анатомії, генетики і т.д.) такі форми малоефективні. Важливе місце серед педагогічних технологій займають квести, які навчають школярів знаходити необхідну інформацію, аналізувати її, систематизувати і розв’язувати поставлені завдання. У сучасних педагогів дуже популярними стають STEM-екскурсії, які залучають учнів до процесу формування компетентностей за допомогою дослідницької діяльності. Мета таких екскурсій – залучити учнів до активного вивчення шкільних дисциплін, надати їм можливість застосувати отримані теоретичні знання на практиці. Одним із важливих етапів підготовки та проведення STEM-екскурсії є рефлексія. Її проводять по завершенню STEM-екскурсії у різних формах: оформлення альбому, проведення вікторини, створення відеофільму, складання графіків, діаграм, доповіді, комп’ютерної презентації чи усного опитування.

У статті подано методичну розробку квесту «Сторінками Червоної книги» для узагальнення та систематизації знань учнів, отриманих у ході STEM-екскурсії у Карпатський біосферний заповідник.

Ключові слова: квест, STEM-екскурсія, рідкісні рослини, педагогічні технології.

QUEST AS A MEANS OF REFLECTION DURING A STEM-EXCURSION

Abstract. Nowadays, modern pedagogical technologies are being actively introduced into the educational process, among which a special place is occupied by personality-oriented, interactive, information and communication, and critical thinking development technologies. Educational technologies are aimed at forming a mobile personality capable of critically comprehending information flows, adapting to modern society and lifelong learning. Biology, as a school subject, has significant potential for implementing various forms of learning organization. Diverse interactive technologies for teaching biology allow for activating the capabilities of both students and teachers, demonstrating areas of practical application for acquired knowledge, skills, and abilities. However, without a solid grasp of fundamental knowledge in the main branches of biology (botany, zoology, anatomy, genetics, etc.), such methods are less effective. Quests hold an important place among pedagogical technologies, as they teach students to find necessary information, analyze it, systematize it, and solve the assigned tasks. STEM excursions have become very popular among modern educators, engaging students in the process of competence formation through research activities. The goal of these excursions is to involve students in the active study of school subjects, giving them the opportunity to apply acquired theoretical knowledge in practice. One of the essential stages in preparing and conducting a STEM excursion is reflection, which is carried out at the end of the excursion in various forms: creating an album, conducting a quiz, making a video, developing graphs, diagrams, reports, computer presentations, or oral surveys.

The article presents a methodological guideline of the quest «Through the Pages of the Red Book» for summarizing and systematizing students' knowledge acquired during a STEM excursion to the Carpathian Biosphere Reserve.

Keywords: quest, STEM excursion, rare plants, pedagogical technologies.

INTRODUCTION

The problem formulation. Nowadays, modern pedagogical technologies are being actively introduced into the educational process, among which a special place is occupied by personality-oriented, interactive, information and communication, and critical thinking development technologies. The main purpose of these technologies is to actively develop not only the cognitive sphere of students, but also their personal qualities (communication skills, mobility, problem-solving skills, idea generation and testing them, etc.). In the light of the implementation of a competence-based approach to biological education at school, the question of how to organise the educational process and what forms of learning will be most effective is particularly acute. Innovations in this regard help to change the attitude of students and teachers to the educational process, giving it special significance, avoiding a formal approach to learning. Modern students have new opportunities, think, and perceive things differently. The task of modern education is to harness these changes for the qualitative and comprehensive development of the individual. Students in contemporary schools are representatives of Generation Z. They work and process information quite rapidly; they have a «click» mentality, preferring to see something once rather than hear or read it a hundred times; if they are engaged in a process, they can work for extended periods without a break.

Biology as a subject offers significant potential for implementing various forms of teaching organization. In the practice of modern biology teachers there are numerous teaching technologies that undoubtedly contribute to achieving subject-specific, interdisciplinary, and personal outcomes, as well as mastery of key competencies.

A variety of interactive teaching technologies in biology provide opportunities to activate the potential of students and teachers, demonstrating practical applications of acquired knowledge, skills, and abilities. However, without mastering basic knowledge from the fundamental branches of biology, such forms can be less effective. They should be subordinate to the main idea of the educational process, which is to «teach a child to learn.» Educational technologies are aimed at forming a mobile personality capable of critically analyzing information flows, adapting to contemporary society, and learning throughout life. One such method that teaches how to find necessary information, analyze it, systematize, and solve tasks is the quest methodology.

