Entry to the Stockholm Junior Water Prize 2023

Report title: Nature under the magnifying glass

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Abstract:

This project is based on observations of a unique ecosystem that was created over the course of two decades in a flooded quarry that was closed to the public. Microphotographs from the quarry and its surroundings, together with other photographs of nature, are used for an experiential educational program demonstrating how climate change and human activities affect the environment. Participants play an escape game that brings them face to face with the conditions at the quarry and they find out what changes have occurred in the landscape there. The program is supplemented with worksheets that can be used in science lessons at elementary schools. The program also includes a mobile exhibit. The goal of the project is to demonstrate the importance of water in nature and to influence people to behave more responsibly.

Keywords:

educational program, water, quarry, ecosystem

Acknowledgements: We would like to thank our teacher, Ms. Fasorová, for her expert advice, the management of OZS Jihlava school for material support, and Nela Šlechtická for help implementing the educational program at elementary schools.

Table of contents:

NATURE UNDER THE MAGNIFYING GLASS

An experiential educational program

INTRODUCTION

This project came about thanks to a coincidence. Several years ago, the Jihlava Gymnasium purchased an Olympus BX53 microscope. At that time, as part of the Quarry Season competition, Českomoravský stěrk a. s., a gravel company, granted students access to Kosov quarry near Jihlava, which had been closed to the public for seventeen years. After mining work was finished there, two small lakes appeared as the quarries flooded: a deeper one and a shallower one, from which it was better to collect samples. Thus, in 2016 Jihlava Gymnasium and the OZS Jihlava school began cooperating to monitor the regeneration of nature after human intervention. One of the outcomes of this project was an exhibition of microphotographs titled "The Beauty of Perfection Hidden in the Details," which made a strong impression on me. Today, we use the previously mentioned microscope in lessons (for example, to conduct biology and chemistry research). Thanks to our teacher, Ms. Fasorová, who was involved in the project, we had the opportunity to watch short videos monitoring the seasons in the quarry. I felt bad that these interesting records were "lying idle" and thought about ways they could be further used.

Seven years had passed since monitoring was conducted at the abandoned quarry, and during that time the landscape around us had changed greatly: many areas were affected by a bark beetle infestation, droughts and extreme weather had become common, Bohemian Switzerland was destroyed by a fire… I wanted to help the general public realize that "ordinary" water is responsible for these changes and motivate people to care for the environment. Thus, I came up with the idea of creating an educational program that would use photographs and documents from the school archive because they demonstrate how beautifully nature often manages by itself. At the same time, I had the need to present the current situation to people. I invited to join the team a student in the Photography and Multimedia programme at OZS Jihlava. We sat at the microscope, and new photographs and documents began to emerge. We supplemented these images with interesting information from the world of science, and thus a sort of "campaign for water" was born. We gave the project the title "Nature under the Magnifying Glass" for two reasons: first, it involves photographs taken by the mentioned microscope, and second, because we took a closer look at water's role in nature, as if using a magnifying glass. Before we got to work, we set several goals:

1) To captivate.
2) To supplement the science curriculum with examples from the Vysočina Region and the Czech Republic.

3) To provide information about new findings and research.
4) To develop students' skills.

We elected to develop an "experiential" educational program using photographs from our region. We supplemented everything with information from the world of science and put it into the context of the story of an abandoned quarry.

In the theoretical part of this work, we first briefly explain why we chose an escape game, a photography exhibition, and worksheets as the basic components of the project. In the practical part, we first explain how monitoring was conducted, without which none of the planned outputs would be possible, and then we describe in greater detail each part of the educational program. In the appendices, you can find examples of worksheets and promotional materials.

2 THEORETICAL PART

2.1 DIDACTIC GAMES

Learning should captivate students. It is an even bigger win if we can get them to start thinking more about the issue being taught and to research it and find more information about it. Play may be a suitable form of motivation. There is a "healthy competitiveness" in most people; this is the reason that we begin playing games even at pre-school age. But a game can be not only motivational but also educational.

Today, escape games are very popular. The goal is to find clues that help participants escape from a room. To get clues, the players find themselves in unusual situations and must solve various puzzles. To play escape games, players must go to a specially equipped room. It is also possible to order a "tailor-made" escape game, focused on a specific topic for a certain group. A custom-made escape game can be a very useful didactic tool. The advantage of a customized game is that we know the target audience and the goal we wish to achieve.

