



DEVELOPMENT OF ESTEAM TEACHING METHODOLOGY



Published by: Idrija Heritage Centre (Slovenia): Nina Erjavec, Mojca Gorjup Kavčič

Editors:

Naturtejo Empresa de Turismo (Portugal): Mariana Vilas Boas, Maria Manuela Catana, Carlos Neto de Carvalho

Magma Geopark (Norway): Cathrine Johannessen Skogen, Pål Thjømøe, Sara Gentilini

Črni Vrh Elementary school (Slovenia): Lilijana Homovec, Maja Sever

Agrupamento de Escolas de Jose Sivestro Ribeiro: André Azeiteiro, Elsa Cantinhas

University of Ljubljana, Faculty for Natural Science – geology department (Slovenia): Andrej Šmuc, Tomislav Popit

Locatify ehf (Iceland): Leifur Bjornsson, Steinunn Anna Gunnlaugsdottir

Texts and photos by: ESTEAM team

Illustrations: Dana Kodermac, De

Proof-reading by: Vanja Živković Sedej

Cover page and ebook design: OblikovANJA računalniško oblikovanje ANJA GOLOB s.p.

©2019 ESTEAM Project

Kataložni zapis o publikaciji (CIP) pripravili v Narodni in univerzitetni knjižnici v Ljubljani

COBISS.SI-ID=300441856

ISBN 978-961-94242-4-7 (pdf)



Co-funded by the
Erasmus+ Programme
of the European Union

Co-funded by the Erasmus+ Programme of the European Union

ERASMUS+: KA2 – Co-operation for innovation and the Exchange of Good Practices/Strategic Partnerships for School Education

The content of this e-book does not reflect the official opinion of the European Union. Responsibility for the information and views expressed in e-book lies entirely with the author(s).

WELCOME!

This book, the second of the intellectual results in the ESTEAM project, presents the process of creating a mobile application for teaching and learning natural science in elementary schools. With this book, we would like to convey to you, our esteemed readers, our experience about designing a methodology that combines classroom and outdoor learning with modern ICT technologies, and also provide you with the tools that we used to achieve this. We hope this publication will arouse your interest in the emerging TeachOUT mobile application, and that you will decide to implement a curriculum with a mobile application. This is done through the third intellectual result of the ESTEAM project - Step by Step guide on the ESTEAM methodology and the TeachOUT application (Science teachers' guide).

ESTEAM team

LIST OF CONTENTS

1. CHAPTER: INTRODUCTION.....	5
2. CHAPTER: DESCRIPTION OF 3 SELECTED THEMES	8
2.1. DESCRIPTION OF THE TOPICS SELECTION PROCESS.....	9
2.2. GEOLOGY	10
2.3. ECOLOGY	15
2.4. MEN AND BIOSPHERE.....	19
3. CHAPTER: ESTEAM TEACHING METHODOLOGY	23
3.1. ESTEAM TEACHING METHODS	24
4. CHAPTER: TeachOUT MOBILE APP CHALLENGES.....	26
4.1. OVERVIEW	27
4.2. BRIEF EXPLANATION HOW THE APP IS USED	27
4.3. CHALLENGE-TYPES IMPLEMENTED	27
5. CHAPTER: ESTEAM EXERCISES	30
5.1. METHODOLOGY OF PREPARING EXERCISES.....	31
5.2. EXERCISES AT THE KARST TRAIL	32
5.3. EXERCISES AT THE MONSANTO TRAIL.....	64
5.4. EXERCISES AT THE HESTNES TRAIL	89
6. CHAPTER: PILOT TESTING ACTIVITIES.....	113
6.1. OVERVIEW	114
6.2. TeachOUT PAPER VERSION TESTING – STUDENTS.....	114
6.3. TeachOUT APP TESTING – STUDENTS.....	120
6.4. TeachOUT APP AND PAPER VERSION TESTING – FUTURE TEACHERS.....	130
6.5. OVERALL TEST RESULTS.....	136
7. CHAPTER: CONCLUSIONS	137
ANNEXES	140

1. CHAPTER: INTRODUCTION

The ESTEAM project is co-financed by the ERASMUS+ programme of the European Union, started in September 2016 and will run for 36 months. For the co-ordination of the project the Idrija Heritage Centre is in charge, which is also the coordinator of Idrija UNESCO Global Geopark activities.

The Consortium of the 8 partners is comprised of three UNESCO Global Geoparks (Idrija Geopark, Magma Geopark and Naturtejo Geopark), two schools within Idrija and Naturtejo Geopark areas and pilot schools within the Magma Geopark area, University of Ljubljana-Faculty of Natural Sciences and Engineering Department for geology and a computer company specialising in ICT Locatify.

The schools are the core of the Consortium and were selected on the basis of the teachers' experience & expertise in the natural sciences and subjects they teach in schools, as well as their connection with the Geopark goals in sustainable education.

All the Geoparks have strong skills in the field of education and they have been co-operating with the schools selected for some time in developing teaching programmes for pupils, developing didactic programmes outdoors and even some ICT technologies.

The University of Ljubljana was chosen as a partner on the basis of previous common work on the popularisation of natural sciences (focusing on the geological) in schools. They were invited as experts and as an educational support on geological and also other contents in the school programmes and sharing best practices on methods & practical exercises, games, possible ways of interpreting difficult geological contents for pupils in elementary school.

ICT company Locatify was chosen on the basis of their vast experience, development of solutions requirements in the project and previous work done in this field, as well as the staff of the company and their ideas and preparation to co-operate through the whole duration of the project.

The ESTEAM project has arisen from from the personal experience and needs of science teachers. We know that learning programmes and the learning process are getting more and more comprehensive, fast and demanding.

The traditional way of teaching is slowly losing its focus. Modern, contemporary and fun ways of teaching with modern technologies included in the learning process are looked for. They should be fun and adapted to ICT technologies. Internationalization is promoted and there is also increased use of digital learning, possibly in combination with teaching in the field.

The ESTEAM project aims to improve the quality of teaching-learning in the school system through an innovative method (teaching methodology, toolkit & users experience space (virtual & nature)) that links National curriculum goals in natural science education with developing of mobile teaching/users experience platform (ICT), in combination with outdoor activities. Additionally, development and findings will result in Guide for Teachers in Natural Science Education – ESTEAM methodology Step by step guide.

The general objective is to improve the teaching process in combination with ICT technologies and outdoor activities.

The specific objectives of the ESTEAM project are:

- Research of National Curricula in project countries, with a list of proposed programmes and tools for designing lessons;
- Create effective content & methodology for science teaching designed in collaboration with teachers, experts in the field of science, interpretation of the natural heritage & experts in the field of ICT;
- Develop mobile teaching/users experience platform;
- Design of Guide for teacher in science education based on outputs, knowledge and experiences;
- Increase the frequency and effectiveness of the use of ICT technologies in the teaching of science;
- Increase the level of digital competence for teachers & pupils;
- Increase the level in foreign languages for teachers & pupils.

In the project several activities will be carried out:

- 1) Project management
- 2) Quality assurance
- 3) Dissemination
- 4) Research of National Curricula with guidelines
- 5) Development of teaching methodology: mobile teaching/users experience platform
- 6) Preparation of Guide for teacher in natural science education – ESTEAM methodology Step by step guide
- 7) Project meetings
- 8) Presentations of ESTEAM Intellectual Outputs and their use in teaching/learning process
- 9) Short-term joint staff training event

The implementation of the project on a transnational level is necessary due to a higher level of the results, and to achieve the initial goals of the project. Partners from 3 countries (Slovenia, Norway and Portugal) with diversified natural & social features participate in the project. Such diversification will have a significant impact on recognising best practices in teaching Science in all partner countries and then help apply them in the partners' environment. At the same time, all partners are joined by the unique natural heritage connected by all three geoparks. The implementation of the project on a transnational level will thus emphasise the visibility of geoparks' territories, their significance in preserving natural heritage within the EU and the importance of interpreting this shared heritage to the general public. The transnationality involved in the project will contribute to a wider scope of spreading the results. Due to the transnationality, foreign language knowledge will improve and a common European identity of all participants will increase during the project.

The target groups of the project are: Science teachers, Future Science teachers, Professors of didactics at faculties, Pupils aged 12-15, Geoparks staff and Employees and educational institutions.

2. CHAPTER: DESCRIPTION OF 3 SELECTED THEMES

2.1. DESCRIPTION OF THE TOPICS SELECTION PROCESS

In the beginning, the partners in the ESTEAM project selected three topics, which were then discussed throughout the continuation of the project. We approached the selection very seriously, as we wanted to cover as much of the natural science as possible. Thus, we initially agreed to work on the following topics:

- Non-living nature
- Living nature
- The influence of man on the environment

With reference to the selected topics, the first part of the project saw an analysis of school curricula for individual subjects and the setting of goals for students. All three countries (Slovenia, Portugal and Norway) prepared a wide range of topics, from which the most important ones and those that take up the most time in the learning process were selected. Subsequently, parallels were drawn between the curricula in the three countries and three specific science fields were selected. They include:

- Geology
- Ecology
- Man and the environment

However, since these fields are very broad and offer a range of subsets, three sub-themes were determined for each science field. The partner consortium selected them from the aspect of topicality in all three countries.

The selected sub-themes in the field of GEOLOGY are:

- Rock cycle
- Rocks
- Landforms

The selected sub-themes in the field of ECOLOGY are:

- Abiotic factors
- Biotic factors
- Biodiversity

The selected sub-themes in the field MAN AND THE ENVIRONMENT are:

- Sources of raw materials
- Geohazard
- The influence of man on the environment

The selection of the three main themes with sub-themes was quite a challenge for the ESTEAM project partners. Even at the very beginning of the project, we realized that science was taught in different subjects in the three countries, and delivered using various methodologies. Hence, we had to take a comprehensive approach. First, we listed all science topics taught at schools and analysed the contents. Then, we classified them by relevance. Only then did we select the three most important themes that are taught in all three countries.

We hope that with this process, we have laid the foundations that will allow teachers and students outside the project to use the ready contents and exercises as well as the application in the continuation of the project.

In the following, the three selected topics are presented in more detail.

2.2. GEOLOGY

Geology is one of the basic natural sciences (like physics and chemistry) that study planet Earth, its structure, composition, processes that act on it and its evolution from its beginning more than 4 billion years ago. In short: geologist work to understand the history of our planet. The better they can understand Earth's history, the better they can foresee how events and processes of the past might influence the future.

Geology is broadly divided into physical geology and historical geology. Physical geology mainly deals with processes and materials of the Earth. Moving of tectonic plates, composition of rocks, earthquakes, volcanoes, geologic resources, weathering and soils, landslides, water and the behaviour of glaciers are just a few examples. Historical geology addresses the Earth's evolution from its beginning up until today. It studies the distribution of seas and lands through time, the growth and destruction of mountains, and the succession of plants and animals that lived on Earth down through the ages. Historical geologist views the results of past geologic events and works backward in time to find their cause.

Although geology primarily studies Earth, its view has broadened to include other planets.

Minerals

Minerals are solid naturally formed inorganic elements or substances that have a characteristic chemical composition and periodically repeating arrangement of atoms i.e. crystal structure. This gives them their distinctive chemical and physical properties. Most common minerals can be relatively easy to identify using properties such as colour, crystal form, hardness, density, cleavage, magmatism or reaction with water or weak acids. Other minerals however can be identified only with the use of microscopes or other specialist equipment.

Up until now, well over 3,000 minerals have been described, however only a few compose common rocks. These rock-forming minerals are divided into two

broad groups: the most abundant are silicates (which contain silicon) while rarer are nonsilicates (which don't contain silicon). Silicates were amongst the first minerals that formed on the planet Earth and represent fundamental group of minerals. Nonsilicate minerals formed only when the planet had cooled enough to support a solid crust and to sustain a hydrosphere (ocean) and an atmosphere, thus allowing weathering of the primordial silicates and precipitation of their products of weathering.

Silicate minerals are the most common crustal minerals (about 90% of Earth's crust). These minerals contain silicon and oxygen (like quartz), often combined with additional elements like aluminium, iron, calcium, sodium, potassium and magnesium. The principal silicate minerals and group of minerals are feldspars, quartz, micas, amphiboles, pyroxenes, olivine, garnet and clay minerals.

Nonsilicate minerals represent only 10% of the Earth's crust. They do not contain the silicon-oxygen structures that characterize silicate minerals. Nonsilicates include carbonates, sulphides, sulphates, chlorides and oxides. Carbonate minerals, such as calcite and dolomite, are the most common.

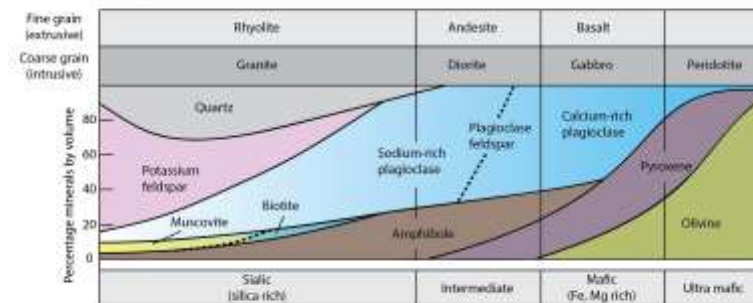
Rocks

Rocks are an aggregate of one or more minerals (like anorthosite, granite, limestone) or a body of undifferentiated mineral matter (like obsidian) or lithified organic material (coal for example). Geologists divide Earth's rocks based on the way in which they formed. The rocks are divided into three great families: igneous, metamorphic and sedimentary. Igneous rocks form when molten rock (magma or lava) cools down and starts to crystallize. Metamorphic rocks are those that undergo change (metamorphosis) in form because of the action of pressure and heat. Sedimentary rocks mainly form when rocks are subjected to weathering that produces sediment. Sediment is then transported, deposited, compacted and cemented into sedimentary rock. Sedimentary rocks can also have a biological or purely chemical origin.

Igneous rocks are most abundant in the Earth's crust and constitute over 90% of rocks. They are however seldom present at the surface, because they are extensively covered by sedimentary rocks. Igneous rocks are formed from magma (molten rock beneath the surface). Magma is more than one thousand degrees of a mixture of molten silicates and gases. When magma penetrates existing rocks and slowly cools down (this process can take millions of years) it solidifies and forms intrusive of plutonic igneous rocks. These rocks have the texture of large intergrown crystals that can be seen with the naked eye. At places when magma breaches the surface, it erupts as lava, the extrusive igneous rocks are formed. This lava cools down quickly and produces a finer texture, in which crystals are too small to be seen without the aid of modern equipment. The classification and naming of igneous rocks is based on their composition and texture.

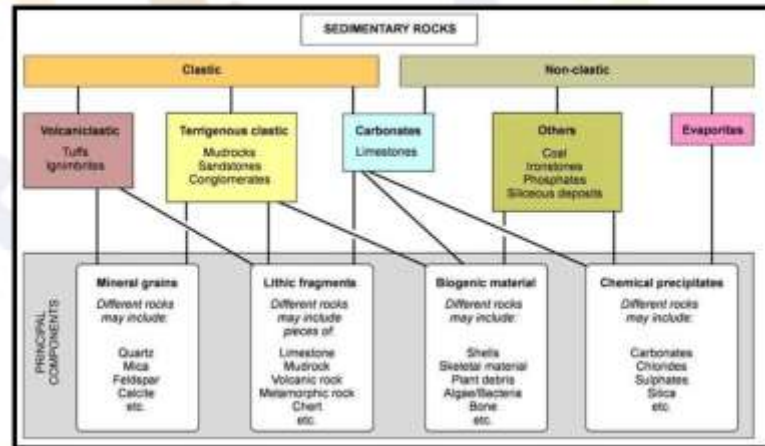
Among the more familiar igneous rocks are granite, diorite, gabbro, rhyolite, andesite, and basalt. Granite is a silica-rich, relatively light-coloured intrusive rock. In addition to quartz, granite contains orthoclase feldspar, sodium plagioclase, and lesser amounts of mica and hornblende. Rhyolite is a fine-grained equivalent of granite. Diorite is a relatively coarse-grained intrusive rock containing less silica than granite. It is composed mainly of plagioclase feldspar. Andesite is the fine-grained equivalent of diorite. In gabbro, the chief mineral is calcium plagioclase, which is darker and more calcium-rich than the plagioclase in diorite. Additional minerals in gabbro are augite and olivine. The fine-grained equivalent of gabbro is basalt.

Classification of magmatic rocks, based on texture and mineral composition, Levine, 2013



Sedimentary rocks are rare compared to the magmatic ones. They consist only in minor quantities of the Earth's crust. They are however the most common rocks on the surface, covering 80% of Earth's surface.

Sedimentary rocks result from the consolidation of loose sediment that has accumulated in layers. These clastic rocks (such as conglomerate and sandstone) are composed of mechanically formed fragments of older rock transported from its source and deposited through the force of water, air or ice. Sedimentary rocks can also form by precipitation from solution (such as rock salt or gypsum). They can have a biological origin and consist of the remains or secretions of plants and animals (such as certain limestones). The sedimentary family also includes pyroclastic rocks composed of fragments blown from volcanoes and deposited on land or in water. Sedimentary rocks are classified into clastic and non-clastic ones. Clastic rocks include volcanoclastic, terrigenous clastic rocks (mudstones, sandstones, breccia and conglomerate) and certain carbonates. Non-clastic rocks are certain carbonates (limestones and dolomites), evaporites and others (coal, ironstones, phosphates and siliceous deposits). The most common are mudstones (app. 50%), followed by sandstones (app. 25%), carbonates (20%), while all other rocks represent only 5%.



Classification of sedimentary rocks based on Nichols, (Nichols, 2009)

Metamorphic rocks make up around 12% of the Earth's surface, but are more common in the Earth's crust.

Metamorphic rocks are any rocks that have been substantially changed (metamorphosed) from their original sedimentary, igneous or earlier metamorphic form. These changes happen when rocks are subjected to high pressure, high heat, hot mineral-rich fluids or some combination of these factors. Conditions for metamorphism are found deep within the Earth or where tectonic plates meet. The process of metamorphism does not melt the rocks, but transforms them into denser, and more compact rocks and involves many processes. It may involve recrystallization, which modifies the shape of the grains without changing the actual mineral. In other cases, new minerals that are stable under the new temperature and pressure conditions are formed. New minerals can also be created by reactions with fluids that enter the rocks. Variations in heat and pressure may result in different kinds of metamorphic rocks, even from the same parent material.

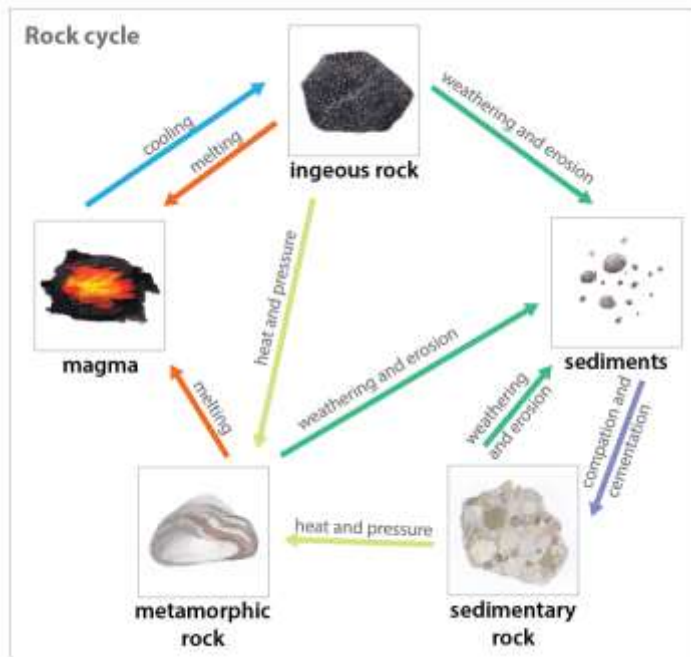
Geologists divide metamorphic rocks into two broad groups, based on the presence or absence of foliation (parallel alignment of mineral grains in a rock). Foliated Metamorphic Rocks (like gneiss and schist) are strongly banded or

foliated. Foliation forms when pressure squeezes the flat or elongated minerals within a rock so they become aligned. These rocks develop a platy or sheet-like structure that reflects the direction of where the pressure was applied. Non-Foliated Metamorphic Rocks (like marble): do not have a platy or sheet-like structure. These rocks form when there is uniform pressure, or the rocks are made of grains that are not flat or elongated, or when the metamorphic agent is mainly heat.

Earth rock cycle

Earth is geologically living planet. It is tectonically active and harbours atmosphere and water in solid, fluid and gas form. This of course means that the Earth is constantly changing: tectonic plates are moving, some are destroyed, new are formed, climates are swinging from greenhouse conditions to ice ages and so on. Consequently, rocks are subject to these changes and depending on what happens in their environment, they can be remelted, can become weathered and reduced to sand and clay minerals to form sedimentary rocks, or can become metamorphosed. Over Earth's 4.56 billion years, rocks have been recycled many times. This recycling process is illustrated in a ROCK CYCLE.

As shown in the rock cycle, any rock may become partially or completely melted to produce igneous rocks. Any previously existing rock can be compressed and altered during mountain building to produce metamorphic rocks. And the weathered and eroded residue of any rock family - igneous, sedimentary, or metamorphic can be observed today being transported to the sea where it is deposited and lithified into new sedimentary rocks. These processes are usually very slow, requiring millions of years. There are only a few exceptions, where the process is compressed into thousands of years. For example in the case of molten lava from a volcano, lava can solidify into igneous rock within hours, and bits of lava blasted into the air can solidify in seconds.



Landscape

Landscape represents a distinct association of landforms that are modified by Earth's surface processes, and that can be seen in a single view (i.e. glacial landscape, karstic landscape etc.).

The landscapes that we see around us are complex, polygenetic and have often developed over long timescales. Landscapes consist of rocks, soils, vegetation, animals, and human constructions. All these factors interact to form a particulate landscape that reflects the complex history, spanning hundreds of millions of years and linking the forces of tectonism and climate, and the physical and the living components of the landscape.

Earth's surface processes are processes that modify the materials, which make up the Earth's surface. We recognize two major types of Earth surface process marked as exogenic and endogenic. **Exogenic** processes are those that are originally fuelled by the Sun's energy and operate through the climate system (erosion and denudation). **Endogenic** refer to those processes powered by energy from inside of the Earth (volcanic and tectonic processes). In this sense, the development of such landscapes can simply be viewed as an interplay between climate and tectonics.

Exogenic processes largely involve the lowering of the land surface through the linked processes of weathering and erosion. Slowly (but sometimes also abruptly), steep mountainsides become eroded into more gentle slopes as sediment is detached, removed and transported away through the river system, ending up in the oceans and large lakes. If the Earth had no tectonic system, its surface would be entirely flattened in a million years as a result of the slow processes of denudation. But, the Earth does have a tectonic system, which is responsible for the endogenic processes shaping the Earth's surface. These processes are mainly constructional. Tectonic uplifts produce mountain ranges, and volcanic eruptions produce new land (such as volcanic islands). In some parts of the world both processes (denudation and tectonic uplift) are active, whereas in other places tectonic activity is rare today, but had an important influence in the distant past.

Each landscape is composed of rocks which have been formed, altered and contorted over millions of years of geological history. On exposure at the Earth's surface, however, these rocks are shaped by water, wind and ice, producing the topography (or relief) we see today, as well as the soils, which blanket the landscape. Both the relief and soils are slowly changing - adapting to new conditions as climatic and other environmental factors change. Vegetation and animal life have spread across these surfaces, leaving their own, continuing impact on soils, relief, and climate. Finally, humans have left, and continue to leave their sometimes indelible imprint on the landscape - through buildings, transport routes, field systems, quarries, and other constructive and destructive activities.