Analysis of recent research and publications. The name «quest» comes from the English word quest, which means «search», «search for adventure». Today, a quest at school is a game based on the step-by-step completion of pre-prepared tasks. Quests can be team-based or individual (Shambir, 2020).

In pedagogy, a «quest» is defined as a technology, method or form of organising research activities in which participants search for information, analyse, systematise it and complete certain tasks. In 1995, in San Diego, university professors Bernie Dodge and Tom March developed the concept of webquests using ICT (Information and Communication Technology) and the Internet. They described a webquest as «an inquiry-based lesson format in which most or all of the information students work with comes from the Internet» (Melnychenko, 2018).

In recent years, the peculiarities of using quests in the educational process have been described in a number of scientific papers. In particular, Sokol I.M. defines the concept of a quest as a game technology with clear didactic tasks, rules and plot (Sokol I., 2013). The author analyses the history of quests, describes the variety of their types and criteria for evaluating their effectiveness. In these works, Sokol I.M. gives examples of methodological developments of web quests in computer science, Ukrainian literature, English, history (Sokol, 2014). The works of Bykhovskyi Ya. (1999), Kononets N. (2012), Mishagina O. (2013), Shamatonova G. (2010) describe the technology of web quest as a practical activity aimed at searching for information on the Internet and performing various intellectual tasks.

Many practicing educators consider quests as mini-projects. In them, students select information from online resources, organise it and solve tasks that are usually related to their future profession. S. Agapshuk offers methodological guideline of quests on biological topics for students in grades 6-11 (Agapshuk, 2016).

AIM AND TASKS RESEARCH

Within this scientific-methodical study we aim to create a quest to repeat, consolidate and test the knowledge of 6-8th grade students about rare plant species protected in the Carpathian Biosphere Reserve. It is also intended to maintain students' interest in studying the nature of their native region through games.

RESEARCH METHODS

In the suggested article theoretical research methods were used, including analysis and synthesis of research results on the problem; method of generalization to formulate conclusions, method of prediction – to determine the prospects for further research.

RESULTS OF THE RESEARCH

The basis of a learning quest is a system of interconnected tasks and tests that are linked by a common theme and goal. The main advantage of this form is the absence of stereotypical solutions, standard answers or ready-made algorithms.

Participants in the quest are engaged in searching for answers to the given tasks, consolidating not only their ideas but also existing knowledge and skills. During the quest, students work in teams, demonstrating the potential for rational interaction, proper allocation of resources, and independence in decision-making.

This ensures the development of communicative competence and demonstrates the organizational abilities and leadership qualities of the participants, which are crucial for the successful completion of the challenges. Biology teachers most commonly use three types of quests in their practice: linear, storming, and ring.

The linear quests are designed so that the correct completion of one task allows you to move on to another. Students are particularly interested in practical tasks that require them to apply their existing knowledge and skills and find a new solution. In some cases, not only the tasks themselves are encrypted, but also the access to them. For example, in order to receive a test task, students have to find it among objects in the classroom (outside the classroom) using short encryptions. For example, access to the challenge could be hidden under a wet fish specimen (hinting at the animal that first developed an internal ear) or under an osteological specimen of a frog («the animal with only one neck vertebra»). Once the access is obtained, the team begins deciphering their route. Each point and station on the route has its own code. The code can be represented by a sequence of tasks. The answer to each task is a specific number; by combining them, they obtain the number of the point or classroom where the students will encounter the next challenge. (For example: the first digit is the number of nuclei in a plant cell (digit «1»), the second is the number of walking legs in arachnids (four pairs - digit «8»), the third digit is the number of closing cells in a stomata cell (digit «2») - code number «182») (Agapshuk, 2016).