2.2 WORKSHEETS

Worksheets are important material didactic aids, which are usually used to supplement the subject matter being taught. A teacher can therefore use them in response to the current situation in the classroom, in the region, in the world, and so forth. Worksheets are usually created with the following goals in mind:

- to enable students to think independently and solve problems in which they apply what they have learned, or to enable students to work in a similar way in groups,
- to enable work with other aids – students can use maps, graphs, and other forms of information;

- to practice newly learned subject matter,
- to create a space for including subject matter that is not covered in textbooks and thus respond to the current situation and regional peculiarities.

A teacher usually creates worksheets so students can practice the material they have learned about. In such cases, these aids can be used to help students discover new things (e. g., for recording the results of experiments, searching for information from different sources).[1]

2.3 EXHIBITION

Exhibitions are essentially a kind of intermediary between the creator and the spectator. We have all been to exhibitions, and most certainly we can all recall the objects that made an impression on us, even years later. Thus, exhibitions have great potential. When we see an exhibition, it leaves a certain impression on us that we take away with us and think about. Thus, it can motivate us to find out more information about a certain problem. Therefore, educational benefits come from more than just reading the captions describing the displayed objects.

3 PRACTICAL PART

3.1 MONITORING

We used an Olympus BX53 microscope to magnify the objects. First, we always needed to take part of the sample and put it on a slide so it fit under the objective lens. Then we lit the slide and tried to find the angle that looked best on the monitor. Once we found the right angle, we needed to then defocus the image and then gradually focus on individual parts of the sample, while taking about 40 to 100 frames in the process. We then proceeded to use Adobe Photoshop to process the microphotographs from these frames. For photographing in the field, we used extension tubes and an external flash that helped us capture interesting details in our images. We then used Adobe Premiere to edit the video we use in our educational program.

3.2 ESCAPE GAME

The escape game is a mobile game primarily intended for upper-elementary-school students, but anyone can play it. We are certain that secondary-school students and adults will learn much new information from it, too. We gave the game the title “WILL AN ABANDONED QUARRY COME TO LIFE?”

The participants enter a room where there are several stations, each with a locked chest. The players then hear a message:

„All life on Earth owes its existence to water. Most of the water is either salty or in an iceberg form. The

freshest water flows freely through the landscape of rivers. But even underground springs, streams, lakes and pools are important donors of life. The volume of water is the largest river in the world, the Amazon. Everything associated with this river is spectacular from the mythical stories to the extraordinary diversity of life. Whereas Amazon river is more known for its natural history, the Nile is famous for its influence on human history. The Nile gave rise to one of the greatest civilizations in the world. In ancient history were floods (caused by the Nile river) considered as tears of the goddess Isis. Regular floods were a blessing for the ancient Egyptians. Life-giving water and alluvial mud full of nutrients fertilized their fields. The effort to predict floods better led to the creation of the ***calendar*** *as we know it today."*[2] *„Our story begins with* ***man's intervention in the landscape.*** *"*

Players should figure out that they need to start at the station where there is a calendar. The calendar contains many notes, one of which reads "the start of mining operations." The correct lock combination is the date that mining work began in the quarry. A letter featuring the following text is contained in the locked chest:

„THE STORY BEGINS… The landscape around Jihlava used to live a peaceful life. But one day the company came and used the probes to verify that there is durbachite rock. On the day you correctly read in the calendar, the mining began. The life seems to have stopped here forever. After few years, machines left and what happens next? The quarry was flooded by water. Can the landscape regenerate itself? Maybe so, but it may need your help. So embark on a challenging journey, on which you will learn a lot of interesting facts about the liquid that is essential for the restoration of the ecosystem. In the room you will find 7 stations to guide you. When unlocking boxes collect individual cards that can help you to save this place. Good luck! Note: If a large group is playing, break it up into smaller groups with each one going to different stations. (The order the stations are visited are not important.) At the end, the groups can join together and look for the combination for opening the chest containing the treasure. (For this, the group will need to have the materials from all the other chests.)"

3.2.1 Exercise 1 – LACK OF WATER

Legend: In the last few years our landscape has changed as a result of prolonged drought and bark beetle calamity. In the Highlands, for example, entire areas of spruce forests have disappeared and hills, previously covered by dense vegetation, have revealed their shape. However, damaged trees are registered in all areas of the Czech Republic, including national parks.[3]

Equipment: chest, lock (4 letters), picture of bark beetle with information, bast fibres.

Inside the chest: Scientists count the bugs – wintering of bark beetle, fire in the Czech Switzerland, information about web nekrmbrouka.cz, information about another parasitic insect.