Glacial landforms form in areas covered by glaciers through complex interaction of glaciers with the landscape. Namely, erosion power of glaciers is huge and they can erode and move enormous quantities of rocks and sediment. On the other hand, melting of the glaciers causes ice to deposit sediment forming distinct glacial deposits (like moraines and drumlins). In areas where the glaciers are adjacent, the glacial runoff changed the landscape due to the action of meltwater loaded with abrasive sediment. At the maximum of the last Ice Age which ended about 20,000 to 15,000 years ago, more than 30 percent of the Earth's land surface was covered by ice. Consequently, glacial landforms still exist in regions that were once glaciated but are now devoid of glaciers.



Karst landscape, is a special type of topography characterised by dolines, cones and towers, caves, sinkholes, underground rivers and the absence of surface rivers and lakes. Karst forms in soluble rocks such as limestone, dolomite by dissolution of bedrock and the formation of underground drainage. The term originally applied to the Kras (Slovenian word for Karst) a karstic region in Slovenia with a barren, rugged limestone surface with numerous dolines and caves. Now the term karst but has been extended to all areas exhibiting similar features. The karst has prime importance in petroleum geology, because as much as 50% of the world's hydrocarbon reserves are hosted in porous karst systems. Karst landscapes vary considerably. Some of them have sharp jagged hills and cliffs, others soft rolling hills and dolines, depressions that used to be sinkholes and so on. In addition, Karst features range in scale. Some of them are microscopic while others can be large as hundreds of square kilometres.



Igneous (granite and anorthosite) landscape forms because resistant nature of these rocks and the fact that they are impermeable (does not let water through). Igneous rocks weather slowly, by chemical and physical weathering. They have a few, widely-spaced fractures, so that a typical style of weathering produces smoothly-curved and rounded shapes in the form of large boulders. Another feature are tors. They form because rocks often have joints that are not evenly spread. Weathering wears down the areas of rock that have a large amount of joints faster than those that don't have cracks for water to enter. Areas of rock that have fewer joints tend to stick out at the surface forming tors. Additional features are connected with impermeability and surface run off of rainwater. Flat-topped moor lands are typical of these areas. Bogs are also common due to standing water as the result of impermeable rocks and high rainfall levels.



2.3. ECOLOGY

Planet Earth is a closed system, which exchanges energy with its surroundings, but whose exchanges of matter with the neighbouring space are not significant. The fact that it is a closed system implies that the quantity of natural resources of our planet is finite and limited.

Planet Earth is also a system composed of four subsystems: the biosphere, which consists of all living beings, the atmosphere, which is the gaseous envelope that surrounds the planet, the geosphere, which consists of the surface part of the planet with the large continental masses and the ocean floor, and the hydrosphere, which encompasses all water in a liquid and solid state found on the earth's surface, including the oceans, seas, lakes, rivers, underground water, ice caps and glaciers. When changes arise in one of these subdomains, the consequences of these changes can affect the other subsystems as they are open and interdependent on the others.



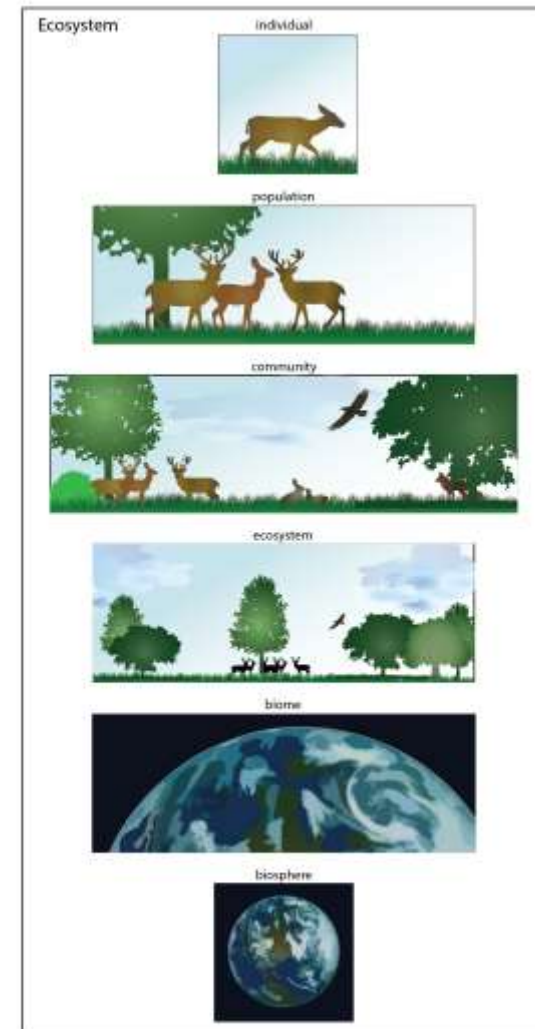
In Nature, there is a great diversity of living beings that interact with each other and with the Environment. This complex arrangement of interactions results in a dynamic which conditions the evolution of life on the planet.

Nowadays, the majority of the human population live in cities, maintaining, therefore, a diminished contact with nature and the wild. However, more than ever, the future of our species depends on how we understand and preserve the relationships between organisms and the environment that surrounds them, because our contribution to changes in the environment and ecosystems is drastic and excessive, without having a complete overview of the result regarding the changes introduced.

It is in this context that Ecology gains more and more relevance.

Ecology is a term formed by the junction of the Greek words "*oikos*", meaning house, and "*logos*", meaning study. This name, the "study of the house", was first used in 1866 by the German biologist Ernst Haeckel.

Ecology can be defined as the study of the relationships between organisms and the environment that surrounds them. The study of ecosystems involves several levels of understanding. Ecologists are often faced with extraordinary challenges in their work of observation, deduction and experimentation: the biologist/ecologist can study individual organisms, clusters of individuals, entire ecosystems, or living beings from the entire planet Earth.



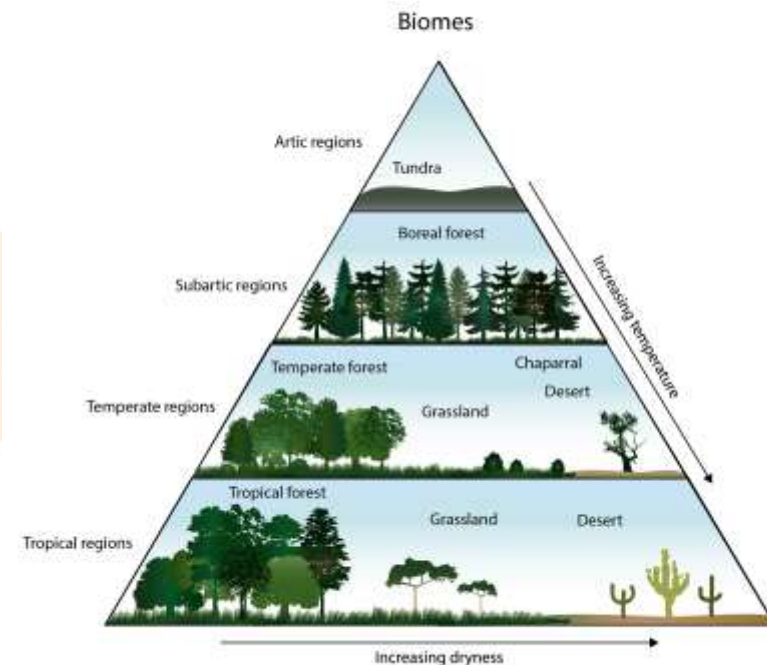
The definition of species involves a certain set of organisms, usually similar, which, when crossed together, originate fertile offspring. A population is defined as a set of individuals of the same species that inhabit a given location, over a certain period of time, interacting with each other and with the different environmental factors. In turn, the various populations that occupy a particular habitat and establish relationships with each other takes the designation of community.

The **Ecosystem** is the community installed in a certain place that, thus, takes the designation of biotic community or Biotic component, the physical environment where the community is installed, that is denominated by Abiotic component, and the interactions between both. The physicochemical factors of the environment can be light, temperature, water, wind and soil, which are the so-called abiotic factors. It is called biotope, the physical environment where the living beings of an ecosystem live (plants, animals, microorganisms); it is the area occupied by a community of living beings that establish different types of relationships (predation, competition, symbiosis, parasitism, etc.) and is characterized by different parameters such as climate and soil properties.



In nature, we can find groups of ecosystems in dynamic interactions, conditioned mainly by the geographical conditions and the climate of the region where they are located, which are called Biomes.

In the biosphere, there are two main biome groups: terrestrial and aquatic. Examples of terrestrial biomes are the tundra, taiga, temperate deciduous forest, tropical forest, savanna, among others. Examples of aquatic biomes are the oceans, mangroves, marshes, rivers, among others.



For the dynamic equilibrium of an ecosystem, there are several interactions between the different living beings that occupy it, as well as these with the environment, that contribute to. Ecosystems have a structure and functioning conditioned by these types of interactions.

The role of ecology is decisive, since the knowledge of these interactions makes it possible to understand the environmental impacts and imbalances perpetrated on populations of living beings as a result of harmful human behaviour.

Of the set of anthropic actions that interfere with the natural balance of the terrestrial subsystems, the destruction of forests stands out; global warming due to changes in the composition of the atmosphere; the extinction of species and the destruction of habitats; the exploration of rocks and minerals in the soil and subsoil; pollution of soil and water, both surface and underground, as a result of agricultural, industrial and urban activities; the destruction of the natural heritage due to the increasing needs of resources to meet the needs of the current society as a result of technological development and population growth.

Awareness of the problems related to the planet's resources has led to the creation of the concept of sustainable development. This set of attitudes aims to meet the needs of the present, without compromising the needs of future generations, by designing action plans to preserve the environment and creating measures that diminish the impact of our presence on the planet.

The policy of the Three Rs has been adopted in recent years as a focal point in the area of environmental protection, and applied in the area of urban solid waste as a contribution to sustainable development. Reduce, Reuse, Recycle.

Reduction is related to small attitudes, practiced by each of us, which, when added together results in a significant whole. Basic behaviours such as closing the tap while we brush our teeth and reduce dependence on plastic bags in the grocery store, integrate a wider range of actions that can have an enormous significance. Reuse has to do with a new application for each product or material, as an alternative to direct discarding into the bin; contributes

significantly to a noteworthy reduction in the volume of litter produced daily. Recycling is a method of processing waste into products suitable for new use, such as glass, paper and paperboard, plastic and aluminium. Currently, this policy has been added with other nouns: Respect and Responsibility, meaning an attitude of respect for the environment and remembering that we are all responsible for environmentally conscious behaviours. Citizens responsible for building a better world.

Earth, a special planet, whose balance is already at risk and sustainability threatened, demands our care and protection and the taking of effective measures to safeguard future generations.

Stephen Jay Gould wrote in his reflections on Natural History that "We have become, by the power of a glorious evolutionary accident called intelligence, the stewards of life's continuity on earth. We did not ask for this role, but we cannot abjure it. We may not be suited to it, but here we are."

2.4. MEN AND BIOSPHERE

Natural science is not just to learn about nature but also to get an understanding of the interaction between nature and humans and human activity. This is the reason for “Men and biosphere” to be chosen as one of three main topics.

Three subthemes were again chosen for further focus - geohazards, impact of man on nature and resources - all described below.

Geohazards

What is a geohazard?

A geohazard is defined as a geological state that may result in widespread damage or risk. A geohazard involves short or long-term geological processes, and even small processes can cause large damaging effects.

Examples of geohazards are:

- Landslides (terrestrial and submarine)
- Rock falls
- Tsunamis (tectonic and caused by landslides)
- Earthquakes
- Flood basalt and volcanism
- Mud flows
- Sinkholes

How does it affect us in our daily life?

Geohazards affect every person on the planet in one way or another and it is a continuous process of work to prevent geohazards from happening. Little can be done, when for example, earthquakes or volcanic eruptions happen, but the extent of the damages can be reduced. Reducing the damages caused by geohazards include many aspects – routines for evacuation and alert, routines for surveillance of potential geohazard, the securing of areas, regulation and planning of infrastructure and settlements, etc.

Some well-known geohazard events

- 2004 - Indian Ocean earthquake and tsunami

- 2011 - Tōhoku earthquake and tsunami
- 2010 - volcanic eruptions of Eyjafjallajökull, Iceland
- 2017 - Landslide in Freetown, Sierra Leone
- 8200 years ago - Storegga submarine landslide



Mundheim, east of Bergen in the Kvam mountain region, Hordaland, March 2004. (Source: [Forskningsrådet](#))



A sinkhole swallowed a city intersection in Guatemala City on 31 May 2010. (Source: [AGU](#))

Impact of man on nature

Implications of "Impact of man on nature"?

The effects of nature are an important factor as how we live our lives - it influences where we choose to settle, where and how we choose to travel and move, and what precautions we as humans need to take in our daily lives.

However, nature is also affected by humans and the way we chose to live. We have become expert in adapting our surroundings to fit our needs and to exploit nature for the resources necessary to sustain our way of living. Today, our influence on nature has become an increasing focus in all aspects of life - research, education, industry, private household etc.

The human impact on nature is called anthropogenic impact and includes changes in both the biophysical environment, ecosystems, biodiversity and natural resources.

How does man have an impact on nature?

Changes that can be seen in nature which scientist now believe to be directly or indirectly caused by human activity include:

- global warming
- environmental degradation
- mass extinction
- biodiversity loss
- ecological crisis
- ecological collapse

Some human actions causing damage to nature can be overconsumption, overexploitation, pollution and deforestation.

Seeing the consequences our actions have on the environment, people are now starting to react. All over the globe, we see an increasing development of positive activity taking place in an attempt to redo, or at least decrease the negative consequences we observe in nature.



Bingham Canyon Mine, Utah - the largest open-pit mine in the world (source: [daily mail](#))



Garbage in Manila Bay, the Philippines (Source: Photograph: Erik de Castro/Reuters)

Resources

What is a resource?

A resource is a source or a supply from where benefits are produced. What a resource is will over time depend on needs, demand and technology. Resources is not only what is found in nature, but can for example also be staff, services and knowledge.

We will focus on natural resources - resources found in nature which are exploited by man, including biological, ecological and geological resources. Natural resources can further be subdivided into abiotic (non-living things) and biotic resources (obtained from the biosphere), potential resources and actual resources, and non-renewable and renewable resources.

Examples of natural resources

Resources from nature are used every day by every single person. Below is a list of groups of some natural resources:

- Petroleum products as fossil fuels, plastic and asphalt
- Rare earth elements and heavy metals – includes ores like iron, silver etc.
- Water – necessary for life to exist but also used to create energy
- Trees – to make fire for cooking and heating, building material
- Air – produce energy
- Animals and plants – for food and medicine
- Land – to grow food, extract other resources

What do we use resources for in our daily life?

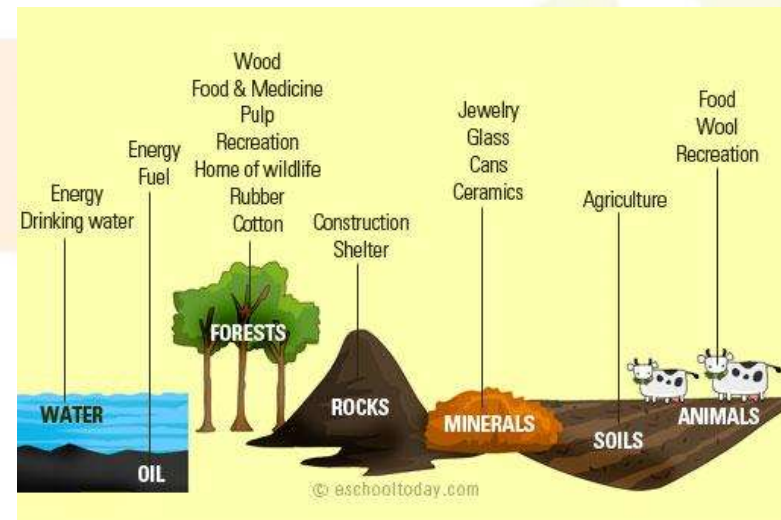
Do you sleep in a bed? Do you brush your teeth? Do you eat food on a plate with cutlery? Do you drive a car? On a gravel or asphalt road? Do you watch TV? Use a phone? Do you play computer games? Do you go to the toilet? If the answer is yes to one or more of these questions, you certainly use a whole lot of natural resources, every day. The list is endless of objects and items we use and need in our daily life that originate from nature. Some are renewable (e.g. water to drink

and flush the toilet) while others are not (e.g. metals for your phone, TV and computer).

Where do resources come from?

Some resources are only found in specific areas, e.g. petroleum, minerals and metals, plants, while others are accessible all over, e.g. air. Russia, the United States and Saudi Arabia are the countries with the highest percentage of natural resources followed by Canada, Iran, China, Brazil, Australia, Iraq and Venezuela. All countries have natural resources of some sort, but there is a large variation on how countries choose to exploit and use them.

Resources are a source of income, and some are necessary to sustain life. Resources are therefore also a source of conflicts. Due to the economic aspect of a resource, exploiting them has in many areas caused a big impact on nature. Today, there is an increasing focus on making the use of resources sustainable – not to overexploit and to cause as little damage to nature as possible.



An overview of some natural resources. (Source: [eschooltoday.com](https://www.eschooltoday.com))



Petroleum platform, North Sea off Norway. (Source: Kartverket.no)

3. CHAPTER: ESTEAM TEACHING METHODOLOGY

3.1. ESTEAM TEACHING METHODS

Man is constantly learning. Learning is a process that does not take place only at school, but practically everywhere. It begins right after birth. From a very early age, even before we go to school, we intensively gather experiences from numerous sources: at home and outside in nature. Upon entering school, a period of planned learning in the classroom begins. The latter, however, should by no means be the only place to acquire knowledge. Especially nowadays, when young people do not spend most of their free time in nature. That is why learning in nature should become an important addition to the traditional teaching approach.

By combining a traditional learning environment - a classroom - with an expanded and enriched learning environment - nature, we surely arouse more curiosity within students, more interest, motivation and inspiration for exploring and seeking new skills. Knowledge gained in nature is based not only on theoretical starting points and facts, but also on direct multisensory experiences, experiments and research in general. Physical activity also has a positive effect on health, development, concentration and consequently on learning.

A teacher is no longer a source of knowledge and experience. Time has brought almost endless possibilities for taking in facts, information and various data from a wide variety of sources. Thus, the times of frontal teaching are over. The teacher's role is to direct students through a dense wood of various information so that they can follow their set goals. This is formal knowledge that the national curriculum wants. Through curricula, the state acquires a systematic insight into their citizens' knowledge.

Within these frameworks, teachers have a wide variety of options, or freedom to achieve set goals. We choose and apply those teaching methods that are best tailored to a group of learners in a certain environment and time-frame. Modern methods are primarily aimed at occupying students and encouraging them to find and choose new values in the world. Therefore, a modern teacher does not organize his/her lessons around the accumulation of new concepts that students

perceive as abstract, but rather aims to provide them with a new set of skills, new "know how".

Assuming that the basic teachings methods include the following:

- Knowledge transfer (accumulation of knowledge, factography, reproduction)
- Encouraging development (enabling the development of potential, awareness raising)
- Directing research (allows constructions of knowledge, responsibility and initiative)
- Developing skills (training, procedural knowledge)

then the modern teacher spends the least amount of time on knowledge transfer, and rather focuses on the other three modes of teaching.

Modern teaching methods mostly combine the characteristics of the last three teaching modes.

- **Learning in nature - fieldwork**

When in nature, students observe, perform experiments, record measurements, classify, manage information ... In doing so, they develop their potential, raise their awareness of nature, develop a responsibility for nature and their peers, take initiative in finding solutions in unforeseen situations and develop skills of observation, experimentation, etc.

- **Work in the lab**

promotes the development of a scientific method as a form of problem solving, and develops accuracy, systematics and observation in students. It is suitable for getting to know new concepts, developing skills and forming individual beliefs.

- **Source management, analysis and discussion**

This method develops an understanding of complex relationships, the formation of opinions and independent decision making in pupils. It is a method where students exchange ideas with each other, discuss experimental results, or plan

new activities. The discussion conforms to the teacher's instructions, or it may also take an unpredictable turn. A group discussion develops an ability for leadership and critical thinking among pupils. It develops a sense of teamwork, and is very suitable for changing opinions by means of democratic dialogue.

- **Role playing**

Pupils identify with people or objects and act out the situation they are exploring. This enables the development of different student potentials, leads to the discovery of new insights, and develops skills and initiatives.

Choosing any of the four basic methods requires the teacher to reflect on the activities that will lead the student to his or her set goal.

Natural science, in particular, with all its subgroups should be taught in direct connection with the source of knowledge, namely nature. We all know that nature is the best classroom, but it is also the most unpredictable and transformative classroom as well.

Everything mentioned earlier can be applied to the TeachOUT application. Therefore, we can justify the benefits arising from the use of this application.

- This application is a tool for learning about nature in nature. Learners can individually decide how they will execute the tasks at hand. The app encourages them to observe nature and be a responsible individual.
- When working in groups, the application enables the pupils to communicate and co-operate with each other and make joint decisions. It gets them accustomed to teamwork, which is the basis for the development of the natural science of the future.
- The application combines fieldwork and the management of sources. It allows the pupil to find appropriate answers with the help of the source, which is accessible via the application.
- By using this application, the student learns about the practical use of modern technology in learning the eternal laws of nature.

- The role-playing method also makes sense when working in nature, as the application offers a production of a video clip, which can be analysed later. Then this analysis can possibly shed light upon new facts.
- When using the application, we are developing skills for handling mobile phones and tablets for educational purposes. Thus, we link modern technology with the learning processes and allow children to think about possible deficiencies and future development.
- The application enables its users to connect all the advantages of fieldwork studies with the advancements in the field of digitization.

Just as children are exploring areas of interest, teachers are constantly on the lookout for the most effective methods for obtaining greater quality knowledge and skills. The TeachOUT application is one of the steps in the ever changing and improving teaching process.

4. CHAPTER: TeachOUT MOBILE APP CHALLENGES

4.1. OVERVIEW

The TeachOut App is developed as part of the ESTEAM project. The app provides teachers with the tools to create and publish treasure hunt games to smartphones for their pupils to enjoy on field trips. The games offer various challenges for their pupils to solve on location using their smartphones. The variation of challenge available include multiple-choice answers to questions, written answers to question, answer a set of questions to find out what the pupil is investigating, ability to take photos of specific subjects, and the ability to decorate the photos by drawing on them or to put predefined graphics on them. Other challenges include drawing a simple photo on a predefined image or on a blank canvas, take a video or mark locations with a pictures. This document describes the variation of challenges available to be used in the games.

GOALS

1. Provide relevant variation of challenges for outdoor teaching as defined by the ESTEAM team
2. Describe the variation of challenges available so teachers can easily deploy them in the games

4.2. BRIEF EXPLANATION HOW THE APP IS USED

After downloading the game on their device, the pupils will follow the directions in the game to go to predefined locations (treasure locations), where the app will present information about the location provided by the teacher. After learning about the location, the pupil will solve various challenges about the subject at hand. Some challenges will require uploading pictures, images or videos to the game server. This will require some network bandwidth to be used to upload the content. If no network is available when the challenge is completed, it will line-up on the device and upload when the user is in network range.

Below, a teacher is referred to as *the author* and the pupil as the *user*.

4.3. CHALLENGE-TYPES IMPLEMENTED

Here is a list of all variations of challenges implemented for the app and a description of how they are being used in practice.

- **Question with multiple-choice answers**

The author can write up the questions and multiple-choice answers to choose from in the CMS and save them to the Question Bank for reuse in the games created. The author marks which answer is the correct one from the list of possible answers. Both the question and the answers can have a text, image or both. The author can also give a hint, which the user can press in order to get additional information before answering the question. It will be shown on the scoreboard if the hint was used or not.

Each question can be translated into multiple languages.

The score for this challenge can be automatically determined based on the answer (correct or incorrect).