The essence of storming quests lies in participants choosing their own method of solving tasks using control prompts. These quests are typically multi-level. All levels are provided to participants simultaneously, along with the indication of the number of points for each. The number of points is proportional to the level of difficulty of the tasks. Each level is encoded; for example, solving a genetic problem and determining Mendel's laws define the level of difficulty of the tasks (participants choose a task on monohybrid or dihybrid crossing, the first, second, or third Mendel's law). Riddle tasks contain information encoded in a certain way, sometimes in an allegorical form. (For example, we encrypt a task about insects as the most numerous representatives on Earth: we place objects on the table: a mosaic, a trachea, a pupa. Students have to explain what these objects have in common and identify the object of encryption). You can use reference books, encyclopaedias, collections, stuffed animals, herbaria, wet preparations, and the Internet to solve and get the code for a level or task. The time to complete each level is limited. If the time limit is not met, points are deducted from the team.

This form of training develops flexibility of thinking, analytical skills, the ability to apply knowledge in a non-standard situation, find a new solution, establish cause and effect relationships, and also helps to develop the ability to quickly and efficiently search for the necessary information and correctly interpret the results.

Ring quests are used to summarise large topics or blocks of biology. They are based on a linear quest for several teams that start at the same time, but from different locations. Students can be offered the quest «In the Labyrinths of Nature», which is based on the integration of biological, ecological and chemical knowledge.

At each stage, the participants have to solve specific tasks from different branches of biology (botany, zoology, anatomy, cytology, histology with the basics of embryology, genetics) with a chemical and ecological component. This integration helps to see the integrity of processes and phenomena in living nature, and gives a better understanding of the organisation of living systems and their interaction with other natural objects (Sokol I., 2013).

Nowadays, Ukraine is implementing the global trend of STEM-education, which promotes the intellectual development of children and quality education in natural sciences, engineering and technology. There is a pressing need for students to acquire methods of scientific inquiry. Among the forms and methods of teaching in STEM-education, excursions occupy a special place as they engage students in the process of developing competencies through research activities. A STEM-excursion is a special type of integrated educational activity conducted outside the educational institution in natural landscapes, industrial sites, museums, exhibitions, etc., aimed at observing and studying various objects and phenomena of the environment to develop knowledge, skills, and competencies (Shustova, 2022). One of the important stages of preparing and conducting a STEM excursion is reflection. It is carried out at the end of the STEM excursion. It takes the form of processing the materials of the excursion, namely: designing an album, conducting a quiz, creating a video, drawing up graphs, diagrams, reports, computer presentations or oral questioning.

We have created an example of a linear quest to summarise and systematise the knowledge gained during a STEM excursion to the Carpathian Biosphere Reserve.

Table 1.

Methodological guideline of the quest «Through the Pages of the Red Book»

Target audience	Students of grades 6-8
Aim	To review, consolidate and test knowledge about rare plant species protected in the Carpathian Biosphere Reserve, including their ecological groups and life forms. Additionally, to continue fostering students' interest in studying the nature of their native region through gamification. To develop students' teamwork skills and review the rules of behavior in protected areas.»
Equipment	Route sheets, maps with routes, stopwatches, printed words for making proverbs, gadgets, photos of rare plant species and their fruits and seeds, markers, paper.
Interdisciplinary connections	Ecology, Ukrainian literature, fine arts, language skills, teamwork skills, civic culture and education.
Expected outcomes	1. Generalisation and consolidation of knowledge about biological and ecological features of rare plant species of the Carpathian Biosphere Reserve. 2. General skills: respect for nature, biodiversity conservation, nature observation, development of attention, logical thinking and creativity. 3. Methodological skills: ability to operate with biological terminology, critical thinking. 4. Social/interpersonal impact: teamwork, observance of the rules of behaviour in nature.
Game rules	Quest-competition. Each team is given a route sheet. It shows the sequence of stations for each team. Participants visit five stations: **«Name me», «Where do I grow», «Captains' competition», «Folk wisdom», «Recognise me», «Maths minute», «Jigsaw puzzles» and «The smartest one»**. Participants must answer the questions and do so not only correctly but also quickly. Because for each wrong or incomplete answer at the end of the game, 5 seconds will be added to the total time. At each station, students give the judge their route sheet, scan the QR code, read the task, and then the time starts. The time is stopped by the judge after receiving the answer. After verifying it, the judge fills out the route sheet. If students encounter difficulties in solving the tasks, they may receive additional hints, but these add time (+2 minutes) to the team's total route time. If students arrive at a station and another team has not yet finished the task, they can move to another station and then return. In other words, it is not necessary to follow the sequence of stations.