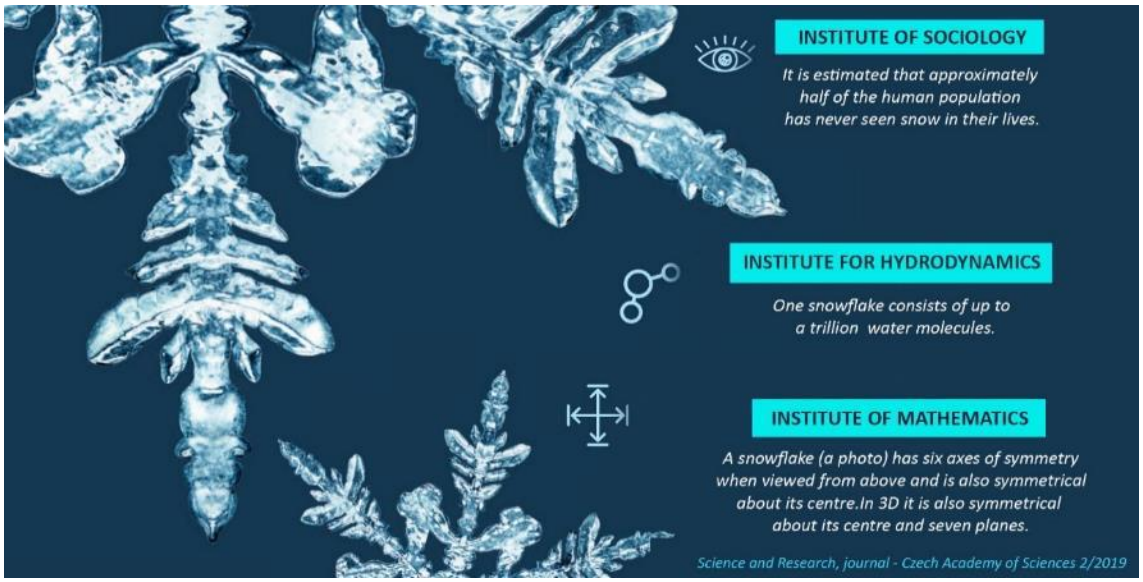
Pic. 1 – exercise 1 – LACK OF WATER

3.2.2 Exercise 2 – WATER'S TRANSFORMATIONS

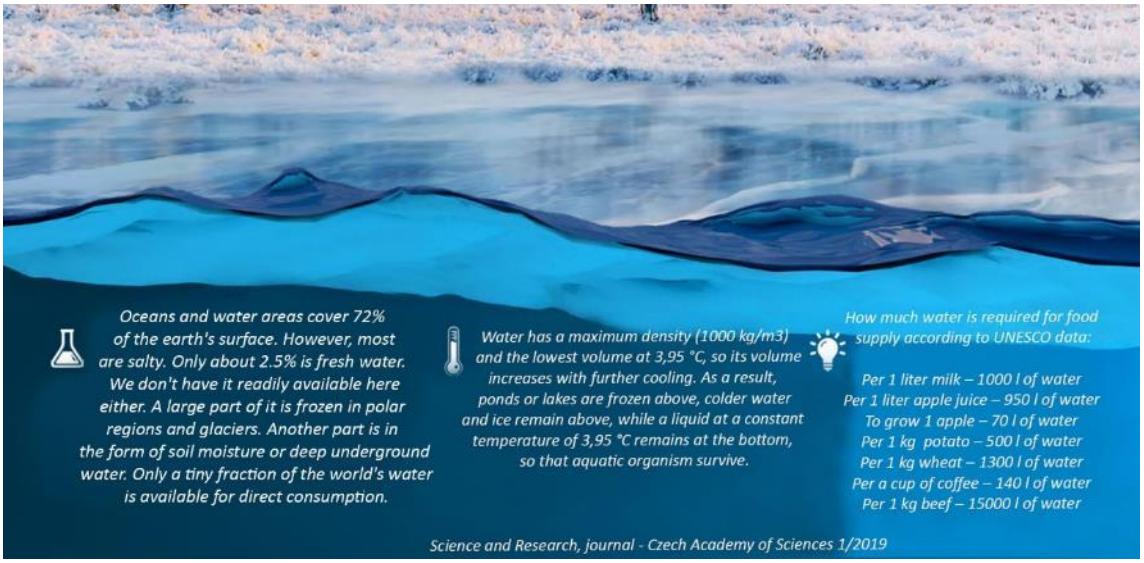
Legend: Not only is water an essential part of everything living, but it can also be beautiful – especially in winter, when it is turned into snowflakes. They say no two snowflakes are alike. This is true of natural snow. However, K. G. Libbrecht, a physics professor, has successfully created two nearly identical snowflakes out of small ice crystals in a laboratory. Can you find four identical snowflakes made in the laboratory?[4]

Equipment: Chest, lock (four letters), snowflakes.