- **Question with a written answer**

The author can write up questions that have written answers. The questions can have a text, picture or both, and then the author writes a list of possible answers. The user will then have to write one of the possible answers to get a correct score. The author can also give a hint, which the user can press in order to get additional information before answering the question. It will be shown on the scoreboard if the hint was used or not.

Each question can be translated into multiple languages.

The score for this challenge can be automatically determined based on the answer (correct or incorrect).

- **Decision tree: Answer a set of questions to find the answer**

With this challenge, the author can define a set of questions and answers, and for each answer, a new question can be defined. Each question and answer can consist of a text, picture, or both.

For example, the users are supposed to find out what they are holding in their hands. The user will then select answers from a set of question and reach a conclusion at the end as to what they are holding in their hand. The first question could for example be, "What kind of material are you holding?", then the possible answers could for example be "organic" and "inorganic". If the user selects organic, the next question could be "What type of organic material is it?", and the possible answers could be "Soil", "Animal", "Plant", "Fungus". From Animal it could go to Bird then from bird to a specific species of bird. Then it concludes.

Each question can be translated into multiple languages.

The score for this challenge is always given, as there is no correct / incorrect answer here. The teacher can adjust the score on the scoreboard.

- **Take a photo of something as instructed**

The author of the challenge can write instructional text, as to what the user should take a photo of. The user will take a photo from the app and it will be uploaded to the scoreboard. A custom message, written by the author in the CMS, will be shown after the photo is taken.

The score for this challenge is always given as there is no correct / incorrect answer here. The teacher can adjust the score on the scoreboard after the game.

The photo is rendered down in size a bit to minimize network bandwidth used to upload the picture to the game server. The photos taken are available from the scoreboard.

- **Take a photo of something and write on it as instructed**

The author of the challenge can write instruction text as to what the user should take a photo of. The user will take a photo from the app, then presented with text, written by the author, what to do with the picture. The user can then use a

simple draw pallet to mark up the picture before uploading it to the game server.

The score for this challenge is always given, as there is no correct / incorrect answer here. The teacher can adjust the score on the scoreboard after the game.

The photo is rendered down in size a bit to minimize network bandwidth used to upload it to the game server. The photos taken are available from the scoreboard.

- **Take a photo of something and decorate it with graphics as instructed**

The author of the challenge can write an instruction text as to what the user should take a photo of. The user will take a photo from the app, then presented with a text, written by the author as to what to do with the picture. The author will upload graphic elements to the CMS for this challenge, and the user can then decorate the picture with the graphic elements uploaded before uploading it to the game server.

The score for this challenge is always given, as there is no correct / incorrect answer here. The teacher can adjust the score on the scoreboard after the game.

The photo is rendered down in size a tad, to minimize network bandwidth used to upload it to the game server. The photos taken are available from the scoreboard.

- **Draw a simple drawing on a blank canvas**

The author can write instructions to the user as to what they are supposed to draw on the landscape canvas and also a message text when the user is done drawing. The drawing is then saved on the device and on the game server as well.

A little network bandwidth is required to upload the drawing to the server.

The score for this challenge is always given, as there is no correct / incorrect answer here. The teacher can adjust the score on the scoreboard after the game.

- **Draw a simple drawing on top of a predefined photo**

The author can upload a photo in the CMS and write instructions to the user as to what they are supposed to draw on the picture. The picture is on the canvas and the user is supposed to draw on it. The author can also write a message text when the user is done drawing. The drawing is then saved on the device and on the game server as well.

Some network bandwidth is required to upload the drawing to the server.

The score for this challenge is always given, as there is no correct / incorrect answer here. The teacher can adjust the score on the scoreboard after the game.

- **Record a video as instructed**

The author of the challenge can write an instructional text as to what the user should record a video of. The user will record the video from the app and upload it to the scoreboard. A custom message, written by the author in the CMS will be displayed after the video is taken.

The score for this challenge is always given, as there is no correct / incorrect answer here. The teacher can adjust the score on the scoreboard after the game.

The video is uploaded to its original size, so a considerable network bandwidth is needed to upload the video. The video is then available from the scoreboard.

- **Mark a GPS point on a map with a picture and/or comment**

In this challenge, the user will take a photo and write a comment and the location where the photo is taken, and then it is marked on the map in the scoreboard. Only the user who took the picture will see it marked on the map, but the picture and the location where it was taken is shown in the scoreboard, along with the comment text the user wrote. The author of the game can write instructions in a text for the user, which is shown prior to the picture taken and the instructions are also shown on the scoreboard.

The score for this challenge is always given, as there is no correct / incorrect answer here. The teacher can adjust the score on the scoreboard after the game.

- **Sort pictures into boxes**

The author can upload pictures, name categories and what category each picture belongs to. The student will then have to put the pictures in the right category. Example: "Plants that grow in the shade or the sun, respectively, often have leaves that look different. Can you describe some typical differences and sort pictures of different examples by placing them into the right box. They need "boxes" to sort the plants into.

5. CHAPTER: ESTEAM EXERCISES

5.1. METHODOLOGY OF PREPARING EXERCISES

The contents for the exercises were prepared using a form for each sub-theme separately. In the forms, we included the pedagogical approach, the didactic and the technical aspect of the content design, and linked this with selected science themes or sub-themes. All content is directly linked to specific themes or paths in the participating UNESCO Global Geoparks.

A general theme was researched and defined in detail by means of particular exercises on different levels. Thus, we first defined the theme and the sub-theme for which content was developed.

In the following, we focused on the work methodology and determined the dynamics of educational work (frontal, group, in pairs, individually), and how students will learn a certain topic (e.g. observation, listening to a teacher or guide, taking photographs, conducting experiments, playing educational games, role-playing, individual learning, competing, worksheets, orientation, application use, sample collection and analysis, mapping and navigation, exploration, etc.).

Different types of tasks (or challenges) in the mobile app include the following possibilities: take a photo, multiple-choice answers with texts and/or pictures, a written text matches a series of possible answers, write or draw on a taken photo, make a simple drawing, make a short film, mark a GPS point on the map with a picture and/or a comment, find something out by answering the questions ... The listed types of tasks (or challenges) are described in more detail in Chapter 4.

The next step was to define additional knowledge, skills, abilities that pupils should acquire after carrying out the tasks, define learning styles (visual, auditory, kinaesthetic), and new terms that young students should gain during the execution of tasks.

The last part of the form included contents of individual tasks, a brief description of particular exercises, pre-preparation and completion. Examples from everyday life were given, where the acquired knowledge is used. This part is intended for fieldwork: pre-preparation process, completion and final discussion in class after completion of the fieldwork.

The form concludes with a detailed exercise scenario and contents, which are then entered via the web editor in the TeachOut application. It also includes a list of required illustrations, photos, texts, sounds, videos, etc.

With the form, we wanted to prepare an integrated tool for teachers. It guides them through the entire preparation process, and enables a step-by-step preparation of the contents from all aspects (work methodology, learning modes, learning styles, etc.). And finally, it allows the preparation of specific contents that are entered via the web editor in the application itself.

In order to make it easier for users to enter data, the ESTEAM project produced the third intellectual result, namely a "Step by Step Guide on the ESTEAM methodology and the TeachOUT application" (Science teachers' guide).

5.2. EXERCISES AT THE KARST TRAIL

Description of the Karst trail

The karst forest educational trail was formed years ago for learning about karst phenomena, getting familiar with flora, and forest management in our environment. Throughout this time, the needs of the user have been shaping it. In this case, particularly the needs of both teacher and pupils. It offers a huge variety of options, which is a general feature of nature. We need to enter it with open eyes and an open heart, and each time it will tell us a new story.

The educational trail takes us through an area where two sedimentary rocks, dolomite and limestone, meet. Dolomite forms peaks on the southern and southwestern outskirts of the plateau. These are Javornik, Čelkov vrh, Velika and Mala peč, Špik and Špičasti vrh. The lower lying levelled out land in the northern and eastern part has a calcareous rocky foundation. Contact between these two rocks is usually characterized by many karst phenomena. The locals call the area where the educational trail takes place Griže, which is the name given to a rocky karst terrain with very little soil. Larger and smaller rocks are seemingly scattered around. However, if we are a tad more familiar with karst topography, we can find almost all karst surface forms. On patches of soil, there are fir and beech forests with characteristic undergrowth. The latter is denser where beech trees grow, and more scarce where firs or spruce dominate. As soon as the first snow melts, hellebore blooms. Butterbur begin to sprout along the trail, and in early spring, *Hacquetia epipactis*, lily of the valley and cyclamen start to grow. Throughout the growing season, we can observe the specimens of the European scopolia. From young shoots to a flowering green beauty and then the mature plant with black berries. Rocky road cuts are overgrown with wall rue, spleenworts and species of fern, such as the eagle fern, the male fern, the common polypody and hart's-tongue fern. Many bushes grow along the trail, elder and hazel being the most dominant.

A forest is a perfect ecosystem, and a perfect example of how even scarce soil that is found on the Črnovrška planota plateau provides a rich and harmonious

existence for many plant and animal species until an external factor destabilizes this balance. This external factor is always a human one. Looking from a global point of view, it is man and his activities that cause climate changes, which in return result in massive occurrences of an organism that then destroys a particular tree species. The bark beetle, for example, could multiply on spruce, which were more vulnerable due to higher summer temperatures and less precipitation. Spruce trees are therefore disappearing. If we allow the forest to renew itself, the tree species that are more adapted to the changed conditions will replace spruce.



Locally, we can also observe changes in the forests caused by man. Large clearings cause erosion of the soil and degradation of the rock substrate. Such wounds in the woods heal over longer periods. Even more time is needed in places with steep inclines. The creation of forest trails has a similar effect.

All that has been written can be observed along the educational trail. Educational work is organized at individual points where we can observe, learn, or verify our knowledge.

The first and foremost important rule is that we came to the forest as visitors, so, we must behave in such manner. When we leave, all forest dwellers should remain as they were and where they were.



There are karren, numerous sinkholes and a karst cave along the educational trail. We can observe grooves in the karren and dripstones in the cave. The latter

houses a dripstone pillar, numerous small stalactites, a rimstone pool and cave animals. Limestone can be determined as a rocky base. Numerous fossils of rudists, which gave limestone its name, can be observed in the rock along the trail. We can determine the most common tree species, find examples of ferns and learn about their way of reproduction. Human activity is noticeable at almost every step. One of the affected trees that survived these activities is home to many animals, which naturally hide from us. We can leave it to our imagination and write a story about their life. In certain places along the educational trail, we can see how the bark beetle has destroyed the spruce. We can also talk about the global warming of the planet and man's general impact on the environment.

All activities are tailored to the school curricula: science, biology, and geography in particular. Tasks that enable us to connect acquired knowledge with everyday life are yet another benefit.

Naturally, we can hike along the educational trail just because of the forest itself. This living organism is a kind and welcoming host, which makes our lives richer.

Exercise 1: GEOLOGY (rock cycle)

Selected theme	<input checked="" type="checkbox"/> Geology <input type="checkbox"/> Ecology <input type="checkbox"/> Men and biosphere	
Subtheme	Rock cycle	
Class	6., 7. class	
Learning goals	<ul style="list-style-type: none"> - children recognize sedimentary, metamorphic and igneous rocks according to their typical features - children learn that rocks can change from one type to another (ROCK CYCLE) - children learn the processes involved in the changing of rocks 	
Working methodology	<input type="checkbox"/> Frontal <input checked="" type="checkbox"/> Groupwork <input type="checkbox"/> Pairwork <input type="checkbox"/> Individual work	
Learning methodology	<div> <input type="checkbox"/> Observing <input type="checkbox"/> Solving worksheets </div> <div> <input type="checkbox"/> Listening to the teacher or a guide <input type="checkbox"/> Orientation </div> <div> <input type="checkbox"/> Taking pictures <input checked="" type="checkbox"/> Use of apps </div> <div> <input type="checkbox"/> Experimental <input type="checkbox"/> Collecting samples and analysing </div> <div> <input type="checkbox"/> Playing educational games, role play <input type="checkbox"/> Use of maps and navigation </div> <div> <input type="checkbox"/> Self-learning <input type="checkbox"/> Investigative performance </div> <div> <input type="checkbox"/> Contest <input type="checkbox"/> Other. Please, specify: </div>	
ESTEAM mobile app challenges	<div> <input type="checkbox"/> Take photo <input checked="" type="checkbox"/> Make a short film </div> <div> <input type="checkbox"/> Questions and multiple-choice answers with pictures and/or texts <input type="checkbox"/> Mark a GPS point on the map with picture and/or comment </div> <div> <input type="checkbox"/> Write text answer to match a set of possible written answers <input type="checkbox"/> Find out what you are holding? <input type="checkbox"/> Answer a set of questions, to find out what it is </div> <div> <input type="checkbox"/> Write or draw on photo taken </div> <div> <input type="checkbox"/> Make a simple drawing </div>	

Additional knowledge, skills and competences	Search for information, children make a movie
Multi-sensory contents	Audio, visual, kinaesthetic (act as a sediment)
Teaching aids	
New terms	Sedimentary rocks, metamorphic rocks, igneous rocks Rock cycle, erosion, weathering, heat and pressure

Description of exercise:

The illustration of a rock cycle appears for the pupils to learn/remember the process involved in the changing of rocks. They can always go back to see and help themselves with the picture when answering the questions that appear at certain points on the trail.

At the end, they have to make a movie using their body parts to show the structure of sedimentary rock.

Prefield work

Students would have to know before going into the field:

- features of different types of rocks (igneous, sedimentary, metamorphic)
- the process of a rock cycle

Location: Behaviour in the forest, Karst features, Rudist fossils

Scenarios for ESTEAM mobile app:



1. Which type of rock is typical for a karst area?
 - a.) Sedimentary rock (CORRECT)
 - b.) Metamorphic rock (INCORRECT)
 - c.) Igneous rock (INCORRECT)

2. Which of these statements is true?
 - a.) Rocks never change. (I)
 - b.) Rocks can change from one type to another. (C)
 - c.) Rocks can only change on the Earth's surface. (I)

3. Which geologic process can change any type of rock into a sediment?
 - a.) Cooling
 - b.) Weathering and erosion (C)
 - c.) Heat and pressure
 - d.) Melting

5. Which of these statements are true for sedimentary rocks:
 - a.) It's made from cooled lava from a volcano.
 - b.) It's made out of sand, pebbles, shells,... (C)
 - d.) It's made on the surface of the Earth. (C)
 - e.) It's made beneath the Earth's surface.
 - f.) You can usually find fossils in this type of rock. (C)
 - g.) This rock is usually smooth and shiny.

6. Make a movie showing the structure of sedimentary rocks using parts of your bodies.

Aids for ESTEAM mobile app:

___ pictures, **drawings**;
please specify:

- the drawing of a rock cycle and processes involved in the changing rocks geological map overlaying satellite map of the area of the trail

___ **photos**
please specify:

___ texts
please specify:

___ **sound files**
please specify:
- sounds for correct and incorrect answer

___ video files
please specify:

- Video of formation for different types of rocks (food!)

___ other,
please specify:

Exercise 2: GEOLOGY (rocks)

Selected theme	<input type="checkbox"/> Geology <input type="checkbox"/> Ecology <input type="checkbox"/> Men and biosphere	
Subtheme	Rocks	
Class	6.	
Learning goals	- determining type of rocks	
Working methodology	<input type="checkbox"/> Frontal <input type="checkbox"/> Groupwork <input type="checkbox"/> Pairwork <input type="checkbox"/> Individual work	
Learning methodology	<div> <input type="checkbox"/> Observing <input type="checkbox"/> Listening to the teacher or a guide <input type="checkbox"/> Taking pictures <input type="checkbox"/> Experimental <input type="checkbox"/> Playing educational games, role play <input type="checkbox"/> Self-learning <input type="checkbox"/> Contest </div> <div> <input type="checkbox"/> Solving worksheets <input type="checkbox"/> Orientation <input type="checkbox"/> Use of apps <input type="checkbox"/> Collecting samples and analysing <input type="checkbox"/> Use of maps and navigation <input type="checkbox"/> Investigative performance <input type="checkbox"/> Other. Please, specify: </div>	
ESTEAM mobile app challenges	<div> <input type="checkbox"/> Take photo <input type="checkbox"/> Questions and multiple-choice answers with pictures and/or texts <input type="checkbox"/> Write text answer to match a set of possible written answers <input type="checkbox"/> Write or draw on photo taken/<u>given illustration</u> <input type="checkbox"/> Make a simple drawing </div> <div> <input type="checkbox"/> Make a short film <input type="checkbox"/> Mark a GPS point on the map with picture and/or comment <input type="checkbox"/> Find out what you are holding? <input type="checkbox"/> Answer a set of questions, to find out what it is </div>	
Additional knowledge, skills and competences		
Multi-sensory contents	kinaesthetic, visual, auditory	
Teaching aids	hammer, diluted hydrochloric acid, glasses and gloves,	
New terms	limestone, acid, sedimentary rocks, fossil	

Description of exercise:

Children make an experiment to determine the type of the rock, observe a reaction and determine the type of rock. They observe the structures seen in rock and make photos of different cross-sections of rudist shells.

Before going into the field, students should know about:

- types of sedimentary rocks
- the reaction of diluted hydrochloric acid
- geology of the area

Location: Karst features**Scenarios for ESTEAM mobile app:**

1. Use a hammer to create a bare/fresh surface on the rock. Do not destroy the karren beside the road, but choose rocks on the other side of the rock! Put some drops of diluted hydrochloric acid on the bare rock. Make a short movie of the reaction!
What happens?
 - a) **Bubbles appear**
 - b) Nothing happens
2. Compare the video with your reaction and determine the type of rock at the location of testing!
 - a) Dolomite
 - b) Anorthosite
 - c) **Limestone**
3. Into which group of rocks does the rock on this site belong? (Location: rudist shells)
 - a) Sedimentary rocks
 - b) Igneous rocks
 - c) Metamorphic rocks
4. Millions of years ago, this rock was formed in the shallow sea. This was home to numerous special sea organisms. The remains of some of them were fossilised and can be observed today at this site. Can you find them? Which of the fossils in the pictures do they resemble?
 - a) snail
 - b) Fossilised rudists
 - c) dinosaur footprints

5. On the illustration of rudists, there are different cross-sections in different directions. Match the corresponding pairs - memory game.



6. Make photos of different cross-sections of the rudist shell fossil, which you find in the rock. Hint: two different directions

Aids for ESTEAM mobile app:

— **pictures, drawings;**

please specify:

- the illustrations of rudists in three different cross-sections and in different directions for memory game

— **photos**

please specify:

- photos of rudists, stromatolites, trilobites

— **texts**

please specify:

— **sound files**

please specify:

— **video files**

please specify:

video with different reactions with different solutions
video showing and explaining different types of rocks

— **other,**

please specify:

Exercise 3: GEOLOGY (landforms)

Selected theme	Geology
Subtheme	Landforms
Class	6.
Learning goals	Children recognize the following typical Karst Landforms <ul style="list-style-type: none"> - Caves - Dolines - Karren
Working methodology	<div> <div>Frontal</div> <div>Groupwork (from 2 to 3 students)</div> <div>Pairwork</div> <div>Individual work</div> </div>
Learning methodology	<div> <div> <div>Observing</div> <div>Listening to the teacher or a guide</div> <div>Taking pictures (of different types of land forms)</div> <div>Experimental</div> <div>Playing educational games, role play</div> <div>Self-learning</div> <div>Contest</div> </div> <div> <div>Solving worksheets</div> <div>Orientation</div> <div>Use of apps</div> <div>Collecting samples and analysing</div> <div>Use of maps and navigation</div> <div>Investigative performance</div> <div>Other. Please, specify:</div> </div> </div>
ESTEAM mobile app challenges	<div> <div> <div>Take photo</div> <div>Questions and multiple-choice answers with pictures and/or texts</div> <div>Write text answer to match a set of possible written answers</div> <div>Write or draw on photo taken</div> <div>Make a simple drawing</div> </div> <div> <div>Make a short film</div> <div>Mark a GPS point on the map with picture and/or comment</div> <div>Find out what you are holding. Answer a set of questions, to find out what it is</div> </div> </div>
Additional knowledge, skills and competences	Mapping, recognizing, students take pictures
Multi-sensory contents	Visual, kinaesthetic, auditory,
Teaching aids	
New terms	<ul style="list-style-type: none"> - Caves - Dolines (Sinkhole) - Karren, Grikes - Stalagmite

- | | |
|--|---|
| | <ul style="list-style-type: none">- Stalactites- Column- Curtain- Uvala- Solution flutes (rillenkarren) |
|--|---|

Description of exercise:

According to the tree identification guide, children learn, recognise and categorise them as karst features.

Before going into the field, students should know about:

- recognition of terms in connection with karst features
- karst processes
- rock types of the area
- limestone features (specifics)

Location: Hrvatova cave, karren, vrtača

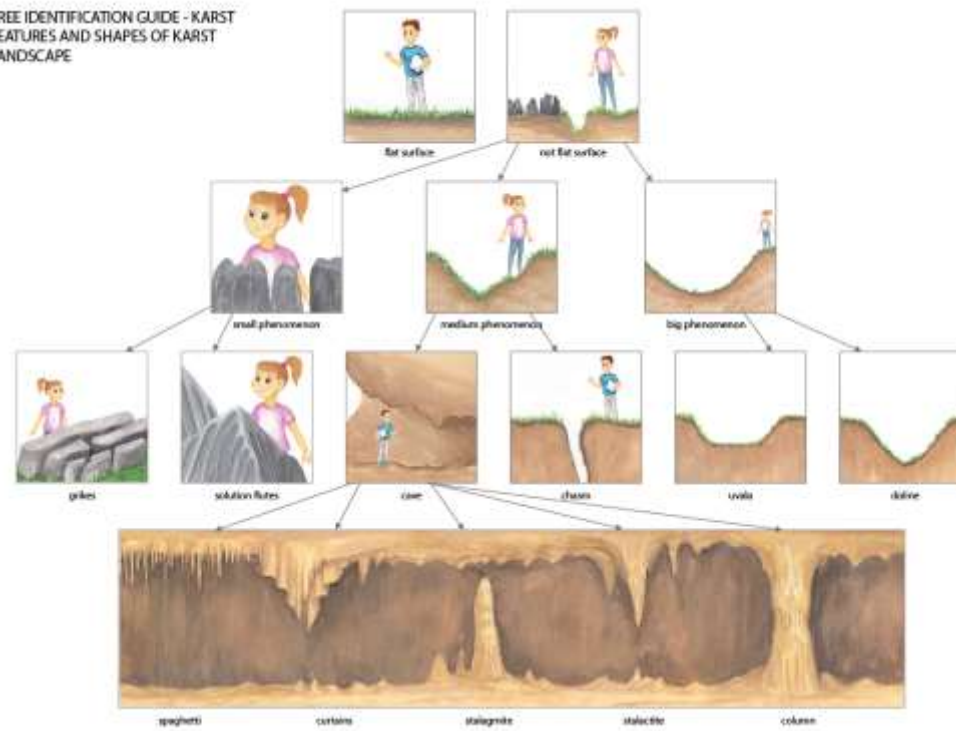
Scenarios for ESTEAM mobile app:

According to the tree identification guide, children determine the landform they see.

Q: Which tree types of karst phenomenon do you see?

- a) doline
- b) karren
- c) solution flutes
- d) stalagmites
- e) stalactites
- f) cave

TREE IDENTIFICATION GUIDE - KARST
FEATURES AND SHAPES OF KARST
LANDSCAPE



Take a picture of the karst phenomenon you can see and mark a gps location (gps tag).