Station «Name me». On the table, there are photographs of rare plant species, photographs of their fruits and seeds, and plates with the names of the species. Participants of the game must establish a correspondence between the name of the species, the photograph of the species, and the fruit. (**Suggested species**: *Allium ursinum* L*., Lilium martagon* L*., Gladiolus imbricatus* L*., Crocus heuffelianus* Herb*., Taxus baccata* L*., Campanula carpatica* Jacq*., Colchicum autumnale* L*., Iris hungarica* L*., Platanthera bifolia (*L*.)* Rich*., Dactylorhiza fuchsii* (Druce) Soo).

Station «Where do I grow?» Students should group photographs of rare plant species by life form (Life forms: trees, shrubs, herbaceous plants) and by habitat (forest, meadows, rocks). (**Suggested species**: *Taxus baccata* L., *Atropa belladonna* L., *Staphylea pinnata* L., *Trifolium badium* Schreb., Rhodiola rosea L., *Rhododéndron myrtifolium* Schott & Kotschy, *Primula minima* L., *Lunaria rediviva* L., *Pinus cembra* L., *Botrychium lunaria* (L.) Sw., *Lonicera caerulea* L., *Antennaria carpatica* (Wahlenb.) Bluff et Fingerh., *Leucojum vernum* L., *Platanthera bifolia* L.).

Station «Captains' competition». Students are asked to identify the plant from the description. The team captain draws out a sheet of paper with a description of the plant, reads out the information, and the team guesses the name of the plant. (*For example*: The name and poisonous properties of this plant are associated with the name of the greatest sorceress in Greek mythology - the daughter of the Colchis king Aeetus and granddaughter of Helios, the poisoner Medea of Colchis. Against her father's will, she helped the Argonaut leader Jason to take possession of the golden fleece and ran away with it. To delay the chase, she killed her brother, cut him into pieces and scattered him across the sea. To spite her first husband, she killed their sons. This plant grows sporadically in the Carpathians in wet and floodplain meadows along rivers and streams. It is a rare and endangered plant listed in the Red Book of Ukraine.

Botanists describe this species as follows: A perennial herb with an underground, brown, scaly corm which bears solitary, long, violet and tubular crocus-like flowers in the autumn. There are six stamens in the flower. The orange anthers give the plant one of its common names. After pollination the seeds remain in the ovary until spring when several large, fleshy, bright glossy-green, oblong to lanceolate leaves appear, arranged in a rosette with the fruit – a capsule – in the centre. The small brown seeds are pitted. All parts of the plant are extremely poisonous. (*The answer*: ***Meadow saffron – Colchicum autumnale* L.**).

Station «Folk wisdom». Participants are asked to compose 10 Ukrainian proverbs written in the form of two-part dominoes. **For example**:

Proverbs about plants:

There is a waterwell in the garden under a willow tree.
Wherever you turn, golden willows grow.
He bent like a willow over the water.
It's true, like pears on a willow.
It pours like a nightingale on a viburnum.
An acorn, no matter how small, grows into a large oak tree.
Periwinkle is for a wreath, and wormwood is for a broom.
To each his own flowers, but to me it's marigolds.

Station «Recognise me». Participants are asked to decipher the anagrams of the names of rare plant species. (An anagram is a random arrangement of letters in a word to form another word.) Solve the anagrams and write your answers in the space provided. The team that decodes the most words in 5 minutes wins. (**For example**: Anagrams: DAWEMO FANSROF, NANEEOM, ODNEHRDNOROD, ROSRMPEI, LEROCV, YLNOUHECSKE, NGEITAN, NOAEABNLLD. The answers: Meadow saffron, anemone, rhododendron, primrose, clover, honeysuckle, gentian, belladonna).

Station «Maths minute». Participants are asked to solve the problem in 2 minutes: **The Carpathian Biosphere Reserve**, one of the oldest nature reserves in Ukraine, is a member of the UNESCO Biosphere Reserve Network. It was established in 1993 to preserve and restore unique wildlife areas and protect rare species of flora and fauna. The nature here is truly unique and rich. The reserve encompasses the most valuable natural areas that have remained virtually untouched to this day. There are 1,000 species of higher vascular plants and about 300 species of vertebrates. Rare animals such as brown bear, lynx, Carpathian newt, forest creeper, black stork, owl and others can be found. Find out how many species of plants and animals listed in the Red Data Book of Ukraine are found in the Carpathian Biosphere Reserve, if the percentage is 22.5% and 24.0% respectively. (*The answers*: The Red Data Book of Ukraine includes 225 species of plants and 72 species of animals).