Inside the chest: Magnified snowflakes, interesting facts about water – water's transformations and what sets it apart from other liquids.



Pic. 2 – one of the information cards from the chest – exercise 2



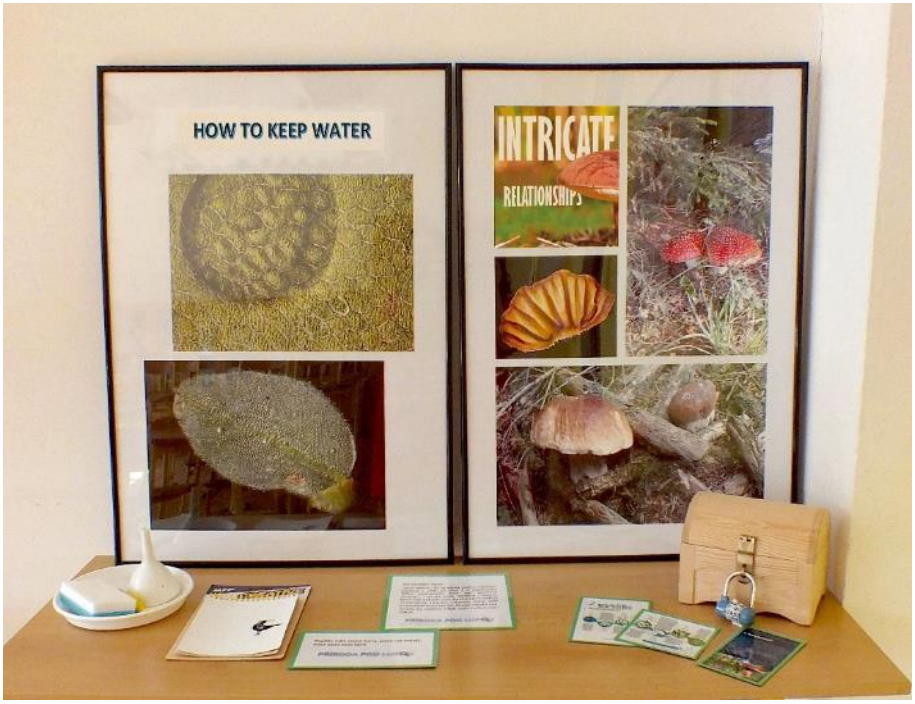
Pic. 3 – one of the information cards from the chest – exercise 2

3.2.3 Exercise 3 – HOW TO KEEP WATER IN NATURE

Legend: „Millions of years ago fungi enabled plants to move from water to land, and they still help them to obtain hardly access nutrients.”[5] Fungi are often found in moss that can hold water. On the desk there are water coloring books with a secret message that leads to the decipherment of the lock code. To uncover the code, you must get water from the attached clues.

Equipment: chest, lock (4 letters), sponge with water, bowl, water coloring book, brush, funnel.

Inside the chest: Information about the project We return water into forests, information about relationship between fungi and plants, the development of plants and the transition from sea to land.