Aids for ESTEAM mobile app:

— pictures, drawings;
please specify:

Tree identification guide (look at picture below)
illustrations for key identification

— photos
please specify:

— texts
please specify:
short texts connected to the illustration of key identification points explaining specific karst feature

Exercise 4: ECOLOGY (abiotic factors)

Selected theme	<input type="checkbox"/> Geology <input checked="" type="checkbox"/> Ecology <input type="checkbox"/> Men and biosphere	
Subtheme	Abiotic factors	
Class	7. class and 8. class	
Learning goals	<ul style="list-style-type: none"> - Life conditions for plants; - determining the type of soil; - measuring pH of the soil; - water in the karst area, permeability of the karst surface 	
Working methodology	<input type="checkbox"/> Frontal <input checked="" type="checkbox"/> Group Work <input type="checkbox"/> Pairwork <input type="checkbox"/> Individual work	
Learning methodology	<input checked="" type="checkbox"/> Observing <input type="checkbox"/> Listening to the teacher or a guide <input type="checkbox"/> Taking pictures <input checked="" type="checkbox"/> Experimental <input type="checkbox"/> Playing educational games, role play <input type="checkbox"/> Self-learning <input type="checkbox"/> Contest	<input type="checkbox"/> Solving worksheets <input type="checkbox"/> Orientation <input checked="" type="checkbox"/> Use of apps <input checked="" type="checkbox"/> Collecting samples and analysing <input type="checkbox"/> Use of maps and navigation <input checked="" type="checkbox"/> Investigative performance <input type="checkbox"/> Other. Please, specify:
ESTEAM mobile app challenges	<input type="checkbox"/> Take photo <input checked="" type="checkbox"/> Questions and multiple-choice answers with pictures and/or texts <input type="checkbox"/> Write text answer to match a set of possible written answers <input checked="" type="checkbox"/> Write or draw on photo taken/given illustration <input checked="" type="checkbox"/> Make a simple drawing	
Additional knowledge, skills and competences	<input checked="" type="checkbox"/> Teamwork <input checked="" type="checkbox"/> Problem solving <input checked="" type="checkbox"/> Decision making <input checked="" type="checkbox"/> Development of independent thinking	
Multi-sensory contents	kinaesthetic, visual, auditory	
Teaching aids	TeachOUT app, litmus paper, pH scale	
New terms	soil layers, pH, litmus paper, acid, alkaline	

Description of exercise:

This topic is divided into three sub-themes: soil, water and a cave.

Students choose the right answers and use the aids (pH indicator) to do the practical work, where necessary, to answer the questions. Children have to create simple drawings on the given illustrations, and to recognize the caving equipment. They also revise how to behave in nature so as not to scare or threaten the animals in their natural environment.

Pre-field work:

Teacher pre teaches the following topics in class:
rules of behaviour in the forest;
the geology of the area;
pH.

After-field work:

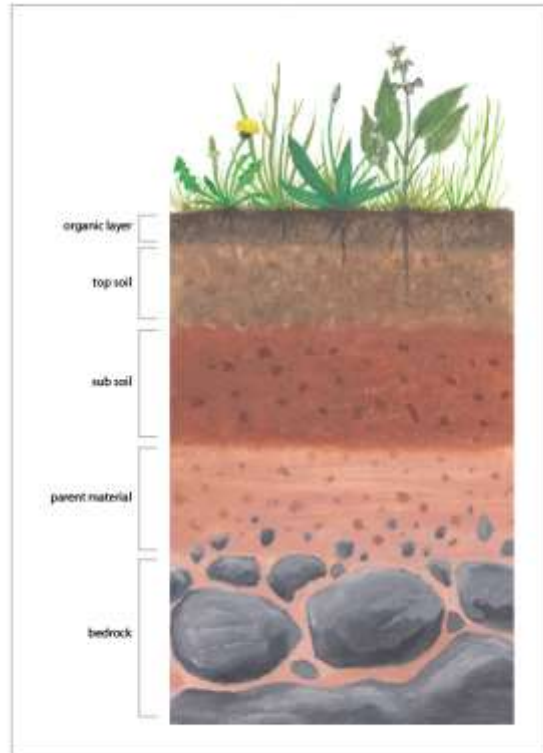
In class discussion, on the basis of the photos taken on the trail, about the missing soil layer in the area and children's arguments about the growth of algae in certain parts of the cave.

Examples of everyday use:

- What are the consequences of the disposal of batteries of all kinds into the abysses and sinkholes in the Karst area?
- Črni Vrh plateau is a water storage area for the Idrijca. What kind of farming do you recommend in this area? Describe it!
- The soil layer on the stone forest ground in the Karst area is very thin. Especially on steep slopes, the root systems of the growing plants protect the soil from erosion caused by rain. What happens if foresters cut down all of the trees on such a slope? What are the current and long-term consequences?

Scenarios for ESTEAM mobile app:**SOIL**

1. Mark the layers of soil, which are missing at this point of the trail in the illustration below.



2. Measure the pH of the soil and write it on the line: _____
3. According to the pH scale, mark whether the soil is acid or alkaline.

1. For visiting the cave, you need special caving equipment. Choose the equipment you would need to enter the cave safely. Drag and drop the pieces of equipment in the right column:

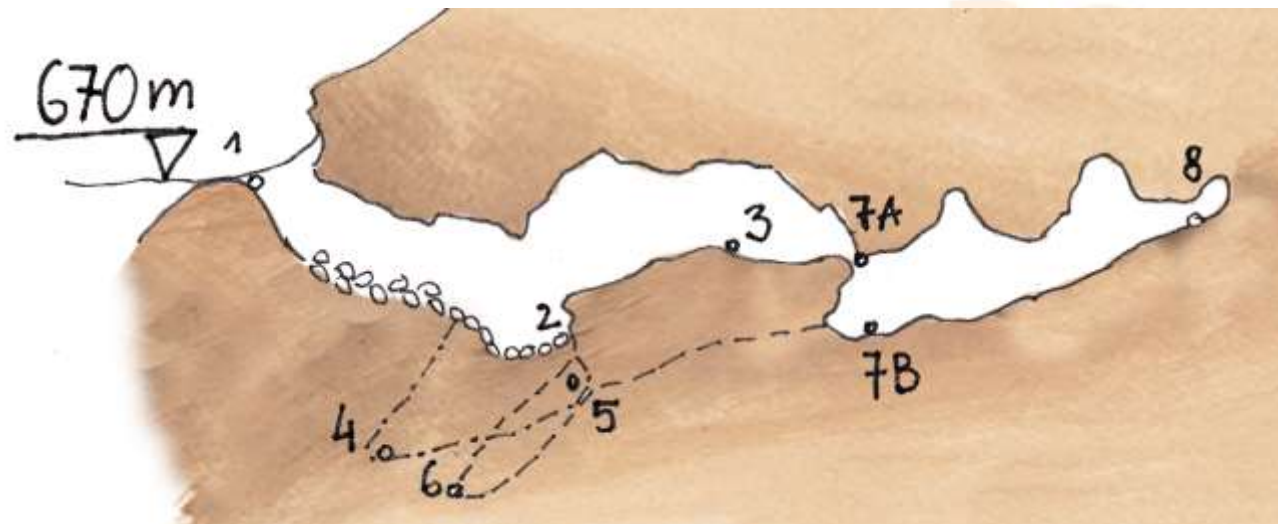
a helmet
a sandwich
a headlamp
a flashlight
a trumpet
boots
gloves
high heels

FOR YOUR SAFETY YOU NEED:	YOU DON'T NEED:

2. Plants need certain conditions for their growth. Look at the illustration and mark the part of the cave, where you can find algae.

Why there? Write your answer on the line. _____

3. Draw some other organisms, which can be found in the cave on the given illustration.



WATER

1. Have you seen water on the trail?

- a) Yes
b) No

2. Choose the right explanation.

- a) Animals drank all the water.
b) Water seeps through the soil and rocks to the undergrounds.
c) Trees with their canopies prevent the rain from reaching the ground.

Aids for ESTEAM mobile app:

X pictures, drawings:

- illustration of a soil profile with all soil layers
- illustration of profile of the cave

__ photos: /

__ texts: /

X sound files: sounds for correct and incorrect answers.

__ video files: /

X other: multiple-choice questions, classification.

Exercise 5: ECOLOGY (biotic factors)

Selected theme	<input type="checkbox"/> Geology <input checked="" type="checkbox"/> Ecology <input type="checkbox"/> Men and biosphere	
Subtheme	Biotic factors (lichens)	
Class	6. – 9. class	
Learning goals	<ul style="list-style-type: none"> - Children can determine the type of lichens; - Children can define the importance of lichens as bioindicators 	
Working methodology	<input type="checkbox"/> Frontal <input checked="" type="checkbox"/> Group work <input type="checkbox"/> Pairwork <input type="checkbox"/> Individual work	
Learning methodology	<input checked="" type="checkbox"/> Observing <input type="checkbox"/> Listening to the teacher or a guide <input checked="" type="checkbox"/> Taking pictures <input type="checkbox"/> Experimental <input type="checkbox"/> Playing educational games, role play <input type="checkbox"/> Self-learning <input type="checkbox"/> Contest	<input type="checkbox"/> Solving worksheets <input type="checkbox"/> Orientation <input checked="" type="checkbox"/> Use of apps <input checked="" type="checkbox"/> Collecting samples and analysing <input checked="" type="checkbox"/> Use of maps and navigation <input type="checkbox"/> Investigative performance <input type="checkbox"/> Other. Please, specify:
ESTEAM mobile app challenges	<input checked="" type="checkbox"/> Take photo <input checked="" type="checkbox"/> Questions and multiple-choice answers with pictures and/or texts <input checked="" type="checkbox"/> Write text answer to match a set of possible written answers <input type="checkbox"/> Write or draw on photo taken <input type="checkbox"/> Make a simple drawing	<input type="checkbox"/> Make a short film <input type="checkbox"/> Mark a GPS point on the map with picture and/or comment <input type="checkbox"/> Find out what you are holding? <input type="checkbox"/> Answer a set of questions, to find out what it is
Additional knowledge, skills and competences	<input checked="" type="checkbox"/> Teamwork <input checked="" type="checkbox"/> Problem solving <input checked="" type="checkbox"/> Decision making <input checked="" type="checkbox"/> Development of independent thinking	
Multi-sensory contents	kinaesthetic, visual, auditory	
Teaching aids	TeachOUT app	
New terms	lichens, bioindicators, biotic, biodiversity	

Description of exercise:

At different locations on the trail, tasks about lichens pop up. Children recognize different types of lichens in the photos and match the photos to the right descriptions. They choose the appropriate answers and take a photo of one of the representatives of the lichens they find on the trail.

Pre-field work:

Children learn:

- how to distinguish three types of lichens;
- how lichens reveal the quality of the air (bioindicators).

After-field work:

In class, a teacher can see photos of the lichens in the Dashboard of the TeachOUT app and discusses the photos of lichens (taken by students), different types of lichens and their frequency in nature.

Examples of everyday use:

- What does the frequency of lichens in the forest tell you about the quality of the air?
- What impact do hotbed effects have on forest ecosystem and on limestone ground?
- Why are climate changes so obviously reflected in Karst forests?

Scenarios for ESTEAM mobile app:

1. What is the rate between the ground surface and air surface of the lichen?
Drag and drop the descriptions (a, b, c) to the appropriate pictures (1, 2, 3).
 - a) The ground surface is the same as the air surface of lichen
 - b) The air surface is larger than the ground surface
 - c) The air surface is the largest



PICTURE 1



PICTURE 2



PICTURE 3

2. Take a photo of one representative that you can find on the trail.
3. Classify it according to the following descriptions:
 - a.) The ground surface is the same as the air surface of lichen
 - b.) The air surface is larger than the ground surface
 - c.) The air surface is the largest
4. What does the appearance of lichen tell you? Choose the correct answers.
 - a) The air is much polluted.
 - b) Air pollution decreases with distance from roads.
 - c) The air is not contaminated.

Aids for ESTEAM mobile app:	<u>X</u> pictures, drawings: pictures of three types of lichens
	<u>X</u> photos: photos of different types of lichens
	__ texts:
	<u>X</u> sound files: sounds for correct and incorrect answers
	__ video files:
	<u>X</u> other: multiple choice questions

Exercise 6: ECOLOGY (biodiversity)

Selected theme	<input type="checkbox"/> Geology <input checked="" type="checkbox"/> Ecology <input type="checkbox"/> Men and biosphere	
Subtheme	Biodiversity (Plant formations)	
Class	6. - 9. class	
Learning goals	<ul style="list-style-type: none"> - Dependence of plant formations on a different rock base; - The influence of soil on the flora; - Interactions between plants and other organisms in biocenosis. 	
Working methodology	<input type="checkbox"/> Frontal <input checked="" type="checkbox"/> Group Work <input type="checkbox"/> Pairwork <input type="checkbox"/> Individual work	
Learning methodology	<input checked="" type="checkbox"/> Observing <input type="checkbox"/> Listening to the teacher or a guide <input checked="" type="checkbox"/> Taking pictures <input type="checkbox"/> Experimental <input type="checkbox"/> Playing educational games, role play <input type="checkbox"/> Self-learning <input type="checkbox"/> Contest	<input type="checkbox"/> Solving worksheets <input type="checkbox"/> Orientation <input checked="" type="checkbox"/> Use of apps <input type="checkbox"/> Collecting samples and analysing <input type="checkbox"/> Use of maps and navigation <input type="checkbox"/> Investigative performance <input type="checkbox"/> Other. Please, specify:
ESTEAM mobile app challenges	<input checked="" type="checkbox"/> Take photo <input checked="" type="checkbox"/> Questions and multiple-choice answers with pictures and/or texts <input type="checkbox"/> Write text answer to match a set of possible written answers <input checked="" type="checkbox"/> Write or draw on photo taken <input type="checkbox"/> Make a simple drawing	<input type="checkbox"/> Make a short film <input type="checkbox"/> Mark a GPS point on the map with picture and/or comment <input type="checkbox"/> Find out what you are holding? <input type="checkbox"/> Answer a set of questions, to find out what it is
Additional knowledge, skills and competences	<input checked="" type="checkbox"/> Teamwork <input checked="" type="checkbox"/> Problem solving <input checked="" type="checkbox"/> Decision making <input checked="" type="checkbox"/> Development of independent thinking	
Multi-sensory contents	visual, kinaesthetic, audio	
Teaching aids	TeachOUT app	
New terms	fern, tree formation, sporangia (reproductive organs)	

Description of exercise:

From the given photos, children recognize the one showing the plant formation on the trail. When they choose a photo, a short text about the type of forest pops up. They take a picture of the dominant tree species. Children take a photo of the fern and mark parts of the plant's reproductive organs in the picture.

Pre-field Work:

Children learn in class about the reproduction of ferns and are able to recognize their reproductive organs.

Post-field Work:

In class, the teacher checks the photos taken on the trail in the Dashboard of the TeachOUT app and discusses them with pupils.

Examples of everyday use:

- Why is the regime of fertilization of agricultural land important in the area of the Črni Vrh plateau?
- The intensive fertilization in karst fields has a significant impact on biodiversity in the area. How can a smaller degree of biodiversity affect faster spread of pests on agricultural land? (example of the May bug)
- How does a smaller variety of vegetation on the extensively fertilized meadows affect the quality of the produced milk and meat?
- Why is grass cutting in late summer important to preserve diversity?
- Why are spruce trees a weak point of the Karst forest in this area?

Scenarios for ESTEAM mobile app:

1. Look around and observe plant formations around you. Between the three different given choices, choose the one that you are observing.



A fir-beech forest



B Mediterranean maquis



C spruce forest

2. Take a photo of the dominant tree species.
3. Find the fern (pteridophyta) in the surroundings and mark the parts of the plant which are in charge of reproduction on the given illustration.



Aids for ESTEAM mobile app:

☒ **pictures, drawings:** illustration of fern with reproductive organs

☒ **photos:** photos of three plant formations

☒ **texts:** additional explanation about plant formations

☒ **sound files:** sounds for correct and incorrect answer

☐ video files: /

☒ **other:** multiple choice questions

Exercise 7: MAN AND THE ENVIRONMENT (resources)

Selected theme	<input type="checkbox"/> Geology <input type="checkbox"/> Ecology <input checked="" type="checkbox"/> Men and biosphere	
Subtheme	Resources	
Class	8. - 9. class	
Learning goals	<ul style="list-style-type: none"> - Pupils learn the process of photosynthesis as the basic process of the circulation of carbon in nature; - pupils recognize the products of complete combustion; 	
Working methodology	<input type="checkbox"/> Frontal <input checked="" type="checkbox"/> Group Work <input type="checkbox"/> Pairwork <input type="checkbox"/> Individual work	
Learning methodology	<input checked="" type="checkbox"/> Observing <input type="checkbox"/> Listening to the teacher or a guide <input checked="" type="checkbox"/> Taking pictures <input type="checkbox"/> Experimental <input type="checkbox"/> Playing educational games <input type="checkbox"/> Role play <input type="checkbox"/> Self-learning <input type="checkbox"/> Contest	<input type="checkbox"/> Solving worksheets <input type="checkbox"/> Orientation <input checked="" type="checkbox"/> Use of apps <input type="checkbox"/> Collecting samples and analysing <input type="checkbox"/> Use of maps and navigation <input type="checkbox"/> Investigative performance <input type="checkbox"/> Other. Please, specify:
ESTEAM mobile app challenges	<input checked="" type="checkbox"/> Take photo <input checked="" type="checkbox"/> Questions and multiple-choice answers with pictures and/or texts <input type="checkbox"/> Write text answer to match a set of possible written answers <input type="checkbox"/> Write or draw on photo taken <input type="checkbox"/> Make a simple drawing	<input type="checkbox"/> Make a short film <input type="checkbox"/> Mark a GPS point on the map with picture and/or comment <input type="checkbox"/> Answer a set of questions, to find out what it is
Additional knowledge, skills and competences	<input checked="" type="checkbox"/> Teamwork <input checked="" type="checkbox"/> Problem solving <input checked="" type="checkbox"/> Decision making <input checked="" type="checkbox"/> Development of independent thinking	
Multi-sensory contents	Audio, visual, kinaesthetic	
Teaching aids	TeachOUT app	
New terms	Photosynthesis, complete combustion, cellulose, glucose, raw material	

Description of exercise:

The illustration of photosynthesis appears to assist pupils to remember the process. They can always help themselves with the picture when answering the questions that appear at a certain point on the trail.

At the end, they have to take a picture of something on them, where wood was used as raw material.

Pre-field work:

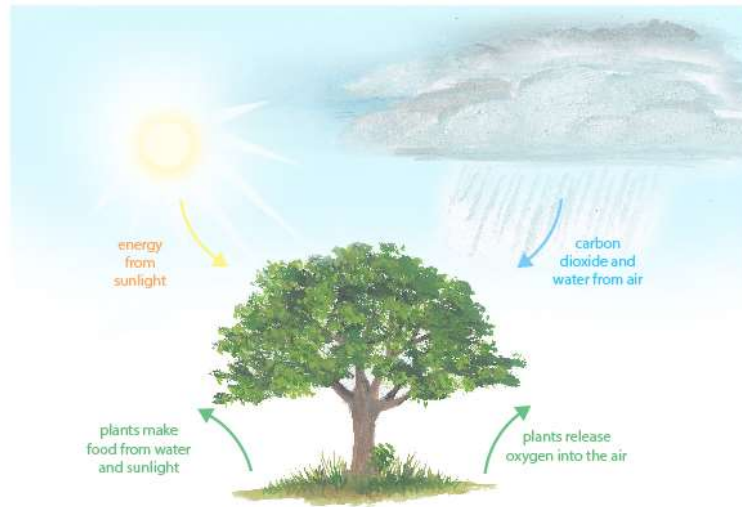
Children learn the process of photosynthesis, parts of a plant, the structure and function of plant organs.

Post-field work:

In class, the teacher checks the photos taken on the trail in the Dashboard of the TeachOUT app and discusses with pupils about the products they use in everyday life and are made of wood as raw materials.

Examples of everyday use:

- Where are you going to put a flower or a plant in your apartment?
(It depends on the species, but anyway, it has to be a bright place, because plants don't grow in dark places.)
- Your home garden. Lettuce in the garden is a food source for human, but at the same time it is also an oxygen producer and we use oxygen for breathing.
- It is possible that the wood for the furniture in your apartment comes from the Amazon rainforest, which produces huge amounts of oxygen. Today, the rainforests are exploited and cut down, which in the future will definitely have a global influence.
- Forests are an important source of wood. Wood is used for the production of furniture, fences, houses, source of energy and for heating.
- Old traditional crafts and ways of living were based on natural resources (for example: making baskets, wooden rakes, tub making)
- How do you heat your house? Using wood, pellets, briquettes, wood logs?

Scenarios for ESTEM mobile app:

1. Take a photo of the plant organ in which photosynthesis takes place!
2. Which substance is produced by photosynthesis besides oxygen?
 - a. Water
 - b. Carbon dioxide
 - c. Glucose
 - d. Wood
3. Which substance is produced from glucose and is stored in the tree trunk?
 - a. Starch
 - b. Carbon dioxide
 - c. Cellulose
 - d. Proteins
4. Take a picture of an object that you have with or on you and is made up of a substance from the previous question.

Aids for ESTEAM mobile app:

X **pictures, drawings:** a drawing of photosynthesis.

X **photos:** children take a photo

__ **texts:** /

X **sound files:** sounds for correct and incorrect answer

__ **video files:** /

X **other:** multiple choice questions

Exercise 8: MAN AND THE ENVIRONMENT (geohazard)

Selected theme	<input type="checkbox"/> Geology <input type="checkbox"/> Ecology <input checked="" type="checkbox"/> Men and biosphere	
Subtheme	Geohazards - Floods in the Karst	
Class	8. 9.	
Learning goals	<ul style="list-style-type: none"> - Gain knowledge about karst - Separate permeable and impermeable rocks 	
Working methodology	<input type="checkbox"/> Frontal <input checked="" type="checkbox"/> Groupwork <input type="checkbox"/> Pairwork <input type="checkbox"/> Individual work	
Learning methodology	<div style="display: flex; justify-content: space-between;"> <div> <input type="checkbox"/> Observing <input type="checkbox"/> Listening to the teacher or a guide <input type="checkbox"/> Taking pictures <input type="checkbox"/> Experimental <input type="checkbox"/> Playing educational games, role play <input type="checkbox"/> Self-learning <input type="checkbox"/> Contest </div> <div> <input type="checkbox"/> Orientation <input type="checkbox"/> Collecting samples and analysing <input checked="" type="checkbox"/> Use of maps and navigation <input type="checkbox"/> Investigative performance <input type="checkbox"/> Other. Please, specify: </div> </div>	
ESTEAM mobile app challenges	<div style="display: flex; justify-content: space-between;"> <div> <input type="checkbox"/> Take photo <input checked="" type="checkbox"/> Questions and multiple-choice answers with pictures and/or texts <input type="checkbox"/> Write text answer to match a set of possible written answers <input type="checkbox"/> Write or draw on photo taken <input type="checkbox"/> Make a simple drawing </div> <div> <input type="checkbox"/> Make a short film <input type="checkbox"/> Mark a GPS point on the map with picture and/or comment <input type="checkbox"/> Find out what you are holding? <input type="checkbox"/> Answer a set of questions, to find out what it is </div> </div>	
Additional knowledge, skills and competences	<input type="checkbox"/> Teamwork <input type="checkbox"/> Problem solving <input type="checkbox"/> Decision making	<input type="checkbox"/> Development of independent thinking <input type="checkbox"/> Other. Please, specify:
Multi-sensory contents		
Teaching aids		
New terms	karst flood, groundwater, permeable rocks , nonpermeable rocks	

Description of exercise:

The task consists of three parts:

Part 1: Theoretical explanation of karst fields and floods on karst fields, which will be illustrated by flood animation. Pupils will have to determine the boundaries of the Karst field through the orthophotography of the Zadloško Karst field, and describe the main characteristics of the karst fields (flat bottom surrounded by higher peaks, permeability, impermeability)

Scenarios for ESTEAM mobile app:

Part 2: The influence of flooding of karst fields on the life of people (the example of the Zadloško Karst field), which will be presented through the audio-reading of the text on life in the Zadloško Karst field in the past in dialect (Text: "Štefkova rupa" Urška Bajec Rupnik). On the basis of the text they will respond to the questions.