Station «Jigsaw puzzles». Participants need to scan the QR code and follow the link to https://www.jigsawplanet.com/VictoriaGniezdilova1.

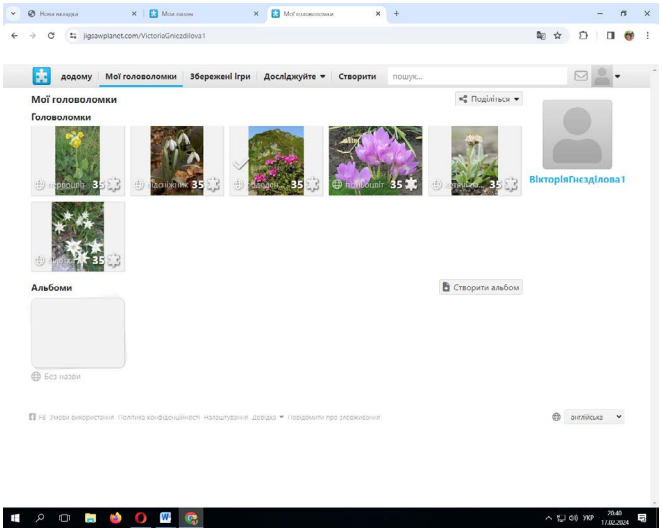

Fig. 1 Home page of the jigsawplanet platform

Here they will find puzzles that need to be completed as quickly as possible and correctly name the plant species. The team that completes the task the fastest wins.

https://www.jigsawplanet.com/?rc=play&pid=0b5b50f21962 – Rhododendron
https://www.jigsawplanet.com/?rc=play&pid=1c1464495c8b – Edelweiss
https://www.jigsawplanet.com/?rc=play&pid=332a7e7da5d8 – Meadow saffron
https://www.jigsawplanet.com/?rc=play&pid=0300c64a05f5 – Mountain Everlasting
https://www.jigsawplanet.com/?rc=play&pid=2cc6802c1e55 – Snowdrop

Station «The smartest one». Participants scan a QR code and solve tests on the Wizer.me platform.

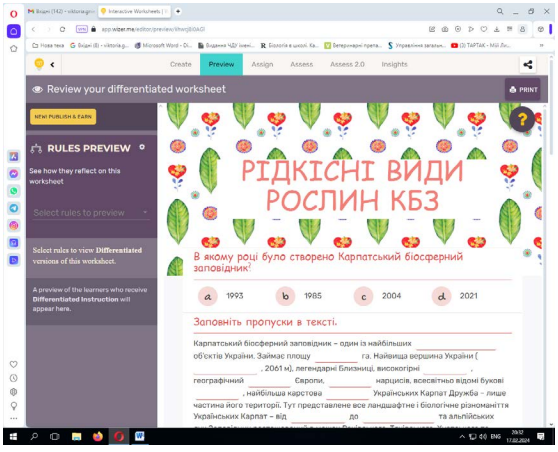

Fig. 2 Tests on the Wizer.me platform

Summing up the results.

The judges count the total time, the number of mistakes, and the number of points scored. The work of each team is evaluated. The winning team is determined.

CONCLUSIONS AND PROSPECTS OF FURTHER RESEARCH

So, the quest can be seen as a new teaching technology that has its own specific methods, forms, and means of work and can be optimally combined with traditional teaching technologies. The quest is based on an intellectual competition with elements of role-playing. This technology contributes to the growth of students' positive motivation to learn; the formation of their methodological, communicative and information competence; and the development of creativity.

The use of quest technology presupposes the availability of free time, the necessary space, unrestricted mobility and a bank of non-standard tasks of varying complexity. Therefore, it is possible and appropriate to implement them at different stages of the educational process: during immersion in a complex topic or block of topics, at the completion stage of topic study, summarising the knowledge and skills gained during a STEM-excursion, and in assessing the quality of formed competencies.

The quest is an innovative interactive learning technology that should be introduced into the educational process both in the study of biology in general secondary education and in higher education in the training of future biology teachers.

Further research is related to the problem of using quests in the educational process of a modern higher education institution.

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