Pic. 4 – exercise 3 – HOW TO KEEP WATER

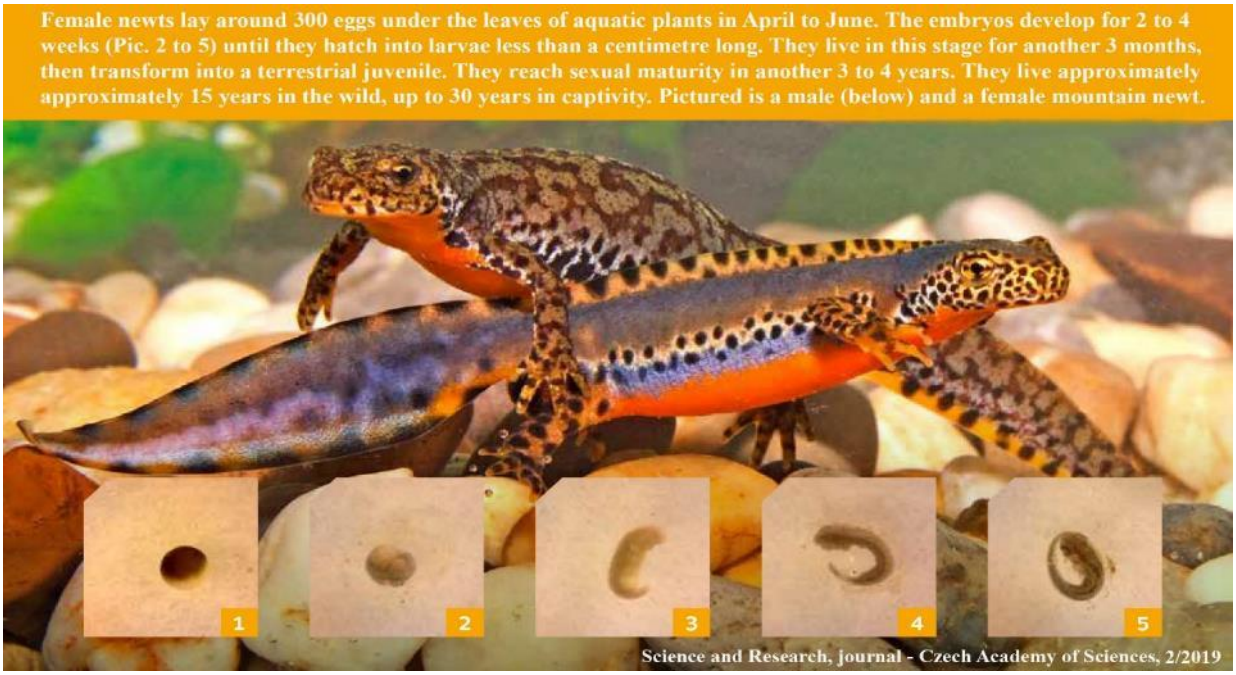
3.2.4 Exercise 4 – LIFE GIVING WATER

Legend: All of the animals and plants need water for its existence. Some of them use water only when they are thirsty, for others water has become their home as well. In the photos there are magnified parts of animals and plants. Will you recognize them? Match each card to one of the photos.

Equipment: chest, lock (4 numbers), microscopic photos of animals and plants from the quarry, 4 cards with description of one chosen photo.

Inside the chest*:* Information about amphibians – research of amphibians near Třebíč, interesting information about local reproduction of edible frog, frog records.

Pic. 5 – exercise 4 – LIFE – GIVING WATER



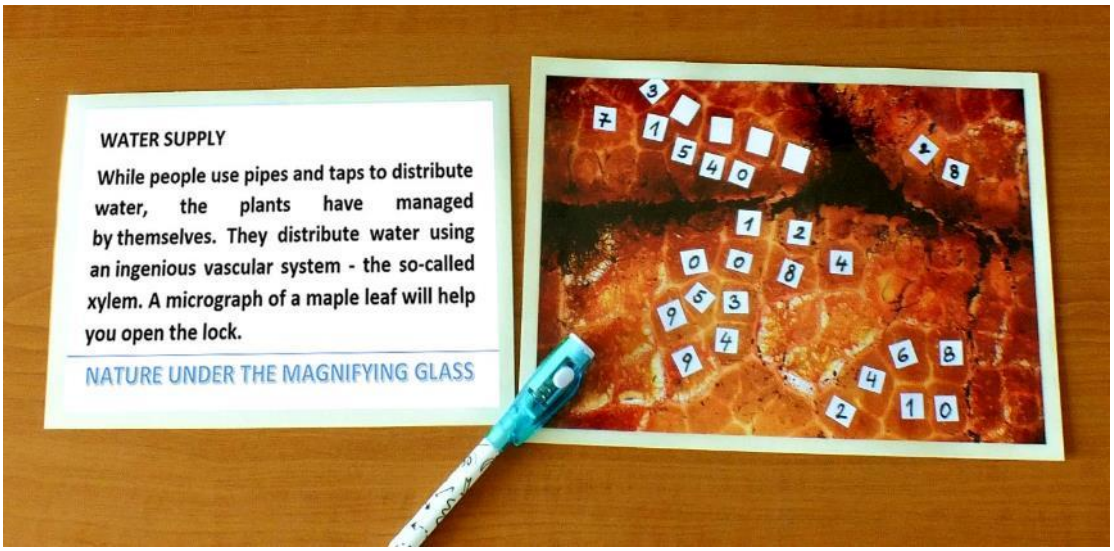
Pic. 6 – exercise 4 – LIFE – GIVING WATER

3.2.5 Exercise 5 – WATER SUPPLY

Legend: While people use pipes and taps to distribute water, the plants have managed by themselves. They distribute water using an ingenious vascular system – the so-called xylem. A micrograph of a maple leaf will help you open the lock.