Štefkove rupe (Urška Bajec Rupnik)

Zadlog je kraško polje brez stalno tekoče vode, pa je kljub temu vode včasih preveč. Nemaikrat se namreč zgodi, da Zadlog za nekaj časa postane jezero.

Polje je posejano z mnogimi vrtačami, v katerih voda izginja v podzemlje. Najobsežnejše in hidrološko najpomembnejše so Štefkove rupe, ki so zaščitene kot naravna vrednota. Nahajajo se sredi Zadloškega polja in so poimenovane po Štefkovi domačiji, ki je v neposredni bližini. V Štefkovih rupah je med majhnimi kotanjami slediti suho strugo. Potoček tu teče le ob večjem deževju in spomladi, ko kopni sneg ter izginja pod večjo skalno steno. Vode, ki se stekajo z južnega obrobja proti Sredi, so v dnu polja izoblikovale večje rupe in slepo dolino. Ta je skoraj 10 metrov globoko vrezana v dno polja. Slep dolina je polna požiralnikov, ki so vezani na razpoko v skalni steni. Zahodno od slepe doline je vrezana plitva struga, ki vodi k drugim požiralnikom v osrednjem delu polja. Požiralniki ne zmorejo požirati večjih količin vode, zato se ob močnejšem deževju in spomladi, ko kopni sneg, vode prelivajo v bolj oddaljene rupe in požiralnike. Ob izredno hudih nalivih je polje okrog požiralnikov poplavljen in voda se na široko razlije po cellem polju. Poplave so najbolj pogoste v zimskem ali zgodnjem spomladanskem času, ko so tla zamrznjena in vode ne odteka po razpokah v zakraselo notranjost (Habič 1968: 60–61).

Potočki, ki se stekajo proti Štefkovim rupam, imajo vsak svoje domače ime. Vsi imajo ženska imena, poimenovani pa so po domačijah, mimo katerih tečejo. Izpod Podtisovega vrha priteče »Figarca«, iz Kota »Cuntuka«, iz Podkroga »Abršca« in iz Plestenic »Sedejka«. Ti potočki se pojavijo le ob večjih padavinah in hitri spomladanski odjugi. Počasi polnijo rupe po polju in na koncu napolnijo Štefkove rupe. Takrat se voda razlije po celotnem polju in Zadlog postane jezero. Hiše so prav iz tega razloga pomaknjene na rob polja.

Najobsežnejše poplave v zadnjih sto letih so bile leta 1895, ob božiču 1909, 1923, 1934, 1936, 1959, 1968, 1984. V župnijski kroniki za leto 1923 beremo: »Prve dni decembra so nalivi in hudourniki z gora zalili zadloško ravnino in jo spremenili v jezero. Nekaterim kmetom se je nalila voda v hleve, da so morali odgnati živino iz njih, ljudje pa se prevažajo po splavih med hišami« (Kronika župnije Črni Vrh). V Kosmačevi kroniki pa je kronist za isto leto zapisal, da je tri dni pred prvo adventno nedeljo deževalo, v nedeljo pa je posijalo sonce in ljudje od blizu in daleč so hodili gledat povodenj (Kosmač 1959). Vode naj bi bilo toliko, da je tri ure tekla čez preval proti Črnemu Vrh.

Ob poplavah se je življenje Zadložanov preselilo na »flose« ali splave, nekateri pa so si naredili tudi čolne. Za kakršenkoli popravek so potrebovali splav, saj je bilo polje popolnoma neprehodno več dni, lahko tudi cel mesec. Kasneje so ob povodnjih uporabljali tudi traktorje, kjer je bilo seveda to možno. Splave so izdelovali iz lesa, ki so ga v ta namen hranili doma, za vesla pa so uporabljali strešne letve.

Največ škode je voda povzročila v hlevih. Živini so postavili »oder« iz desk, da so bile na suhem. Od leta 1927 je v Zadlogu delovala mlekarna, kamor so kmetje dnevno oddajali mleko. Ob poplavah so ga naložili na »flose« in odveslali proti »Štefku«, kjer je bila mlekarna. Otroci so se v Črni Vrh k verouku in kasneje v šolo prav tako vozili na splavih. Odpeljali so jih do prevala, od koder so potem pot nadaljevali peš. Velikokrat jih je bilo na splavu preveč in se je prevrnil.

Ob poplavah pa je bilo tudi veliko zabave, zato med domačini kroži veliko prigod o tako imenovanem »zadloškem morju«. Tako so se na »flos« naložili zadloški muzikantje oziroma zadloška »pleh muzka«, ki je delovala po prvi svetovni vojni do leta 1928. Veslali so po polju in igrali. Seveda so se obvezno tudi ustavili v gostilni pri »Bizarju« in »Figarju«. »Flosanje« je bilo v veliko veselje tudi otrokom. Nevarno pa je bilo, da bi kdo padel v vodo, saj skoraj nihče ni znal plavati. Večkrat se je to tudi zgodilo, ampak so vse še pravočasno rešili. Veliko zabave je bilo tudi pri izdelavi splavov oziroma čolnov. Veslanje po »zadloškem morju« je predstavljalo pravi izziv, a je bilo nevarno, ker je polje polno požiralnikov, ki so splave vleкли v globino. Še posebej nevarno je bilo zato, ker večina ljudi ni znala plavati.

Poplave so bile največkrat zgodaj spomladi, zato takrat še ni bilo večjega dela na polju. Velikokrat pa se je zgodilo, da je odjugi sledila zmrzal in je »jezero« zamrznilo. Ljudje so si takrat najpogosteje pomagali s smučmi. To je bilo še bolj nevarno, ker je bil led tanek in se je prediral. Ob otoplitvi pa je led pokal in ljudje pravijo, da je »pokalo kot na fronti«. Ko je voda odtekla, so na površju ostale velike ledene ploskve, na katerih so se otroci radi drsali in sankali.

Part 3: will be designed to understand and perform the acquired knowledge. Based on role play and the previously prepared scenario, the pupils will be placed into the role of a journalist, a local (living on the edge of the Zadlogo Karst field), a fireman (who participated in recent floods in the Zadlog Karst field)

Aids for ESTEAM mobile app:

- | |
|---|
| __ pictures, drawings;
please specify: animation of floods on the karst |
| __ photos
please specify: photos - karst floods on Zadlog karst field (Urška Bajec Rupnik) |
| __ texts
please specify: description about karst floods (Text: Urška Bajec Rupnik) |
| __ sound files
please specify: |
| __ video files
please specify: |
| __ other,
please specify: |

Exercise 9: MAN AND THE ENVIRONMENT (Impact of man on environment)

Selected theme	<input type="checkbox"/> Geology <input type="checkbox"/> Ecology <input checked="" type="checkbox"/> Men and biosphere	
Subtheme	Impact of men on the environment	
Class	6., 7. class	
Learning goals	<ul style="list-style-type: none"> - Negative influence of men on environment; - connections between flora and fauna; - the ability of flora and fauna to adapt to the influence of man. 	
Working methodology	<input type="checkbox"/> Frontal <input checked="" type="checkbox"/> Groupwork <input type="checkbox"/> Pairwork <input type="checkbox"/> Individual work	
Learning methodology	<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <input checked="" type="checkbox"/> Observing <input type="checkbox"/> Listening to the teacher or a guide <input checked="" type="checkbox"/> Taking pictures <input type="checkbox"/> Experimental <input checked="" type="checkbox"/> Playing educational games, role play <input type="checkbox"/> Self-learning <input type="checkbox"/> Contest </div> <div style="width: 45%;"> <input type="checkbox"/> Solving worksheets <input type="checkbox"/> Orientation <input checked="" type="checkbox"/> Use of apps <input checked="" type="checkbox"/> Collecting samples and analysing <input type="checkbox"/> Use of maps and navigation <input type="checkbox"/> Investigative performance </div> </div>	
ESTEAM mobile app challenges	<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <input checked="" type="checkbox"/> Take photo <input checked="" type="checkbox"/> Questions and multiple-choice answers with pictures and/or texts <input type="checkbox"/> Write text answer to match a set of possible written answers <input type="checkbox"/> Write or draw on photo taken/given illustration <input type="checkbox"/> Make a simple drawing </div> <div style="width: 45%;"> <input checked="" type="checkbox"/> Make a short film <input type="checkbox"/> Mark a GPS point on the map with picture and/or comment <input type="checkbox"/> Answer a set of questions, to find out what it is </div> </div>	
Additional knowledge, skills and competences	<input checked="" type="checkbox"/> Teamwork <input checked="" type="checkbox"/> Problem solving <input checked="" type="checkbox"/> Decision making <input checked="" type="checkbox"/> Development of independent thinking	
Multi-sensory contents	kinaesthetic, visual, auditory	
Teaching aids	TeachOUT app	
New terms	ecology, environment, infrastructure, pollution, adaptation, modification	

Description of exercise:

When children pass the special beech tree on the trail, the multiple choice questions pop up. Children answer the questions. They make a movie - role play showing life in and on the tree and take pictures to document the impact of man.

Pre-field work:

Children recognize different tree species and the animals that live in the forest. Children are aware of the fact that people exploit the forest and its resources and leave the evidence.

After-field work:

In class, children watch their videos from the Dashboard of the TeachOUT app and discuss the life around the tree. They also discuss the photos of evidence of man on the trail.

Examples of everyday use:

- You probably noticed that the wood in the surrounding area was cut off. This was mostly because of a natural catastrophe in 2014, namely sleet. Sleet damaged the trees, and created the perfect conditions for the bark beetle to massively reproduce. People have been cutting down all the spruce trees, injured by the bark beetle, which gradually causes a change to the landscape.
- Garbage disposal: Karst dolines are often filled with garbage. Do you notice garbage along the path? Does it look nice to you? You then have to clean it or organise environmental action within your local community. A big ecological problem of water pollution in the karst region.
- Roads. All kinds of roads have an impact on nature – they damage the landscape, cause erosion (in some cases), destroy homes for animals, etc.
- Because of human impact (human stupidity, greed and ignorance) it is necessary to protect nature or special places on Earth which have a higher value in the sense of rarity or uniqueness.
- Sports activities in nature: when you go for a walk or you play with your mates in nature, you cause noise, which disturbs animals.

Scenarios for ESTEAM mobile app:

1. What type of tree is in front of you?
 - a) Spruce tree
 - b) Beech tree
 - c) Fir tree
2. In a group, take roles of different animals which live or had lived here in this tree (for example woodpecker, bugs, dormouse, squirrel, snail).
Make a short film of life in this tree house in the last year!
3. Is the tree still alive? Explain your answer!
 - a) Yes Your explanation:*
 - b) No

* Children write explanation on the line. Teacher grades it and gives extra points.
4. Find at least three other forms of evidence regarding the impact of man on the environment and take photos.

Aids for ESTEAM mobile app:

__ pictures, drawings: /

X photos: children take a photo

__ texts: /

X sound files: sounds for correct and incorrect answer

X video files: children make a video – role play

X other: multiple choice questions

5.3. EXERCISES AT THE MONSANTO TRAIL

Description of the Monsanto trail

The place that serves as the basis for the trail defined for the digital application *TEACHOUT*, fruit of the *ESTEAM PROJECT* financed by the Erasmus+ program, is located in MONSANTO, a historic village in the municipality of Idanha-a-Nova, Castelo Branco district, central Portugal, and is integrated in the territory of GEOPARK NATURTEJO, under the auspices of UNESCO, since 2006.

Since ancient times human occupation of this territory has been conditioned by its geodiversity, since human activities have always been dependent on geomorphology and geological resources. Thus, the castles and settlements were mostly located in strategic positions, places with great field of vision, in order to provide a better defence, namely on elevated areas, such as those where the castles of Idanha-a-Nova and Monsanto are located.

The Naturtejo Geopark, a UNESCO World Geopark, stretches for some 5000 km² of land and includes several counties, including Castelo Branco and Idanha-a-Nova. From the *Raia* to the *Beira Interior*, it is a territory of great tourist potential and contains a significant number of sites of geological interest (*geosites*) of special scientific, aesthetic and educational relevance, and also associated with archaeological, ecological, historical and cultural heritage. Most of the territory of the Geopark is made up of metamorphic rocks, about 600 million years old, in some cases. This group constitutes the predominant rocky substrate in the region, and the rocks that form it are cut in several zones by granite rocks, which never dominate the landscape, although they sometimes constitute relatively extensive outcrops.

Nature's ruin, rising sharply vertical from the contiguous plains, MONSANTO attracts our senses by its granite grandeur and opulence. The monstrous boulders lost in the slopes of the mount, which are imposed when looking at most of the horizons, are natural monuments of this Historical Village of Portugal. Its unique charm led to the titles of *Most Portuguese Village of Portugal* in 1938 and *Historical Village* in 1995. Located on the steep slopes of a magnificent hill, Monsanto (*Mons Sanctus*) is one of the most beautiful villages in Portugal. Fascinating and picturesque, a walk through its streets takes us on a

time travel. The village is set up on the *Inselberg* of Monsanto, which is one of the 17 geomonuments of the Geopark.



An INSELBERG is a shallow relief that emerges abruptly from a flattened surface. They are called "*island hills*" because they are mountains, mounts or hills that stand out abruptly from the plains that surround them, as if they were islands of the sea. During the formation of Pangaea, 310 million years ago, the installation of a mass of magma that originated the granite occurred. Millions of years later, the waters of the rains infiltrated into the fractures and modified these rocks. Later, schists, rocks that surrounded the granite, changed more quickly, allowing the chemical alteration of the granite that gave rise to blocks of different sizes and configurations, chaotically heaped (chaos of blocks).



The path intersects the *Boulders Trail*, nature trail that runs through the village streets and suburbs. Apparently unique, each granite ball was modelled and exposed by erosive agents for millions of years, creating patterns that excite our imagination. Monsanto represents 300 million years of Earth's dynamics, one of the most spectacular geomonuments of the Naturtejo Geopark of UNESCO, by the action of tectonic forces that have raised crystallized granites from the depths of the earth's crust. Houses of stone darkened by time develop through an endless landscape of granite giants. Narrow streets squeezed between cliffs filled with history, their own religious feel and fascinating legends, transports us to unique monuments.

Monsanto is its people, simple lives, proud of its past in the history of Portugal. A history full of heroes and deprivations that have strengthened the mimetic proximity to its unforgettable surrounding nature that is only found here, in Monsanto.

Exercise 1: GEOLOGY (Rock cycle)

Selected theme	Geology	
Subtheme	Rock Cycle	
Class	7th-9th grade (13-15 years old)	
Learning goals	Summarize the action of water, wind and living beings as external geological agents. Describe the cycle of rocks. List the geological processes involved in the rock cycle.	
Working methodology	<input type="checkbox"/> Frontal <input type="checkbox"/> Groupwork <input checked="" type="checkbox"/> Pairwork <input type="checkbox"/> Individual work	
Learning methodology	<input checked="" type="checkbox"/> Observing <input type="checkbox"/> Listening to the teacher or a guide <input type="checkbox"/> Experimental <input type="checkbox"/> Playing educational games, role play <input checked="" type="checkbox"/> Taking pictures	<input checked="" type="checkbox"/> Self-learning <input type="checkbox"/> Contest <input type="checkbox"/> Orientation <input type="checkbox"/> Collecting samples and analysing <input type="checkbox"/> Use of maps and navigation <input type="checkbox"/> Investigative performance
ESTEAM mobile app challenges	<input checked="" type="checkbox"/> Take photo <input type="checkbox"/> Questions and multiple-choice answers with pictures and/or texts <input type="checkbox"/> Write text answer to match a set of possible written answers <input type="checkbox"/> Write or draw on photo taken <input type="checkbox"/> Make a simple drawing <input type="checkbox"/> Make a short film	<input type="checkbox"/> Mark a GPS point on the map with picture and/or comment <input type="checkbox"/> Find out what you are holding? <input type="checkbox"/> Answer a set of questions, to find out what it is <input type="checkbox"/> Sort into the right box
Additional knowledge, skills and competences	<input checked="" type="checkbox"/> Teamwork <input checked="" type="checkbox"/> Problem solving <input checked="" type="checkbox"/> Decision making	<input checked="" type="checkbox"/> Development of independent thinking
Multi-sensory contents	Visual, kinaesthetic	
Teaching aids	TeachOUT app	
New terms	Petrology; Erosion; Rock cycle; Sedimentogenesis; Meteorization;	

Introduction:

Granite results from the solidification of magma at great depths (plutonic magmatic rock). The rocks that surround it, preventing the release of heat, do not allow for the rapid cooling of the magma, delaying its solidification. In this way, the minerals that constitute it have the necessary time to develop, thus presenting this rock, with its granular texture in which the constituent minerals are very visible and identifiable: quartz, feldspars (orthoclase, Sanidine and microcline) and micas (biotite and muscovite).

The rocky massifs that appear on the surface - outcrops - are subject to pressure conditions, a temperature and chemical environment very different from those in which they were generated. Therefore, weathering and erosion of these massifs occur.

As a result of these processes, granite takes different forms. A granite landscape usually has some characteristic features such as fractured massif (diabases), sandstone and, at a later stage of disintegration, tors or a set of rounded blocks - the chaos of blocks.

Description of exercise:

The pupils should look at the landscape and identify erosion of the granite.

In the chosen site there are examples of different erosion landscapes.

The students must establish the correct sequence of phenomena that lead to the resulting type of landscape.

After that, they should take a photo of two different kinds of granite erosion (tors, diabases, the chaos of blocks).



Pre-field work

- Know the process for the formation of plutonic rocks.
- Identify different aspects of the granite landscape.
- Realize the formation of the chaos of the blocks and tors.

After-field work

- Analyse the granite landscape around the school.

Examples of everyday use

- The different erosive forms referring to the local rocks are of economic interest associated with geotourism.
- The different geotectonic processes contributed to the regional, geological arrangement and determined the existence of geosites which are of key natural, scientific, educational and economic value.
- The mineral-medicinal waters of the region are due to local geological dynamics and economic developmental factor.
- The rational use of different geological resources ensures sustainable development.
- The geological processes of local magmatism and metamorphism allowed for the exploration of several ores (gold, wolframite, antimonite, amongst others) and rocks (sands and granites).

Scenarios for ESTEAM mobile app:

The app should present the question which consists of sorting out the geological phenomena that lead to the landscape: Establish the correct sequence of images representing the erosion of granite.

The app should permit picture taking and data saving: Take two photographs that represent the result of erosion on the granite massif.

Aids for ESTEAM mobile app:

- | |
|---|
| __ pictures, drawings;
please specify: |
| __ photos
please specify: |
| __ texts
please specify:
geological phenomena (erosion) |
| __ sound files
please specify: |
| __ video files
please specify: |
| __ other,
please specify: |

Exercise 2: GEOLOGY (Rocks)

Selected theme	Geology	
Subtheme	Type of Rocks	
Class	7th-9th grade (13-15 years old)	
Learning goals	<p>To identify landscapes of volcanic rocks and landscapes of plutonic rocks through their main characteristics.</p> <p>Identify the type of landscape in the region where the school is located.</p> <p>Identify minerals in rocks (biotite, feldspar, moscovite), correlating some properties.</p> <p>To identify different types of plutonic rocks and volcanic rocks, based on hand samples.</p> <p>To relate the genesis of magmatic rocks to their texture, based on size, and in the macroscopic identification of its constituent minerals.</p>	
Working methodology	<input type="checkbox"/> Frontal <input type="checkbox"/> Groupwork <input checked="" type="checkbox"/> Pairwork <input type="checkbox"/> Individual work	
Learning methodology	<input checked="" type="checkbox"/> Observing <input type="checkbox"/> Listening to the teacher or a guide <input type="checkbox"/> Experimental <input type="checkbox"/> Playing educational games, role play <input checked="" type="checkbox"/> Taking pictures	<input checked="" type="checkbox"/> Self-learning <input type="checkbox"/> Contest <input type="checkbox"/> Orientation <input checked="" type="checkbox"/> Collecting samples and analysing <input type="checkbox"/> Use of maps and navigation <input type="checkbox"/> Investigative performance
ESTEAM mobile app challenges	<input checked="" type="checkbox"/> Take photo <input checked="" type="checkbox"/> Questions and multiple-choice answers with pictures and/or texts <input type="checkbox"/> Write text answer to match a set of possible written answers <input checked="" type="checkbox"/> Write or draw on photo taken <input type="checkbox"/> Make a simple drawing <input type="checkbox"/> Make a short film	<input type="checkbox"/> Mark a GPS point on the map with picture and/or comment <input type="checkbox"/> Find out what you are holding? <input type="checkbox"/> Answer a set of questions, to find out what it is <input type="checkbox"/> Sort into the right box
Additional knowledge, skills and competences	<input checked="" type="checkbox"/> Teamwork <input checked="" type="checkbox"/> Problem solving <input type="checkbox"/> Decision making	<input checked="" type="checkbox"/> Development of independent thinking
Multi-sensory contents	Tactile, visual, smell	
Teaching aids	TeachOUT app	
New terms	Mineralogy; Magmatic; Mineral; Texture;	

Introduction:

In the earth's crust, there is a great diversity of rocks. The rocks are classified into three major groups: the sedimentary, the metamorphic and the magmatic. Magmatic rocks are rocks that result from the solidification of magma. This solidification may occur inside the crust or on its surface. The magmatic rocks that solidify inside the Earth's crust are called intrusive or plutonic magmatic rocks. The magmatic rocks that solidify on the surface of the Earth's crust are called extrusive or volcanic magmatic rocks.

Description of exercise:

The pupils should look at the granite boulders in front of them and analyse its mineralogy. They must answer a question about the set of minerals that appears in the rock (granite). After identifying the minerals, using the granite sand on the ground or in the rock itself, they must choose a point and take a picture that correctly shows the mineralogy of the rock.

Pre-field work

- Know the three types of rocks on the planet.
- Distinguish the origin of plutonic and volcanic rocks.
- Identify the mineralogy of different magmatic rocks from hand samples.

Post-field work

- Identify rocks that are frequently used in construction.
- Identify different uses of (magmatic) rocks.
- Relate the formation of magmatic rocks to their mineralogical characteristics.

Examples of everyday use

- Knowledge of the geological history of the region and explains the human occupation that has occurred over time.
- The existence of certain geological resources (rocks and minerals) gave rise to the populating of different communities and the development of several economic activities, locally.
- The construction of buildings over time made use of local geological resources.
- The mineral-medicinal waters present in the region are related to the local tectonic structures and the physical and chemical properties of local rocks.
- The characteristics of local rocks influence the quality and characteristics of the soil, agricultural production, forest production, types of vegetation and water quality.

Scenarios for ESTEAM mobile app:

Present the question (multiple choice):

The magmatic rock present in this location is granite.