Equipment: chest, lock (4 numbers**)**, photos of a maple leaf, UV light source (a pen).

Inside the chest: A picture with new findings about the vascular plant system, an invoice – consumption and price for water and sewer in a place X.



Pic. 7 – exercise 5 – the clue

3.2.6 Exercise 6 – WATER POLLUTION

Legend: "A specific feature of the Czech Republic's surface water resources is that there are very few naturally occurring lakes. In our country there are tens of thousands of manmade bodies of water, mainly fishponds, reservoirs, and flooded quarries. Scientists pay close attention to these areas. Hydrobiologists regularly take water samples and try to improve the ecological potential of such bodies of water."[6] Step into the shoes of a hydrobiologist and pick out which of the water samples on the table are polluted. They might help you find the right combination.

Equipment: Chest, lock (four numbers), glasses containing water, phenolphthalein.

Inside the chest: Information about water pollution – fish as an indicator, information about the disappearance of the crucian carp from Czech ponds, information about the time it takes for various types of waste to decompose, information about the Save the Crucian Carp campaign.

3.2.7 Exercise 7 – HEALERS FROM THE WATER

Legend: Some animals, even though they might look like enemies, are actually our helpers. These used to be used for "bloodletting."[7] Do you recognize them? By putting them **together** you can reveal the correct combination…

Equipment: Chest, lock (four numbers), magnet, string, a branch, aquatic animals with magnets, a pencil, and paper.

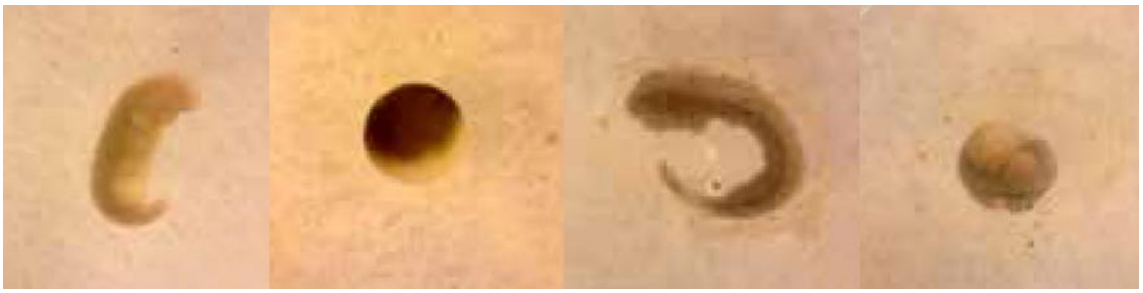
Inside the chest: Information about leeches, information about the founder of hydrotherapy.

3.2.8 Final exercise – THE TREASURE CHEST

Legend: You are at the end of your journey. It might not seem it, but twenty years have passed since the quarry was closed. What does the landscape around the old quarry look like today? You'll find everything out when you open the final chest. As you have certainly noticed, it's bigger than all the others. Maybe there's a treasure inside!

Equipment: Large chest, lock (four numbers) and picture – clues.

Inside the chest: Treasure.



Pic. 8 – the clue – a treasure chest

Figure 8 depicts a newt egg and the numbered stages of newt development. Players get the picture in the chest located at Station 4 – LIFE-GIVING WATER (Pic. 6). When they open it, players will find a treasure and then watch a short video about how nature has reclaimed the quarry: https://youtu.be/zmGh2Tuqvko.

After watching this short film demonstrating the regeneration of nature, we talk with students about how we collected samples, how the photographs used in the educational program were taken, and what findings we made thanks to monitoring activities. Then we organize an exhibition of microphotography at their school, where we leave it for some time.

3.3 WORKSHEETS

The escape game is supplemented by four worksheets (see Appendices 1 and 2). To fill them out, students may use the information cards they found inside the chests, a map of the Vysočina Region, and the video

they watched. The video talks about not only how the quarry has come back to life (i.e., about the important role of water in the ecosystem) but also about the Jihlava Massif as a place where durbachite can be found. One worksheet therefore focuses on "non-living nature."