What is the set of minerals that best characterize this rock:

- a. quartz, feldspar, diamond
- b. quartz, amphibole, micas
- c. quartz, calcite, micas
- d. quartz, feldspar, micas

Possibility of taking a picture

(Take a picture showing the different minerals in the granite)

Record the data

Aids for ESTEAM mobile app:	__ pictures, drawings; please specify: Schematic diagram of granite and its mineralogy.
	__ photos please specify:
	__ texts please specify:
	__ sound files please specify:
	__ video files please specify:
	__ other, please specify:

Exercise 3: GEOLOGY (Landforms)

Selected theme	Geology	
Subtheme	Landforms	
Class	7th-9th grade (13-15 years old)	
Learning goals	Identify landscapes of volcanic rocks and plutonic rocks through their main characteristics. Identify the type of landscape in the region where the school is located. Sum up the action of water, wind and living beings as external geological agents.	
Working methodology	<input type="checkbox"/> Frontal <input checked="" type="checkbox"/> Groupwork <input checked="" type="checkbox"/> Pairwork <input checked="" type="checkbox"/> Individual work	
Learning methodology	<div> <input checked="" type="checkbox"/> Observing <input checked="" type="checkbox"/> Listening to the teacher or a guide <input type="checkbox"/> Experimental <input type="checkbox"/> Playing educational games, role play <input type="checkbox"/> Taking pictures </div> <div> <input checked="" type="checkbox"/> Self-learning <input type="checkbox"/> Contest <input checked="" type="checkbox"/> Orientation <input type="checkbox"/> Collecting samples and analysing <input checked="" type="checkbox"/> Use of maps and navigation <input checked="" type="checkbox"/> Investigative performance </div>	
ESTEAM mobile app challenges	<div> <input type="checkbox"/> Take photo <input checked="" type="checkbox"/> Questions and multiple-choice answers with pictures and/or texts <input type="checkbox"/> Write text answer to match a set of possible written answers <input type="checkbox"/> Write or draw on photo taken <input type="checkbox"/> Make a simple drawing <input type="checkbox"/> Make a short film </div> <div> <input type="checkbox"/> Mark a GPS point on the map with picture and/or comment <input type="checkbox"/> Find out what you are holding? <input checked="" type="checkbox"/> Answer a set of questions, to find out what it is <input type="checkbox"/> Sort into the right box </div>	
Additional knowledge, skills and competences	<input checked="" type="checkbox"/> Teamwork <input checked="" type="checkbox"/> Problem solving <input checked="" type="checkbox"/> Decision making	<input checked="" type="checkbox"/> Development of independent thinking
Multi-sensory contents	Visual, auditory, kinaesthetic	
Teaching aids	TeachOUT app	
New terms	Inselberg; Plutonic Rocks; Volcanic Rocks; Erosion; Geological Landscape;	

Introduction:

An inselberg is an isolated rock hill, knoll, ridge, or small mountain that rises abruptly from a gently sloping or virtually level surrounding plain. They are called "island-hills" because they are mountains and hills that stand out abruptly from the plains that surround them, as if they were islands in the sea.

Monsanto's granite inselberg emerges from the surface, consisting essentially of schists and graywackes, and rises more than 300 meters, reaching 758 meters at the top. Its rise dates back 310 million years. In the Cretaceous, the climate was different from the present one, being characterized by being tropical, very hot and humid. These conditions allowed the circulating fluids fractures from the rainwater, corroded the granite in depth. Later, the rocks surrounding the granite (mainly schist) changed even more rapidly, favouring the formation of a basal alteration front that led to the exposure of the granite relief.

Description of exercise:

On the top of the Inselberg (Monsanto), the students should listen and watch a video that demonstrates the formation of the Inselberg where they are. They should understand the geological reality around them. When listening to the explanation, they should look around and understand that the landscape around and underneath them was the result of magnificent tectonic forces and the erosion of rocks. After that, they must answer a question about the formation of the Inselberg that consists in sorting out schemes.

Pre-field work

- Distinguish magmatic rocks from metamorphic rocks.
- Know the process for the formation of plutonic rocks.
- Know the steps in the formation of the inselberg of Monsanto.

Post-field work

- Research the existence of other inselbergs worldwide.

Examples of everyday use

- Local geology and associated landscapes are a factor of local economic development through nature tourism.
- Nature sports associated with local geological landscapes are a factor of local development.
- Human occupation and associated buildings must obey the design of the geological landscape and the nature of local rocks.
- The rivers and the geological arrangement of the region allowed for the construction of water storage structures for human consumption, irrigation and electricity production.
- The relief of the region enables the installation of structures for the use of wind energy (wind turbines).

Scenarios for ESTEAM mobile app:

Must allow the video, show a map of the surroundings, and enable the type of question.

Question: Sort out the schemes that explain the formation of the Inselberg of Monsanto.

Aids for ESTEAM mobile app:

- | |
|---|
| ___ pictures, drawings;
please specify:
Schemes to explain the formation of the Inselberg |
| ___ photos
please specify:
Photo of an Inselberg (Monsanto) |
| ___ texts
please specify:
(text explaining the formation of the Inselberg) |
| ___ sound files
please specify: |
| ___ video files
please specify: Animated movie about the formation of the Inselberg |
| ___ other,
please specify: |

Exercise 4: ECOLOGY (Abiotic factors)

Selected theme	Ecology	
Subtheme	Abiotic factors	
Class	7th-9th grade (13-15 years old)	
Learning goals	<p>To describe the influence of abiotic factors (light, water, soil, temperature, wind) on ecosystems.</p> <p>To test variables that allow students to study, in a laboratory, the influence of the abiotic factors in ecosystems.</p> <p>To conclude on how the different variables of the environment influence ecosystems.</p> <p>To predict the influence of abiotic factors on the dynamics of ecosystems in the region where the school is located.</p> <p>Relate the changes in the environment to the evolution or extinction of species.</p>	
Working methodology	<input checked="" type="checkbox"/> Frontal <input checked="" type="checkbox"/> Groupwork <input checked="" type="checkbox"/> Pairwork <input checked="" type="checkbox"/> Individual work	
Learning methodology	<input checked="" type="checkbox"/> Observing <input checked="" type="checkbox"/> Listening to the teacher or a guide <input type="checkbox"/> Playing educational games, role play <input checked="" type="checkbox"/> Experimental <input checked="" type="checkbox"/> Self-learning	<input checked="" type="checkbox"/> Orientation <input type="checkbox"/> Contest <input checked="" type="checkbox"/> Collecting samples and analysing <input checked="" type="checkbox"/> Use of maps and navigation <input checked="" type="checkbox"/> Investigative performance
ESTEAM mobile app challenges	<input type="checkbox"/> Take a photo <input checked="" type="checkbox"/> Questions and multiple-choice answers with pictures and/or texts <input checked="" type="checkbox"/> Write text answer to match a set of possible written answers <input type="checkbox"/> Write or draw on photo taken <input type="checkbox"/> Make a simple drawing <input type="checkbox"/> Make a short film	<input type="checkbox"/> Mark a GPS point on the map with picture and/or comment <input checked="" type="checkbox"/> Find out what you are holding? <input type="checkbox"/> Answer a set of questions, to find out what it is <input type="checkbox"/> Sort into the right box
Additional knowledge, skills and competences	<input checked="" type="checkbox"/> Teamwork <input checked="" type="checkbox"/> Problem solving <input checked="" type="checkbox"/> Decision making	<input type="checkbox"/> Development of independent thinking
Multi-sensory contents	Tactile, visual, smell, kinaesthetic	
Teaching aids	TeachOUT app	
New terms	Abiotic factors; Environment; Ecosystem;	

Introduction:

Water acts as an erosive agent and, simultaneously, as an abiotic factor, affecting the distribution of organisms in the environment.

In ecology, abiotic factors are all the influences that living beings can receive in an ecosystem, derived from the physical, chemical or physicochemical aspects of the environment, such as light and solar radiation, temperature, wind, water, soil composition, pressure and others.

As a landscape-shaping agent, water plays a key role, either through rainfall or through surface water.

Description of exercise:

The students must analyse the information given, which concerns the importance of water (superficial and underground water), and the evolution of the landscape in Monsanto and the ecology associated.

After giving the name of the water point present, the students must recognise the chemical formula that characterizes the water molecule.

The students should collect a sample of water to later analyse in class.

In the classroom afterwards, the answers will be evaluated and discussed.

Pre-field work

Recognize water as an agent shaping the landscape and an important erosive agent.

Know the molecular structure of water.

Post-field work

Analyse the different water samples collected during the field trip.

Examples of everyday use

- Sustainable use of local geological resources (minerals and soil) influences the dynamics of the region's ecosystems.
- The maintenance of the soils physical and chemical properties, determines agricultural production and water quality in aquifers.
- Forest management allows the establishment of plants, the rise of pioneer communities and a balanced organization of ecosystems.
- The poor organization of different human activities can lead to the extinction of species and modification of the dynamics of local ecosystems.
- The role of local people in protecting water resources optimizes the maintenance of these places of great environmental, social and economic importance.

Scenarios for ESTEAM mobile app:

Present the question

Aids for ESTEAM mobile app:

___ pictures, drawings;
please specify:

___ photos
please specify:

___ texts
please specify:

Text file explaining the role of water in the ecological and geological history of Monsanto.

___ sound files
please specify:

Audio file explaining the role of water in the ecological and geological history of Monsanto.

___ video files
please specify:

___ other,
please specify:

Exercise 5: ECOLOGY (Biotic factors)

Selected theme	Ecology	
Subtheme	Biotic Factors	
Class	7th-9th grade (13-15 years old)	
Learning goals	Identify types of biotic relationships. Evaluate the consequences of some biotic relationships in the dynamics of ecosystems. Explain how biotic relationships can lead to the evolution or extinction of species. To describe the influence of abiotic factors (light, water, soil, temperature, wind) on ecosystems. To present examples of adaptations of living beings to the abiotic factors studied. Describe the stages of an ecological succession. Distinguish primary ecological succession from secondary ecological succession.	
Working methodology	<input checked="" type="checkbox"/> Frontal <input checked="" type="checkbox"/> Groupwork <input checked="" type="checkbox"/> Pairwork <input checked="" type="checkbox"/> Individual work	
Learning methodology	<div> <input checked="" type="checkbox"/> Observing <input checked="" type="checkbox"/> Listening to the teacher or a guide <input type="checkbox"/> Experimental <input type="checkbox"/> Playing educational games, role play <input checked="" type="checkbox"/> Taking pictures </div> <div> <input checked="" type="checkbox"/> Self-learning <input type="checkbox"/> Contest <input type="checkbox"/> Orientation <input checked="" type="checkbox"/> Collecting samples and analysing <input type="checkbox"/> Use of maps and navigation <input checked="" type="checkbox"/> Investigative performance </div>	
ESTEAM mobile app challenges	<div> <input checked="" type="checkbox"/> Take a photo <input checked="" type="checkbox"/> Questions and multiple-choice answers with pictures and/or texts <input type="checkbox"/> Write text answer to match a set of possible written answers <input checked="" type="checkbox"/> Write or draw on photo taken <input type="checkbox"/> Make a simple drawing <input type="checkbox"/> Make a short film </div> <div> <input type="checkbox"/> Mark a GPS point on the map with picture and/or comment <input checked="" type="checkbox"/> Find out what you are holding? <input type="checkbox"/> Answer a set of questions, to find out what it is <input type="checkbox"/> Sort into the right box </div>	
Additional knowledge, skills and competences	<div> <input checked="" type="checkbox"/> Teamwork <input checked="" type="checkbox"/> Problem solving <input type="checkbox"/> Decision making </div> <div> <input checked="" type="checkbox"/> Development of independent thinking </div>	
Multi-sensory contents	Tactile, visual, smell, kinaesthetic	
Teaching aids	TeachOUT app	
New terms	Biotic relationships; Intra-specific relations; Inter-specific relations; Symbiosis; Environment; Ecosystem; Evolution; Extinction; Primary ecological succession; Secondary ecological succession;	

Introduction:

Lichens are organisms that result from a symbiosis between a fungus and an organism capable of photosynthesis, in most cases green algae.

Lichens fill in with colour and shape the places where they grow, whether these are trunks and branches of trees (epiphytes), rocks (saxicultural) or soil (earthlings). They also grow in many man-made structures such as roofs and walls. They assume diverse forms, similar to tiny shrubs (fruitful), to leaves (foliaceous) or crusts (crusty lichens).

Lichens are ecologically similar to bryophytes, their content in water varies with that of the atmosphere. Because they have no roots, lichens absorb all the water and nutrients directly from the atmosphere, as well as many pollutants. Some pollutants are lethal to almost all species while others have the opposite effect, depending on species, such as nitrogen. There are lichens that are benefited by their deposition, and others that are harmed. It is for these reasons that lichens are considered excellent biomonitors of atmospheric conditions and their diversity is often used as an ecological indicator of air quality, and even the quality of ecosystem itself.

Description of exercise:

The students must observe the surrounding walls and trees and identify the lichen.

They will listen to an (audio) explanation about the lichen and the type of biotic relationship established, identifying the species involved in this relationship.

They will answer a set of questions in order to identify the type of biotic relationship.

They must identify the species (lichen) from the other species around (mosses).

They must take a picture to analyse later in class.

Pre-field work

- Know different biotic relationships.
- Characterize the biotic relationship established in lichens.

Post-field work

- Compare the different photographs of lichens taken on the field trip in order to distinguish different species.

Examples of everyday use

- Human activities, such as agriculture, ranching and hunting, play a decisive role on food webs.
- Local agriculture should be encouraged in order to ensure product quality and a lesser ecological footprint.
- The role of local people in protecting aquatic ecosystems ensures the maintenance of these sites of great environmental, social and economic importance.
- The organization of farmers into associations of organic farming and crop management benefits agricultural production.

Scenarios for ESTEAM mobile app:

Set of questions

Taking Pictures

Aids for ESTEAM mobile app:

___ pictures, drawings;
please specify:

___ photos
please specify:

___ texts
please specify:

___ sound files
please specify: Explanation about the ecological succession and species involved. Explanation of symbiotic relationship in a lichen.

___ video files
please specify:

___ other,
please specify:

Exercise 6: ECOLOGY (Biodiversity)

Selected theme	Ecology	
Subtheme	Biodiversity (Flora & Fauna)	
Class	7th-9th grade (13-15 years old)	
Learning goals	Describe the levels of biological organization of living beings. Recognize cells as the basic unit of living beings. Present an ecosystem definition. Describe the levels of biological organization of ecosystems. Use the concepts of structure, operation and equilibrium of ecosystems in a practice exercise near the place where the school is located. Present examples of adaptations of organisms related to the different abiotic factors.	
Working methodology	<input checked="" type="checkbox"/> Frontal <input checked="" type="checkbox"/> Groupwork <input checked="" type="checkbox"/> Pairwork <input checked="" type="checkbox"/> Individual work	
Learning methodology	<input checked="" type="checkbox"/> Observing <input type="checkbox"/> Listening to the teacher or a guide <input type="checkbox"/> Experimental <input type="checkbox"/> Playing educational games, role play <input checked="" type="checkbox"/> Taking pictures	<input checked="" type="checkbox"/> Self-learning <input type="checkbox"/> Contest <input type="checkbox"/> Orientation <input checked="" type="checkbox"/> Collecting samples and analysing <input type="checkbox"/> Use of maps and navigation <input checked="" type="checkbox"/> Investigative performance
ESTEAM mobile app challenges	<input checked="" type="checkbox"/> Take a photo <input checked="" type="checkbox"/> Questions and multiple-choice answers with pictures and/or texts <input type="checkbox"/> Write text answer to match a set of possible written answers <input type="checkbox"/> Write or draw on photo taken <input type="checkbox"/> Make a simple drawing <input type="checkbox"/> Make a short film <input type="checkbox"/> Mark a GPS point on the map with picture and/or comment <input checked="" type="checkbox"/> Find out what you are holding? <input type="checkbox"/> Answer a set of questions, to find out what it is <input type="checkbox"/> Sort into the right box	
Additional knowledge, skills and competences	<input checked="" type="checkbox"/> Teamwork <input type="checkbox"/> Problem solving <input checked="" type="checkbox"/> Decision making <input checked="" type="checkbox"/> Development of independent thinking	
Multi-sensory contents	Tactile, visual, smell, kinaesthetic	
Teaching aids	TeachOUT app	
New terms	Biodiversity; Flora; Fauna; Species; Ecosystems; Autochthonous;	

Introduction:

Biodiversity, also called biological diversity, is the variety of life found in a place on Earth or, often, the total variety of life on Earth. A common measure of this variety, called species richness, is the number of species in a designated area.

Biodiversity is variable according to different biomes characteristics: the tropics, for example, have more biodiversity than temperate regions. A general species count is not the only measure of diversity. Furthermore, biodiversity encompasses the genetic variety within each species and the variety of ecosystems that species create.

Although examining the number of species is perhaps the most common method used to compare the biodiversity of various places, in practice biodiversity is weighted differently for different species, the reason being that some species are deemed more valuable or more interesting than others. One way this “value” is assessed is by examining the diversity that exists above the species level, in the genera, families, orders, classes, and phyla to which species belong.

The environment affects living beings, not only for the space necessary for their survival and reproduction, but also for their vital functions, including their behaviour and metabolism. For this reason, the environment determines the number of individuals and species that can live in the same habitat. On the other hand, living beings also permanently alter the environment in which they live.

Description of exercise:

The students should look around the spot they are in.

They must identify the plant species (*Spartium* or *Cytisus*) – autochthonous plant.

They will answer a multiple choice game with questions related to familiar species that describes the plant in question.

They must identify the correct one.

After, they must take a picture of an example of the plant and save it into the data log.

In class, the picture will be analysed and awarded extra points.

Pre-field work

- Recognize the different levels of biological organization.
- Build a sense of biodiversity.
- Know the structure and functioning of an ecosystem.

Post-field work

- Identify plant species on the school grounds, synthesizing distinctive features.

Examples of everyday use

- Global warming from human activities contributes to the greenhouse effect and changes the dynamics of ecosystems.
- The alteration of rocks and soil formation plays an important role in the rise of pioneer communities.
- Human activities, such as agriculture and hunting, play a decisive role in the dynamics of ecosystems.
- Different human activities can have a detrimental effect on local biodiversity.
- The use of traditional ancestral techniques with less environmental impact in agri-food and handicraft production should be encouraged.
- Collaboration between the entities responsible for protected and classified areas and local communities in the management of these sites of increased ecological importance promotes the biodiversity and dynamics of local ecosystems.

Scenarios for ESTEAM mobile app:

The app will provide the question:

What is the autochthonous plant that you can observe in this place:

- a. common broom (*Cytisus* or *Spartium* / giesta)
- b. rosemary (*Lavandula* / rosmarininho)
- c. rockrose (*Cistus* / esteva)
- d. madrones (*Arbutus* / medronheiro)

Take a picture that portrays the plant in question.

The app will allow the picture and save it.

Aids for ESTEAM mobile app:	__ pictures, drawings; please specify: pictures of four different species (multiple choice game)
	__ photos please specify:
	__ texts please specify: Text explaining the characteristics of the plant
	__ sound files please specify:
	__ video files please specify:
	__ other, please specify:

Exercise 7: MAN AND THE ENVIRONMENT (resources)

Selected theme	Man and biosphere	
Subtheme	Resources	
Class	7th-9th grade (13-15 years old)	
Learning goals	<p>Present a natural resource definition. Distinguish energy resources from non-energy resources, with examples. To define renewable resources and non-renewable resources. Identify ways of exploiting natural resources. Describe the main transformations of natural resources. To deduce the impacts of the exploitation and transformation of natural resources.</p>	
Working methodology	<input type="checkbox"/> Frontal <input checked="" type="checkbox"/> Groupwork <input checked="" type="checkbox"/> Pairwork <input checked="" type="checkbox"/> Individual work	
Learning methodology	<input checked="" type="checkbox"/> Observing <input type="checkbox"/> Listening to the teacher or a guide <input type="checkbox"/> Experimental <input type="checkbox"/> Playing educational games, role play <input type="checkbox"/> Taking pictures	<input checked="" type="checkbox"/> Self-learning <input type="checkbox"/> Contest <input type="checkbox"/> Orientation <input type="checkbox"/> Collecting samples and analysing <input type="checkbox"/> Use of maps and navigation <input checked="" type="checkbox"/> Investigative performance
ESTEAM mobile app challenges	<input type="checkbox"/> Take a photo <input checked="" type="checkbox"/> Questions and multiple-choice answers with pictures and/or texts <input type="checkbox"/> Write text answer to match a set of possible written answers <input type="checkbox"/> Write or draw on photo taken <input type="checkbox"/> Make a simple drawing <input type="checkbox"/> Make a short film	
Additional knowledge, skills and competences	<input checked="" type="checkbox"/> Teamwork <input type="checkbox"/> Problem solving <input checked="" type="checkbox"/> Decision making	<input type="checkbox"/> Mark a GPS point on the map with picture and/or comment <input type="checkbox"/> Find out what you are holding? <input type="checkbox"/> Answer a set of questions, to find out what it is <input type="checkbox"/> Sort into the right box <input type="checkbox"/> Development of independent thinking
Multi-sensory contents	Tactile, visual, smell	
Teaching aids	TeachOUT app	
New terms	Natural resources; Renewable resources; Non-renewable resources;	

Introduction:

Nature is full of resources used by humans. Mankind, in general, from the earliest times, has always made use of the goods available in nature for their sustenance.

In the present times, with technological advancements and the increase in the planet's population, this logic is intensified, causing a vast quantity of natural resources to be used and marketed in the world.

Natural resources are of vital importance for the functioning of societies, which means that some have a high strategic value. An example is oil, which is used in the manufacture of various materials, being the subject of disputes between countries for its monopoly.

The unregulated use of the planet's natural resources can lead to its depletion. Non-renewable resources must be preserved and used in a controlled manner. Investment in renewable resources should be a global priority.

Description of exercise:

The students must look around and identify the type of resource (rock) in man-made constructions (medieval castle, chapel and graves).

They should write their answer in the app.

They must take a picture of a section showing a type of rock used in the constructions to be analysed later in the classroom.

Pre-field work

- Discuss the notion of natural resources.
- Distinguish renewable resources from non-renewable resources.
- Discuss the impact of the exhaustive exploitation of natural resources.

Post-field work

- On the way home from school, identify an example of the use of natural resources in buildings or other local infrastructures.
- Present the analysed case to the class, in a classroom setting.

Examples of everyday use

- Plant and animal species must be recognized and valued as biological and ecological heritage, promoting indigenous species and their conservation.
- Agriculture, livestock, hunting and nature tourism are directly related to the environment and are key economic areas in local development.
- Natural resources are extremely important to the local and national economy.
- Knowledge of the different types of minerals and rocks, in terms of formation and composition, allows to rationally define their use.
- Knowledge of rock formation processes allows a sustainable approach to its daily application.

Scenarios for ESTEAM mobile app:

Present the question:

What is the type of rock used in human-made constructions seen (medieval castle, chapel and graves)?

Acknowledge the answer: granite; magmatic rock; plutonic rock.

Allow the taking of a picture and data saving.

Aids for ESTEAM mobile app:

___ pictures, drawings;
please specify:

	__ photos please specify:
	__ texts please specify: question and possible answers
	__ sound files please specify:
	__ video files please specify:
	__ other, please specify:

Exercise 8: MAN AND THE ENVIRONMENT (Impact of man on environment)

Selected theme	Man and biosphere	
Subtheme	Impact of man on the environment	
Class	7th-9th grade (13-15 years old)	
Learning goals	Associate human interventions with impacts on geological processes (atmosphere, hydrosphere and lithosphere). Extrapolate the impact of population growth on resource consumption, the environment and sustainability of life on Earth. Indicate impacts of human action that contribute to the change in the dynamics of food webs. Discuss measures to minimize the impact of human action on changing the dynamics of ecosystems. Present a definition of sustainable development. Extrapolate how pollution, deforestation, fires and biological invasions affect the balance of ecosystems. Construct a summary of an existing environmental problem in the region where the school is located, indicating possible ways to minimize damage, in the form of a letter addressed to a nature conservation organization or a project work.	
Working methodology	<input type="checkbox"/> Frontal <input checked="" type="checkbox"/> Groupwork <input type="checkbox"/> Pairwork <input type="checkbox"/> Individual work	
Learning methodology	<input checked="" type="checkbox"/> Observing <input checked="" type="checkbox"/> Listening to the teacher or a guide <input type="checkbox"/> Experimental <input type="checkbox"/> Playing educational games, role play <input checked="" type="checkbox"/> Taking pictures	<input checked="" type="checkbox"/> Self-learning <input type="checkbox"/> Contest <input checked="" type="checkbox"/> Orientation <input checked="" type="checkbox"/> Collecting samples and analysing <input type="checkbox"/> Use of maps and navigation <input checked="" type="checkbox"/> Investigative performance
ESTEAM mobile app challenges	<input checked="" type="checkbox"/> Take a photo <input type="checkbox"/> Questions and multiple-choice answers with pictures and/or texts <input type="checkbox"/> Write text answer to match a set of possible written answers <input type="checkbox"/> Write or draw on photo taken <input type="checkbox"/> Make a simple drawing <input checked="" type="checkbox"/> Make a short film	<input checked="" type="checkbox"/> Mark a GPS point on the map with picture and/or comment <input type="checkbox"/> Find out what you are holding? <input type="checkbox"/> Answer a set of questions, to find out what it is <input type="checkbox"/> Sort into the right box
Additional knowledge, skills and competences	<input checked="" type="checkbox"/> Teamwork <input type="checkbox"/> Problem solving <input checked="" type="checkbox"/> Decision making	<input checked="" type="checkbox"/> Development of independent thinking
Multi-sensory contents	Visual, tactile, smell, auditory, kinaesthetic	
Teaching aids	TeachOUT app	
New terms	Pollution; Environment; Atmosphere; Lithosphere; Hydrosphere; Sustainable development; Human impact on the environment;	

Introduction:

Each one of us, in his/her daily life, cause a certain impact on nature and on the planet. Our choices as consumers, the way we move, the amount of waste we produce and even the type of food we consume imply the use of a certain portion of natural resources. The ecological footprint translates the area of productive land (soil and sea) needed to produce these resources and assimilate the waste produced by a citizen or a particular population.