CONCLUSION

The aim of our project was to demonstrate the irreplaceable role water plays in the ecosystem. For this purpose, we developed an experiential educational program that is primarily intended to supplement the People and Nature unit in the upper-elementary-school curriculum. According to the Czech Framework Educational Programme for Basic Education, students should above all "receive an opportunity to get to know nature as a system whose constituent parts are interconnected and interrelated and mutually influence one another. Based on this knowledge, pupils realize the importance of maintaining the natural balance of existing living systems, including humans. The educational area also significantly promotes the creation of open thinking (open to alternative viewpoints), critical thinking and logical consideration."[8] Our program meets these goals.

In the escape game, players open seven chests containing interesting information from the world of science that has some connection to water. But they also gain important information while they are looking for the combinations to open the locks. Following the clues they have found, they must apply this new knowledge in practice, contributing to the development of many skills. For example, at Excercise 3 – HOW TO KEEP WATER IN NATURE, how moss retains water and acts like a "sponge" is briefly described. This station features micrographs of thyme-moss taken near the quarry. To open the chest, the players will need water because the combination can only be revealed by painting a special page with water. Therefore, they have to know how to get this code. Once they open the chest, they learn something about the mutual relationships between plants and mushrooms and about a project titled We're Returning Water to the Forest.

For the sake of completeness, we will also give a description of two other stations. Exercise 1 – LACK OF WATER – is supplemented with photographs from a bark beetle infestation in the Vysočina Region, a microphotograph of the European spruce bark beetle and infested bark, and a photograph of Vír Reservoir during a drought. After discovering the correct combination, the players learn how infested trees dry out. On cards they will find information about the Don't Feed the Beetle Project, about new research on how bark beetles overwinter (the danger of not processing forestry waste), and about the fire in Bohemian Switzerland. Excercise 4, LIFE-GIVING WATER, features microphotographs of animal and plant parts that were taken as part of monitoring activities at Kosov quarry. The players here must match the clues with a photograph, which (with the application of combinatorial skills) leads to them discovering the combination to the lock. When they open the chest, they will find information about amphibians – "Will newts survive climate change in the Vysočina Region?" "Can frogs breed without females?" Players must

collect all the cards from each chest. At the end they will use them to open the final chest containing the treasure and to fill out the worksheets. They do not need to complete the worksheets right away. The worksheets, alongside the cards, the map of the Vysočina Region, and the link to the video, stay in the school, and teachers may use them whenever they want to supplement their lessons.

The project supplements natural science and physics classes, and also touches upon geography and chemistry. Participation in the program develops many competences – especially problem-solving skills, communication skills, and social skills.

Thus far, we have tested the program twice. The first time, we offered it to the younger siblings of our classmates (of upper-elementary-school age).

We created a flyer to promote the program (see Appendix 3) and sent it to elementary schools. So far, we have heard back from four schools interested in the program. On 22 March 2023, eighth-graders from Zhoř Elementary School and Kindergarten played the escape game (see Pics. 9 and 10), and the exhibition of microphotographs is currently on display at the school.

We wanted to create a didactic aid that would captivate our target audience: upper-elementary-school students. The program's other objectives are described in the Introduction. We verified that the goals we set were met in practice. Our project has been popular not only with upper-elementary students but also with secondary-school students. We have also received initial positive feedback from teachers, who primarily appreciate the program for how it combines the exhibition, the game, and the worksheets and also for how the program itself can be modified to meet time constraints. (The game can be shortened because the stations are fully independent of each other.)

We have further plans for our project. The escape game can also be played outdoors, and therefore during the summer holidays we would like to offer it to institutions providing educational and leisure activities to children in our region. A great challenge for us will be to regularly update the program, to collect more samples, take more photographs, and add new information cards.

Pic. 9 – escape game at primary school Zhoř

Pic.10 – presentation after the escape game at primary school Zhoř

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Sources of images:

[1, 4, 5, 7, 9, 10] Photography by the Adam Kejda

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ATTACHMENTS

ATTACHMENT 1 – WORKSHEET – Forests

Worksheet – Forests Name:

Picture 1 shows ..... In recent years, it has become very widespread in some areas. It is supposed that climate change is mainly to blame. Fill in which change it is and why it caused the overpopulation of this beetle:

.....

.....

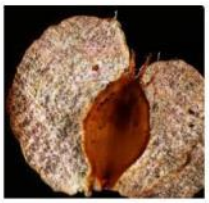
Picture 1

Describe why trees attacked by this beetle wither: .....