Sustainable development presupposes concern not only with the present but also with the quality of life of future generations. The protection of vital resources and the pursuit of economic growth, which is friendly to the environment and to people, is key to safeguarding ecosystems.

Man's attitude toward the environment and the adoption of behaviours that indicate actions that are characteristic of good environmental practices are decisive in reducing the impact of man on the environment.

Description of exercise:

This is the first station of the trail.

There will be information about the location and about the Naturtejo geopark provided via the app by a short video.

After that, the monitor should explain the course and type of tasks / questions that the students will find ahead.

There will be a small presentation about the protection of nature and care during the course.

Students should collect the rubbish they encounter during the course and note / mark locations where environmental problems or situations of pollution or the impact of man on the environment are detected. They should take notes, take pictures and/or make a small video that allows them to present the problem, in the following days, to the local authorities with responsibility with the environment.

This shall be an exercise to organise in the classroom, in the days following the realization of the trail

Pre-field work

- Relate the four terrestrial subsystems.
- Discuss the notion of ecological footprint.
- Analyse individual and global behaviours, and determine their positive or negative impact on the environment.

Post-field work (Examples of everyday use)

- Give the appropriate destination for the rubbish collected during the journey.
- Organize the information collected during the trail regarding to a situation of serious pollution or a negative environmental impact detected. Present the situation to the competent organizations or municipal environmental officials with an explanation of the situation and accompanied by testimonies, photographic evidence or video recording.

Examples of everyday use

- Sustainable use of local geological resources (minerals and soil) influences the dynamics of the region's ecosystems.
- The maintenance of the soils physical and chemical properties determines agricultural production and water quality in aquifers.
- Forest management allows the establishment of plants, the rise of pioneer communities and a balanced organization of ecosystems.
- The poor organization of different human activities can lead to the extinction of species and modification of the dynamics of local ecosystems.
- The role of local people in protecting water resources optimizes the maintenance of these places of great environmental, social and economic importance.

Scenarios for ESTEAM mobile app:

Presentation of educational video.

Picture taking (to be made along the course, at different spots).

Video making (to be made along the course, at a chosen spot).

Aids for ESTEAM mobile app:	__ pictures, drawings; please specify:
	__ photos please specify:
	__ texts please specify:
	__ sound files please specify:
	Explanation of the way the students should do the work
	__ video files please specify:
	Presentation of the Geopark Naturtejo
	__ other, please specify:

Exercise 9: MAN AND THE ENVIRONMENT (Impact of man on the environment)

Selected theme	Man and biosphere	
Subtheme	Impact of man on environment	
Class	7th-9th grade (13-15 years old)	
Learning goals	Identify ways of exploiting natural resources. Describe the main transformations of natural resources Deduce the impacts of the exploitation and transformation of natural resources. Extrapolate the impact of population growth on resource consumption, the environment and the sustainability of life on Earth.	
Working methodology	<input checked="" type="checkbox"/> Frontal <input checked="" type="checkbox"/> Groupwork <input checked="" type="checkbox"/> Pairwork <input checked="" type="checkbox"/> Individual work	
Learning methodology	<input checked="" type="checkbox"/> Observing <input checked="" type="checkbox"/> Listening to the teacher or a guide <input type="checkbox"/> Experimental <input type="checkbox"/> Playing educational games, role play <input type="checkbox"/> Taking pictures	<input checked="" type="checkbox"/> Self-learning <input type="checkbox"/> Contest <input type="checkbox"/> Orientation <input type="checkbox"/> Collecting samples and analysing <input type="checkbox"/> Use of maps and navigation <input checked="" type="checkbox"/> Investigative performance
ESTEAM mobile app challenges	<input type="checkbox"/> Take a photo <input checked="" type="checkbox"/> Questions and multiple-choice answers with pictures and/or texts <input type="checkbox"/> Write text answer to match a set of possible written answers <input type="checkbox"/> Write or draw on photo taken <input type="checkbox"/> Make a simple drawing <input type="checkbox"/> Make a short film	<input type="checkbox"/> Mark a GPS point on the map with picture and/or comment <input type="checkbox"/> Find out what you are holding? <input type="checkbox"/> Answer a set of questions, to find out what it is <input type="checkbox"/> Sort into the right box
Additional knowledge, skills and competences	<input checked="" type="checkbox"/> Teamwork <input checked="" type="checkbox"/> Problem solving <input type="checkbox"/> Decision making	<input checked="" type="checkbox"/> Development of independent thinking
Multi-sensory contents	Tactile, visual, auditory, kinaesthetic	
Teaching aids	TeachOUT app	
New terms	Natural resources; Natural resources exploitation; sustainability of life on earth;	

Introduction:

Located in a cliff that imposes itself when looking at most horizons, the Historic Village of Monsanto in Portugal has a singular charm, for which contribute the two titles attributed in the century. XX - Most Portuguese Village of Portugal in 1938, and Aldeia Histórica in 1995. Tourist icon of the region, Monsanto is a peculiar experience for those who visit it. The oldest part is at the highest point, where the Templars built a wall with a keep.

Monsanto lies to the northeast of the lands of Idanha, nestled on the slope of a steep rise - Monsanto's head (Mons Sanctus) - which erupts abruptly into the meadow. At its highest point, it reaches to

758 meters. Through the various hillsides and at the foot of the mountain, there are scattered villages, attesting to the population displacement towards the plain. Monsanto is one of the few Portuguese settlements where adufe appears as the only instrument to accompany singing in folk music. It is also in Monsanto that the art of playing the "adufe" by the women of the area is distinguished by its complexity and rhythmic richness.

Description of exercise:

The students are at a sightseeing point where they can appreciate the surroundings of the village.

They will listen to a brief explanation about the historic village, the construction of handicrafts through the use of local natural products, popular traditions, geological landscapes and typical products. They will be enlightened about the «adufes and marafonas» craftsmanship.

After this, the students will answer a question, which is related to the typical local instrument: adufe.

They will be invited to perform and create a short video playing the «adufe».

Pre-field work

- Brief presentation on the history of Monsanto: its traditions and local products.

Post-field work

- Talk with family and friends and elaborate on the importance of the «adufe» in the local culture.
- Collect local traditions associated with the village's traditions and folklore.

Examples of everyday use

- Plant and animal species must be recognized and valued as biological and ecological heritage, promoting indigenous species and their conservation.
- Agriculture, livestock, hunting and nature tourism are directly related to the environment, and are key economic areas in local development.
- Natural resources are extremely important to the local and national economy.

Scenarios for ESTEAM mobile app:

Present an explanation of Monsanto's history and traditions (video).

Present the question: »What are called the local women who play the adufe, a typical Beira Interior instrument?« and allow for a the multiple-answer type of question.

Enable the making of a video.

Aids for ESTEAM mobile app:

___ pictures, drawings;
please specify:

___ photos
please specify:

___ texts
please specify:

Explanation of Monsanto's history and traditions

___ sound files
please specify:
Musical instrument sounds

___ video files
please specify:
explanation of Monsanto 's history and traditions

___ other,
please specify:

5.4. EXERCISES AT THE HESTNES TRAIL

Description of Hestnes Trail

Hestnes is an area close to urban Egersund, but it is untouched by development and valued as an important area for recreational activities for locals in Egersund. The nature is diverse, and the trails are well taken care of and allow for hiking and jogging. There are several viewpoints where visitors can linger in the beauty of the North Sea or the natural sound of Egersund. There are also quiet coves and benches along the trail, where you can enjoy a snack or even a picnic surrounded by nature.

The diversity of nature in this area makes it ideal for educational purposes. There are bare mountains, a deciduous forest, the sea, coastline, remains from WW2 fortifications, industrial areas at the start of the trail, proximity to schools and the city centre, and a rich variety of birds and wildlife.

There are several trails in the Hestnes area, but the one we are using in our testing is about 4 km. However, the kids need to return the same way to get back to school, so for some of them it is a bit of a workout. The trail is also demanding physically as it has quite a few taxing uphill sections.



Exercise 1: GEOLOGY (Rock cycle)

Selected theme	<input checked="" type="checkbox"/> Geology <input type="checkbox"/> Ecology <input type="checkbox"/> Men and biosphere	
Subtheme	Rock cycle	
Class	8th to 10th grade.	
Learning goals	<p>NATURAL SCIENCE SUBJECT CURRICULUM Competence aims after Year Level 10</p> <ul style="list-style-type: none"> - explain the main characteristics of theories on how the earth is changing and has changed over the eons, and the underpinning of these theories <p>SOCIAL STUDIES SUBJECT CURRICULUM Competence aims after Year Level 10</p> <ul style="list-style-type: none"> - explain the basic forces of nature, focusing on the internal and external forces on the Earth, movement in air masses, circulation of water, weather, climate and vegetation, and discuss and elaborate on the relationship between nature and society 	
Working methodology	<input type="checkbox"/> Frontal <input checked="" type="checkbox"/> Group work <input type="checkbox"/> Pairwork <input type="checkbox"/> Individual work	
Learning methodology	<input type="checkbox"/> Observing <input type="checkbox"/> Listening to the teacher or a guide <input type="checkbox"/> Taking pictures <input type="checkbox"/> Experimental <input type="checkbox"/> Playing educational games, role play <input type="checkbox"/> Self-learning <input type="checkbox"/> Contest	<input type="checkbox"/> Orientation <input type="checkbox"/> Collecting samples and analysing <input type="checkbox"/> Use of maps and navigation <input type="checkbox"/> Investigative performance <input type="checkbox"/> Other. Please, specify:
ESTEAM mobile app challenges	<input type="checkbox"/> Take photo <input type="checkbox"/> Questions and multiple-choice answers with pictures and/or texts <input type="checkbox"/> Write text answer to match a set of possible written answers <input type="checkbox"/> Write or draw on photo taken <input type="checkbox"/> Make a simple drawing	<input type="checkbox"/> Make a short film <input type="checkbox"/> Mark a GPS point on the map with picture and/or comment <input type="checkbox"/> Find out what you are holding? <input type="checkbox"/> Answer a set of questions, to find out what it is
Additional knowledge, skills and competences	<input type="checkbox"/> Teamwork <input type="checkbox"/> Problem solving <input type="checkbox"/> Decision making	<input type="checkbox"/> Development of independent thinking <input type="checkbox"/> Other. Please, specify: _____
Multi-sensory contents	Audio, visual, kinaesthetic, tactile	
Teaching aids	<ul style="list-style-type: none"> • TeachOut app 	

	<ul style="list-style-type: none"> • Smartphone <p>Before fieldwork – in the classroom: Easy description of the rock cycle http://www.nhm.uio.no/skoletilbud/undervisningsopplegg/hovedoya/geologi/bergarter-mineraler/bergartssyklusen/</p> <p>Animation of the rock cycle and other cycles in nature http://geologiskolen.uit.no/generellGeologiskolen/prosesser/kretslop/bergartssyklus.html</p> <p>How to work as a geologist in the field (in Norwegian, but with great samples from the rock cycle from the field).</p>
New terms	Traces after the ice, anorthosite, formations, landforms

Description of exercise: Task 5 The pupils will go to the designated GPS point “task 2.2” and work on the task: “Anorthosite is a very stable rock. It looks like it did when it was formed by the ice 930 million years ago in the core of the Earth. Take photos of different rock formations and traces of the ice that you can see in the area around Erna. Mark with arrows or drawings on the photos how, and in which direction you think these formations were shaped.”	
Scenarios for ESTEAM mobile app: <ul style="list-style-type: none"> • Get the following task when they reach the designated GPS point: “Anorthosite is a very stable rock. It looks like it did when it was formed by the ice 930 million years ago in the core of the Earth. Take photos of different rock formations and traces of the ice that you can see in the area around Erna. Mark with arrows or drawings on the photos how, and in which direction you think these formations were shaped.” • Take photos • Draw and write on photos • Use GPS to find task 	
Description of example in everyday use: <ul style="list-style-type: none"> • Knowledge used to explain and prove the constant continental drift on Earth. • Miners use information on local rocks when they extract minerals and rocks. • Information used for planning housing development and industrial development. • Information on bedrock and minerals are used for the calculation of agricultural potential, and natural resources. • Ability to recreate the processes that have shaped the landscape; ice and water. 	
Aids for ESTEAM mobile app:	__ pictures, drawings; please specify:
	x photos please specify: take photos of rock formations and traces of the ice.
	x texts please specify: the task
	__ sound files please specify:
	__ video files please specify:
	x other , please specify: draw/write on photos

Exercise 2: GEOLOGY (Rocks)

Selected theme	<input checked="" type="checkbox"/> Geology <input type="checkbox"/> Ecology <input type="checkbox"/> Men and biosphere	
Subtheme	Rocks and geological map	
Class	8th to 10th grade. Geology is normally part of 8th grade, but this is up to the different schools.	
Learning goals	NATURAL SCIENCE SUBJECT CURRICULUM Competence aims after Year Level 10 - explain the main characteristics of theories on how the earth is changing and has changed over the eons, and the underpinning of these theories SOCIAL STUDIES SUBJECT CURRICULUM Competence aims after Year Level 10 - explain the basic forces of nature focusing on the internal and external forces on the Earth, movement in air masses, circulation of water, weather, climate and vegetation, and discuss and elaborate on the relationship between nature and society	
Working methodology	<input type="checkbox"/> Frontal <input checked="" type="checkbox"/> Group work <input type="checkbox"/> Pairwork <input type="checkbox"/> Individual work	
Learning methodology	<div> <input type="checkbox"/> Observing <input type="checkbox"/> Listening to the teacher or a guide <input type="checkbox"/> Taking pictures <input type="checkbox"/> Experimental <input type="checkbox"/> Playing educational games, role play <input type="checkbox"/> Self-learning <input type="checkbox"/> Contest </div> <div> <input type="checkbox"/> Orientation <input type="checkbox"/> Collecting samples and analysing <input type="checkbox"/> Use of maps and navigation <input type="checkbox"/> Investigative performance <input type="checkbox"/> Other. Please, specify: </div>	
ESTEAM mobile app challenges	<div> <input type="checkbox"/> Take a photo <input type="checkbox"/> Questions and multiple-choice answers with pictures and/or texts <input type="checkbox"/> Write text answer to match a set of possible written answers <input type="checkbox"/> Write or draw on photo taken <input type="checkbox"/> Make a simple drawing </div> <div> <input type="checkbox"/> Make a short film <input type="checkbox"/> Mark a GPS point on the map with picture and/or comment <input type="checkbox"/> Find out what you are holding? <input type="checkbox"/> Answer a set of questions, to find out what it is </div>	
Additional knowledge, skills and competences	<div> <input type="checkbox"/> Teamwork <input type="checkbox"/> Problem solving <input type="checkbox"/> Decision making </div> <div> <input type="checkbox"/> Development of independent thinking <input type="checkbox"/> Other. Please, specify: </div>	
Multi-sensory contents	Visual, auditive, kinaesthetic	
Teaching aids	<ul style="list-style-type: none"> • TeachOut app • Smartphone • Geological maps of Norway https://www.ngu.no 	
New terms	Relative age, geological map, sedimentary rocks, metamorphic rocks, igneous rocks, mineral.	

Description of exercise:**Task 1**

This is an ongoing exercise. The pupils will get it at the start of the trail:

“Mark along the way on the map with the GPS when you find, watch and observe interesting geological findings. Write what you think it is on the photo. Print the map with all your findings when you are back in the classroom. Present the maps to each other and discuss the findings.”

Scenarios for ESTEAM mobile app:

- Mark GPS points through the entire trail (waypoints).
- Take photos connected to the GPS points.
- Write on photos
- Download satellite photo with all the GPS points integrated after the field work - and print

Description of example in everyday use:

- Being able to use a GPS, and to mark GPS points is a skill that is useful in many industries and professions.
- Being aware of your surroundings is mindfulness and part of being present in the now. Both kids and adults need to focus on where they are, not where they've been or where they are going. It's good for mental health.
- To be aware of the variety in geological phenomena in your local area is useful for geologists, but also for people who have a greater interest in the uniqueness of their local landscape and geological heritage. Seeing the different geological findings will trigger questions, and this will enhance curiosity and learning.

Aids for ESTEAM mobile app:

__ pictures, drawings;
please specify

x **photos**
please specify: take photos of geological findings

x **texts**
please specify:

- write on photos
- Task is written

__ sound files
please specify:

__ video files
please specify:

x **other**,
please specify: get the waypoints in printable version with photos and notes.

Exercise 3: GEOLOGY (Landforms)

Selected theme	<input checked="" type="checkbox"/> Geology <input type="checkbox"/> Ecology <input type="checkbox"/> Men and biosphere	
Subtheme	Landforms	
Class	8th to 10th grade	
Learning goals	<p>NATURAL SCIENCE SUBJECT CURRICULUM Competence aims after year level 10</p> <ul style="list-style-type: none"> Explain the main characteristics of theories on how the earth is changing and has changed over the eons and the underpinning of these theories. <p>SOCIAL STUDIES SUBJECT CURRICULUM Competence aims after year level 10</p> <ul style="list-style-type: none"> Explain the basic forces of nature, focusing on the internal and external forces on the Earth, movement in air masses, circulation of water, weather, climate and vegetation, and discuss and elaborate the relationship between nature and society. Describe and explain the natural and cultural landscapes in the local community. 	
Working methodology	<input type="checkbox"/> Frontal <input checked="" type="checkbox"/> Groupwork <input type="checkbox"/> Pairwork <input type="checkbox"/> Individual work	
Learning methodology	<input type="checkbox"/> Observing <input type="checkbox"/> Listening to the teacher or a guide <input type="checkbox"/> Taking pictures <input type="checkbox"/> Experimental <input type="checkbox"/> Playing educational games, role play <input type="checkbox"/> Self-learning <input type="checkbox"/> Contest	<input type="checkbox"/> Orientation <input type="checkbox"/> Collecting samples and analysing <input type="checkbox"/> Use of maps and navigation <input type="checkbox"/> Investigative performance <input type="checkbox"/> Other. Please, specify:
ESTEAM mobile app challenges	<input type="checkbox"/> Take a photo <input type="checkbox"/> Questions and multiple-choice answers with pictures and/or texts <input type="checkbox"/> Write text answer to match a set of possible written answers <input type="checkbox"/> Write or draw on photo taken <input type="checkbox"/> Make a simple drawing	<input type="checkbox"/> Make a short film <input type="checkbox"/> Mark a GPS point on the map with picture and/or comment <input type="checkbox"/> Find out what you are holding? <input type="checkbox"/> Answer a set of questions, to find out what it is
Additional knowledge, skills and competences	<input type="checkbox"/> Teamwork <input type="checkbox"/> Problem solving <input type="checkbox"/> Decision making	<input type="checkbox"/> Development of independent thinking <input type="checkbox"/> Other. Please, specify:
Multi-sensory contents	Visual, kinaesthetic	

Teaching aids	<ul style="list-style-type: none"> Norwegian web page with basic information on how the ice has changed and formed our landscape: https://www.viten.no/vitenprogram/vis.html?tid=1065511 Smartphone TeachOut
New terms	Landforms, weathered rocks, erratic boulders, stress marks.

Description of exercise: The pupils will go to the designated GPS point “task 2.1” and work on the task: “Some landforms are created by humans, others by nature. Take photos of different landforms and sort them into the right box. Mark your findings with the GPS and write what it is”.	
Scenarios for ESTEAM mobile app: When the task opens, pupils will get a written task: “Some landforms are created by humans, others by nature. Take photos of different landforms and sort them into the right box. Mark your findings with the GPS and write what it is”. <div style="display: flex; justify-content: space-around; margin-top: 20px;"> <div style="border: 1px solid black; background-color: #d9e1f2; padding: 20px; width: 40%; text-align: center;"> <p>Made by man</p> </div> <div style="border: 1px solid black; background-color: #d9e1f2; padding: 20px; width: 40%; text-align: center;"> <p>Made by nature</p> </div> </div> <p>The pupils must be able to take photos of the landforms, and mark GPS- points at their findings. They must also be able to transfer the GPS- points to a satellite photo and get it digitally. Need access to https://www.viten.no/vitenprogram/vis.html?tid=1065511 and our information bank in the field.</p>	
Description of example in everyday use: <ul style="list-style-type: none"> It is important to be able to describe and explain the natural and cultural landscapes in the local community to be active contributors within our local area. Preserving cultural heritage is part of our duty - to pass on to new generations. Teachers, people working in museums, scientist are all working in preserving it for future generations. To trigger curiosity, pupils should be taught how to investigate and ask questions. These are important skills for scientists and researchers. Using GPS is a skill that is useful in several occupations, and also when hiking and enjoying nature. 	
Aids for ESTEAM mobile app:	__ pictures, drawings; please specify:
	__ x photos please specify: taking photos
	__ texts

	please specify:
	__ sound files please specify:
	__ video files please specify:
	__ x other , please specify: <ul style="list-style-type: none">• Sort into boxes• GPS- points into satellite photo

Exercise 4: ECOLOGY (Abiotic factors)

Selected theme	<input type="checkbox"/> Geology <input checked="" type="checkbox"/> Ecology <input type="checkbox"/> Men and biosphere	
Subtheme	Abiotic factors (water, soil, temperature, light)	
Class	8th - 10th grade	
Learning goals	<p>NATURAL SCIENCE SUBJECT CURRICULUM Competence aims after Year Level 10</p> <ul style="list-style-type: none"> - investigate and register biotic and abiotic factors in a local ecosystem and explain the relationship between these factors <p>SOCIAL STUDIES SUBJECT CURRICULUM Competence aims after Year Level 10</p> <ul style="list-style-type: none"> - explain the basic forces of nature, focusing on the internal and external forces on the Earth, movement in air masses, circulation of water, weather, climate and vegetation, and discuss and elaborate on the relationship between nature and society 	
Working methodology	<input type="checkbox"/> Frontal <input type="checkbox"/> Groupwork <input type="checkbox"/> Pairwork <input type="checkbox"/> Individual work	
Learning methodology	<input type="checkbox"/> Observing <input type="checkbox"/> Listening to the teacher or a guide <input type="checkbox"/> Taking pictures <input type="checkbox"/> Experimental <input type="checkbox"/> Playing educational games, role play <input type="checkbox"/> Self-learning <input type="checkbox"/> Contest	<input type="checkbox"/> Orientation <input type="checkbox"/> Collecting samples and analysing <input type="checkbox"/> Use of maps and navigation <input type="checkbox"/> Investigative performance <input type="checkbox"/> Other. Please, specify:
ESTEAM mobile app challenges	<input type="checkbox"/> Take a photo <input type="checkbox"/> Questions and multiple-choice answers with pictures and/or texts <input type="checkbox"/> Write text answer to match a set of possible written answers <input type="checkbox"/> Write or draw on photo taken <input type="checkbox"/> Make a simple drawing	<input type="checkbox"/> Make a short film <input type="checkbox"/> Mark a GPS point on the map with picture and/or comment <input type="checkbox"/> Find out what you are holding? <input type="checkbox"/> Answer a set of questions, to find out what it is <input type="checkbox"/> Sort into the right box
Additional knowledge, skills and competences	<input type="checkbox"/> Teamwork <input type="checkbox"/> Problem solving <input type="checkbox"/> Decision making	<input type="checkbox"/> Development of independent thinking <input type="checkbox"/> Other. Please, specify:
Multi-sensory contents	visual, kinaesthetic, tactile	
Teaching aids	TeachOut and smartphone	
New terms	Abiotic factors; sun and shade	

Description of exercise:**Task 1**

The pupils go to the designated GPS point for task 3.1 and work on this:

"Plants that grow in the shade and in the sun, respectively, often have leaves that look different. Can you describe some typical differences and take pictures of different examples of these? Place them in the right box."