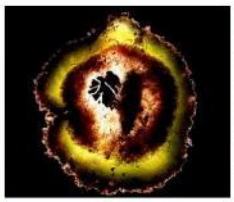
.....

Picture 2

Picture 3



Picture 4



Picture 5

Picture. 6

Trees, whose enlarged parts you can see in pictures 2 – 5, would never been attacked by this beetle. On the contrary, the tree in picture 6 is its host. Can you label the images?

.....

A *maple* **B** *wilow* **C** *spruce* **D** *ash* **E** *birch*

It looks like the bug in picture 1 has no enemies. But something attacked his larva which you can see in picture 7. Write the name of the parasitic insect .....

Picture 7

What disaster hit Czech Switzerland on July 24, 2022? .....

This "natural disaster" can also have positives for the ecosystem. Explain: .....

.....

.....

.....

Recently, spruce forests have been typical for the Czech Republic. Forests being planted now are ..... (State the type of forest.)

State why it is important not to leave infected trees and even fallen bark in the forest over the winter from these trees: .....

ATTACHMENT 2 – WORKSHEET – Ekology

Worksheet – Ecology Name:

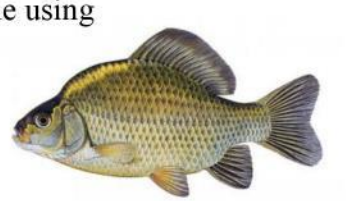
What can be the cause of the pollution of water reservoirs? Give at least two examples:

……

……

……

We can detect polluted water with the naked eye or from the sample using chemicals (indicators). A quality indicator of the water in the tank may also be the fish that live in it. Fish in Picture 1 is disappearing from Czech reservoirs and is threatened with extinction, despite being a master at surviving the inhospitable conditions. Specify:



Picture 1

a) Which fish it is: ……

b) The reason why it is threatened with extinction: ……

……

Picture. 2

Picture 2 shows garbage around the Jihlava River in the Stará Hora part. If someone doesn't clean them up, they will be there for a very long time. State how long time it takes to decompose in nature:

Paper ……. Plastics ……. P lastic bottle …….

Water has many properties that distinguish it from the standard behavior of other liquids. List the properties of water that allow fish to survive in the pond even in winter. Explain it:

……

……

Water is irreplaceable and that is why we should save it. Specify how much water is needed to provide these foods: Apple …… 1 kg of potatoes …… 1 L of apple juice ……

You also got an invoice for X's place water consumption while unlocking boxes in the escape game. Fill in the price for 1cbm (cubic metre) - water is ……. for 1cbm - sewage is ……. In total, for 1cbm the residents of this house paid ……. *(Consider the price for the last billing period).*

The family chose the pool in the catalogue in Pic. 3. How much will they pay for filling it if the diameter of the pool is 4 m, the depth is 1.5 m and water will be filled up to 10 cm below the edge of the pool? …… *(Consider that the price has remained the same since the last billing period).*

Picture 3

Formula for calculating the volume of a cylinder: $V = \pi . r^2 . v$, *where r is the radius and v is the height of the cylinder.*

See pic.1: https://www.najdirevir.cz/atlas-ryb/karas-obecny, See pic. 2: catalogue Mountfield

ATTACHMENT 3 – MEMORY GAME PAIRS

Nature under the magnifying glass

Some organisms need water as a basic environment for their life, others only need a short-term contact with water.

Different types of water ecosystems are a space for the life of the most diverse plants and animals that would not survive in any other environment. Like, for example, the quarry near Kosov Jihlava.

A few principles for those who want to reduce water consumption at home:

- do not wash dishes under running water,
- take a short shower instead of bathing,
- repair water leaks as soon as possible – dripping taps, pipes…
- use energy-saving toilet flushers,
- also use alternative sources of utility water, e.g., collecting rainwater for watering.

Moss (Plagiomnium) leaf

Moss (Plagiomnium) leaf

Fungus (Rickenella) - detail

Fungus (Rickenella) - detail

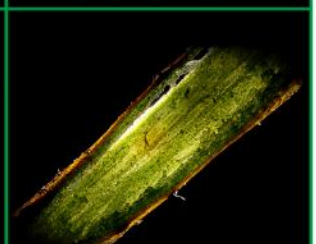
Life under the water

Life under the water

Maple (Acer) - leaf detail

Maple (Acer) - leaf detail

Maple (Acer) - horizontal cut



Maple (Acer) - horizontal cut

Magic of spider

Magic of spider

ATTACHMENT 4 – CALENDAR

ATTACHMENT 5 – POSTER