Plants in sun

Plants in shadow

Scenarios for ESTEAM mobile app:

- Get task: "Plants that grow in the shade and in the sun, respectively, often have leaves that look different. Can you describe some typical differences and take pictures of different examples of these? Place them in the right box."
- They need "boxes" to sort the plants into:

Plants in sun

Plants in shadow

- There must be a question appearing after the sorting is done: "In general; what will you say are the most distinct differences between plants growing in the shade and plants that grow in the sun". The pupils will deliver a written sentence to this answer, which will then be included in the final report.

Description of example in everyday use:

- Knowledge about how abiotic factors affect plants and biotic factors are crucial for farmers and agriculture.
- Knowing what to look for in terms of the optimum conditions for plants and grain will help producers optimize their land and harvest.
- Climate change introduces new challenges in agriculture. Farmers and producers must think in new directions, when it comes to preparing for extreme conditions (heat, cold, wind) and using the elements as resources instead of thinking of it as the enemy.

Aids for ESTEAM mobile app:	__ pictures, drawings; please specify:
	x photos please specify: The pupils must be able to take photos of the different plants before sorting them into the right box.
	x texts please specify: <ul style="list-style-type: none"> • The task • The pupils must answer a question at the end of the task in writing.
	__ sound files please specify:
	__ video files please specify:
	x other, please specify: The pupils needs to sort the photos into the right box.

Exercise 5: ECOLOGY (Biotic factors)

Selected theme	<input type="checkbox"/> Geology <input checked="" type="checkbox"/> Ecology <input type="checkbox"/> Men and biosphere	
Subtheme	Biotic factors (a living thing, as an animal or plant , that influences or affects an ecosystem)	
Class	8th to 10th grade	
Learning goals	NATURAL SCIENCE SUBJECT CURRICULUM Competence aims after Year Level 10 <ul style="list-style-type: none"> investigate and register biotic and abiotic factors in a local ecosystem and explain the relationship between these factors 	
Working methodology	<input type="checkbox"/> Frontal <input type="checkbox"/> Groupwork <input type="checkbox"/> Pairwork <input type="checkbox"/> Individual work	
Learning methodology	<div> <input type="checkbox"/> Observing <input type="checkbox"/> Listening to the teacher or a guide <input type="checkbox"/> Taking pictures <input type="checkbox"/> Experimental <input type="checkbox"/> Playing educational games, role play <input type="checkbox"/> Self-learning <input type="checkbox"/> Contest </div> <div> <input type="checkbox"/> Orientation <input type="checkbox"/> Collecting samples and analysing <input type="checkbox"/> Use of maps and navigation <input type="checkbox"/> Investigative performance <input type="checkbox"/> Other. Please, specify: put photo in the right box </div>	
ESTEAM mobile app challenges	<div> <input type="checkbox"/> Take a photo <input type="checkbox"/> Questions and multiple-choice answers with pictures and/or texts <input type="checkbox"/> Write text answer to match a set of possible written answers <input type="checkbox"/> Write or draw on photo taken <input type="checkbox"/> Make a simple drawing </div> <div> <input type="checkbox"/> Make a short film <input type="checkbox"/> Mark a GPS point on the map with picture and/or comment <input type="checkbox"/> Find out what you are holding? <input type="checkbox"/> Answer a set of questions, to find out what it is </div>	
Additional knowledge, skills and competences	<div> <input type="checkbox"/> Teamwork <input type="checkbox"/> Problem solving <input type="checkbox"/> Decision making </div> <div> <input type="checkbox"/> Development of independent thinking <input type="checkbox"/> Other. Please, specify: _____ </div>	
Multi-sensory contents	Visual, auditive, kinaesthetic, tactile	
Teaching aids	<ul style="list-style-type: none"> Need to put the terms manufacturers, consumers and breakers into our dictionary. Species data bank https://www.artsdatabanken.no Smartphone TeachOut 	
New terms	Manufacturers, consumers, breakers, ecosystem, biotic factors	

Description of exercise:**Task 3**

The pupils will go to the designated GPS point, task 3.3, and work on the task:

“The ecosystem; by the stream. How many **manufacturers, consumers and breakers** can you find? Take pictures and place in the correct box.”

Scenarios for ESTEAM mobile app:

Get the task: **“The ecosystem;** by the stream. How many **manufacturers, consumers and breakers** can you find? Take pictures and place in the correct box.”

The pupils will take **photos** of different insects and small animals found by the stream and **sort** them into the right box:

Producers	Consumers	Decomposers
-----------	-----------	-------------

Description of example in everyday use:

- For farmers and people working close with nature, knowledge of the different workers in an ecosystem is important to develop sustainable systems for preserving the natural, cultural and agricultural heritage.
- The general public is starting to be more aware of the fact that all products have a “circle of life”. Recycling at home make us more involved in the natural process of decomposition. Knowledge regarding the different participants in a ecosystem will help us understand these processes, and also to understand our part in the ecosystem - both locally and globally.
- To touch and study insects is a good way for young children to develop curiosity in life - and the Natural Sciences. To be able to recognise different insects or small animals will help them to foster a sense of empathy and a sense of belonging. It is also more likely that kids who know more about the biological diversity on this planet, will grow to love and take care of her.

Aids for ESTEAM mobile app:

__ pictures, drawings;

please specify:

x__ **photos**

please specify:

__ texts

please specify:

__ sound files

please specify:

__ video files

please specify:

x__ other,

please specify: **sort photos into boxes to classify.**

Exercise 6: ECOLOGY (Biodiversity)

Selected theme	<input type="checkbox"/> Geology <input checked="" type="checkbox"/> Ecology <input type="checkbox"/> Men and biosphere	
Subtheme	Biodiversity	
Class	8th to 10th grade	
Learning goals	<p>NATURAL SCIENCE SUBJECT CURRICULUM</p> <p>Competence aims after Year Level 10</p> <ul style="list-style-type: none"> collect and process natural science data, calculate and produce results graphically investigate and record biotic and abiotic factors in an ecosystem in the immediate area, and explain the relationships between these factors <p>GENERAL PART OF THE CURRICULUM</p> <ul style="list-style-type: none"> Fostering must emphasize the connection between the understanding of nature, and experiencing nature: knowledge about the elements and interactions in the living environment, must go along with the recognition that we depend on other species, interact with them and enjoy nature. 	
Working methodology	<input type="checkbox"/> Frontal <input type="checkbox"/> Group work <input type="checkbox"/> Pairwork <input type="checkbox"/> Individual work	
Learning methodology	<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <input type="checkbox"/> Observing <input type="checkbox"/> Listening to the teacher or a guide <input type="checkbox"/> Taking pictures <input type="checkbox"/> Experimental <input type="checkbox"/> Playing educational games, role play <input type="checkbox"/> Self-learning <input type="checkbox"/> Contest </div> <div style="width: 45%;"> <input type="checkbox"/> Orientation <input type="checkbox"/> Collecting samples and analysing <input type="checkbox"/> Use of maps and navigation <input type="checkbox"/> Investigative performance <input type="checkbox"/> Other. Please, specify: Question tree. </div> </div>	
ESTEAM mobile app challenges	<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <input type="checkbox"/> Take a photo <input type="checkbox"/> Questions and multiple-choice answers with pictures and/or texts <input type="checkbox"/> Write text answer to match a set of possible written answers <input type="checkbox"/> Write or draw on photo taken <input type="checkbox"/> Make a simple drawing </div> <div style="width: 45%;"> <input type="checkbox"/> Make a short film <input type="checkbox"/> Mark a GPS point on the map with picture and/or comment <input type="checkbox"/> Find out what you are holding? <input type="checkbox"/> Answer a set of questions, to find out what it is </div> </div>	
Additional knowledge, skills and competences	<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <input type="checkbox"/> Teamwork <input type="checkbox"/> Problem solving <input type="checkbox"/> Decision making </div> <div style="width: 45%;"> <input type="checkbox"/> Development of independent thinking <input type="checkbox"/> Other. Please, specify: _____ </div> </div>	
Multi-sensory contents	Visual, audio, tactile, kinaesthetic	

Teaching aids	<ul style="list-style-type: none"> • TeachOut • Smartphone • Web Page with facts and taxonomy, in Norwegian, about common bird and plant species in Norway. http://www.naturfakta.no/planter/
New terms	Species

Description of exercise:

Task 2

The pupils will go to the designated GPS point, task 3.2, and work on the task:

“How many different **species** of trees can you find? Use the question tree to classify your findings in this area.”

Scenarios for ESTEAM mobile app:

Access to web page (<http://www.naturfakta.no/planter/>) in the description of the task.

Get the task: “How many different **species** of trees can you find? Use the question tree to classify your findings in this area.”

Question tree:

Needles? Short needles? Hard needles? Bush? Juniper bush

Tree? Spruce tree

Soft needles? Larch

Long needles? Pine

Leaves? Brown trunk? Whole leaf? Round leaf? Nuts? Hazel

Small pinecones? Alder

Long leaf? Oak

Many small leaves? Rowan

White trunk? - Birch

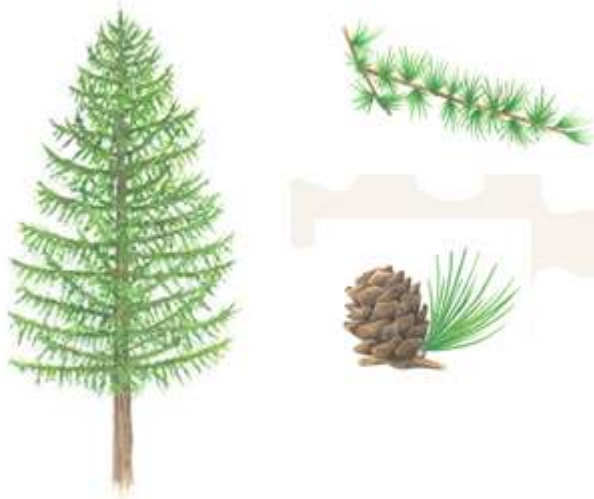
Juniper bush:



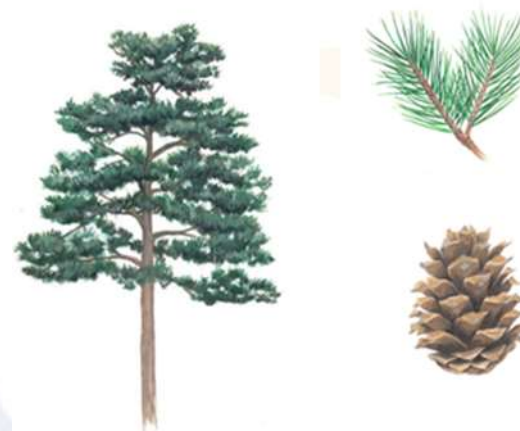
Spruce tree:



Larch:



Pine:



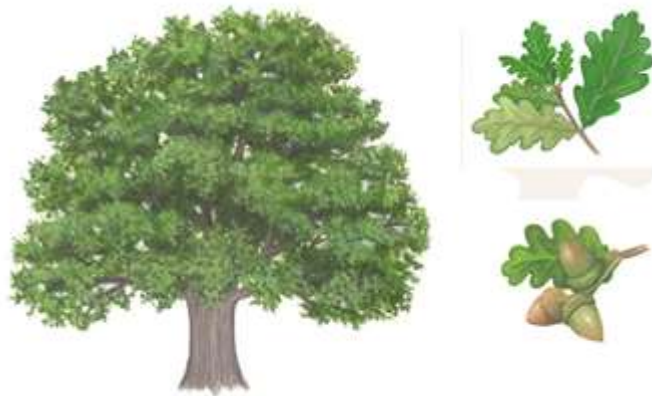
Hazel:



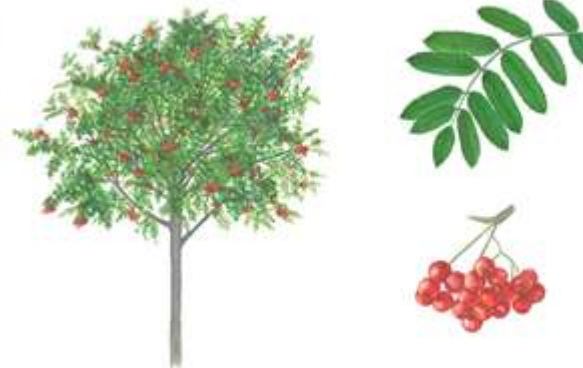
Alder:



Oak:



Rowan:



Birch:



When the pupils have concluded their answer in the question tree, they will get the correct picture on the screen and they need to confirm, with the aid of a button on the screen that their classification is correct.

Description of example in everyday use:

- Biodiversity is necessary for ecosystems to function. Few people will notice if a rare plant or animal species disappears from its natural area, but it can play a decisive role in the functioning of the ecosystem. We know too little about the nature of species in ecosystems. This uncertainty is of vital importance as to why we must take care of all species, the so-called precautionary principle.
- Biodiversity is needed to maintain food chains and food networks.
- The richness of species is important for soil erosion and for the degradation processes in nature.
- A beautiful and pristine nature is a natural source of recreation and joy.
- The food, the building materials and the clothes we use come from the resources we harvest in nature. In addition, we enjoy nature's "goods and services" in the form of water and air purification, climate control and production of oxygen.
- Different trees have different characteristics. For carpenters, farmers, cabinetmakers and other industries working with wood, it is important to be able to distinguish the different varieties of trees for different uses.

Aids for ESTEAM mobile app:	__ pictures, drawings; please specify: Pictures of all the trees in the question tree.
	__ photos please specify:
	__ texts please specify: <ul style="list-style-type: none">• The task• A button to confirm that their answer is what they would like to submit.
	__ sound files please specify:
	__ video files please specify:
	x other, please specify: Question tree

Exercise 7: MAN AND THE ENVIRONMENT (resources)

Selected theme	<input type="checkbox"/> Geology <input type="checkbox"/> Ecology <input checked="" type="checkbox"/> Men and biosphere	
Subtheme	Resources	
Class	8th to 10th grade	
Learning goals	SOCIAL STUDIES SUBJECT CURRICULUM Competence aims after Year Level 10 <ul style="list-style-type: none"> - explain the basic forces of nature, focusing on the internal and external forces on the Earth, movement in air masses, circulation of water, weather, climate and vegetation, and discuss and elaborate on the relationship between nature and society - investigate how people exploit natural resources, other resources and technology. In Norway and other countries around the world, and discuss the premise for sustainable development. - investigate and discuss the use and misuse of resources, consequences this may have for the environment and society, and conflicts this can create locally and globally 	
Working methodology	<input type="checkbox"/> Frontal <input checked="" type="checkbox"/> Group work <input type="checkbox"/> Pairwork <input type="checkbox"/> Individual work	
Learning methodology	<div> <input type="checkbox"/> Observing <input type="checkbox"/> Listening to the teacher or a guide <input type="checkbox"/> Taking pictures <input type="checkbox"/> Experimental <input type="checkbox"/> Playing educational games, role play <input type="checkbox"/> Self-learning <input type="checkbox"/> Contest </div> <div> <input type="checkbox"/> Orientation <input type="checkbox"/> Collecting samples and analysing <input type="checkbox"/> Use of maps and navigation <input checked="" type="checkbox"/> Investigative performance <input type="checkbox"/> Other. Please, specify: </div>	
ESTEAM mobile app challenges	<div> <input type="checkbox"/> Take a photo <input type="checkbox"/> Questions and multiple-choice answers with pictures and/or texts <input type="checkbox"/> Write text answer to match a set of possible written answers <input type="checkbox"/> Write or draw on photo taken <input type="checkbox"/> Make a simple drawing </div> <div> <input type="checkbox"/> Make a short film <input type="checkbox"/> Mark a GPS point on the map with picture and/or comment <input type="checkbox"/> Find out what you are holding? <input type="checkbox"/> Answer a set of questions, to find out what it is </div>	
Additional knowledge, skills and competences	<div> <input type="checkbox"/> Teamwork <input type="checkbox"/> Problem solving <input type="checkbox"/> Decision making </div> <div> <input type="checkbox"/> Development of independent thinking <input type="checkbox"/> Other. Please, specify: </div>	
Multi-sensory	Auditory, visual, kinaesthetic, tactile	

contents	
Teaching aids	TeachOut app Smartphone
New terms	Fish landing, overfishing, fish flour

Description of exercise:

The pupils will go to the designated GPS point »task 1.2«, and work on the task:

“Egersund is a big fishing port. In Ryttervik, we have large factories that have long traditions regarding fish reception and fishmeal production. Create a news report using video and interviews (play different roles), where you will find out what's positive about these factories and fishing, and what's negative. Remember to make a short introduction and presentation of the area and some background information.”

Scenarios for ESTEAM mobile app:

- When opening the task, the pupils will get the following written introduction: “Egersund is a big fishing port. In Ryttervik, we have large factories that have long traditions regarding fish reception and fishmeal production. Create a news report using video and interviews (play different roles), where you will find out what's positive about these factories and fishing, and what's negative. Remember to make a short introduction and presentation of the area and some background information.”
- Filming a video with interviews and presentation of the area.
- Saving the video so the pupils can show it in the classroom after the completion of the fieldwork.

Description of example in everyday use:

- Aquaculture and fishing are two local natural resources, and a lot of different job opportunities are to be had in these industries.
- Wind turbines, solar cells, oil and gas are energy resources we have a lot of in this area.
- A prerequisite for using natural resources is to think about sustainability.
- Environmentalists are focused on sustainability, but the industries are thinking about profit margins and how to create jobs out of our natural resources. It is important that the children are aware of the different arguments in these processes, and that they can take an active stand in these discussions.

Aids for ESTEAM mobile app:	__ pictures, drawings; please specify:
	__ photos please specify:
	__ texts please specify: The task
	__ sound files please specify:
	__ video files please specify: The pupils will make their own video.
	__ other, please specify:

Exercise 8: MAN AND THE ENVIRONMENT (Geohazard)

Selected theme	<input type="checkbox"/> Geology <input type="checkbox"/> Ecology <input checked="" type="checkbox"/> Men and biosphere	
Subtheme	Geohazards	
Class	8th to 10th grade	
Learning goals	<p>NATURAL SCIENCE SUBJECT CURRICULUM Competence aims after Year Level 10</p> <ul style="list-style-type: none"> - formulate testable hypotheses, plan and conduct investigations of them, and discuss any and all observations and results in a report - collect and process natural science data, calculate and produce results graphically <p>SOCIAL STUDIES SUBJECT CURRICULUM Competence aims after Year Level 10</p> <ul style="list-style-type: none"> - explain the basic forces of nature, focusing on the internal and external forces on the Earth, movement in air masses, circulation of water, weather, climate and vegetation, and discuss and elaborate on the relationship between nature and society - formulate questions about relationships in society, plan and conduct an investigation, and discuss the findings and results orally, and in writing 	
Working methodology	<input type="checkbox"/> Frontal <input type="checkbox"/> Group work <input type="checkbox"/> Pairwork <input type="checkbox"/> Individual work	
Learning methodology	<input type="checkbox"/> Observing <input type="checkbox"/> Listening to the teacher or a guide <input type="checkbox"/> Taking pictures <input type="checkbox"/> Experimental <input type="checkbox"/> Playing educational games, role play <input type="checkbox"/> Self-learning <input type="checkbox"/> Contest	<input type="checkbox"/> Orientation <input type="checkbox"/> Collecting samples and analysing <input type="checkbox"/> Use of maps and navigation <input type="checkbox"/> Investigative performance <input type="checkbox"/> Other. Please, specify:
ESTEAM mobile app challenges	<input type="checkbox"/> Take a photo <input type="checkbox"/> Questions and multiple-choice answers with pictures and/or texts <input type="checkbox"/> Write text answer to match a set of possible written answers <input type="checkbox"/> Write or draw on photo taken <input type="checkbox"/> Make a simple drawing	<input type="checkbox"/> Make a short film <input type="checkbox"/> Mark a GPS point on the map with picture and/or comment <input type="checkbox"/> Find out what you are holding? <input type="checkbox"/> Answer a set of questions, to find out what it is
Additional knowledge, skills and competences	<input type="checkbox"/> Teamwork <input type="checkbox"/> Problem solving <input type="checkbox"/> Decision making	<input type="checkbox"/> Development of independent thinking <input type="checkbox"/> Other. Please, specify:

Multi-sensory contents	Auditive, kinaesthetic, tactile, visual
Teaching aids	TeachOut app Smartphone
New terms	Geohazards, tsunami

Description of exercise: The pupils will go to the designated GPS point »task 2.3« and work on the task: Stand on the lookout point towards Rundevoll. Take pictures of different areas that you see, preferably with buildings. Use the animation feature on the app and colour the areas you think will be affected by geohazards like a flood, rock slash or a tsunami.	
Scenarios for ESTEAM mobile app: <ul style="list-style-type: none"> • Get the task: "Stand on the lookout point towards Rundevoll. Take pictures of different areas that you see, preferably with buildings. Use the animation feature on the app and colour the areas you think will be affected by geohazards like a flood, rock slash or a tsunami." • Take multiple photos in the same task. • Draw/colour areas on the photo (like a GIS layer). • Save the edited photos and transport them to be reported upon back at the school. 	
Description of example in everyday use: <ul style="list-style-type: none"> • More extreme weather will cause more geohazards. • In Norway, people will have to move because of increased risk of floods, extreme winds and rockslides - climate refugees. • Agricultural land will be lost to erosion and flooding. • Climate change will affect crops and grazing for livestock. • A change in the climate will change the living conditions for both animals and plants. Some of them will disappear from our flora and fauna. 	
Aids for ESTEAM mobile app:	__ pictures, drawings; please specify: Drawing/colouring on photos
	__ photos please specify: Take photos
	__ texts please specify:
	__ sound files please specify:
	__ video files please specify:
	__ other, please specify:

Exercise 9: MAN AND THE ENVIRONMENT (Impact of man on the environment)

Selected theme	<input type="checkbox"/> Geology <input type="checkbox"/> Ecology <input checked="" type="checkbox"/> Men and biosphere	
Subtheme	Impact of man on the environment	
Class	8th to 10th grade	
Learning goals	NATURAL SCIENCE SUBJECT CURRICULUM Competence aims after Year Level 10 <ul style="list-style-type: none"> - observe and provide examples of how human activities have affected a nature area, investigate the views of different interest groups on these effects and propose measures that might preserve nature for future generations - formulate testable hypotheses, plan and conduct investigations of them, and discuss any and all observations and results in a report - collect and process natural science data, calculate and produce results graphically 	
Working methodology	<input type="checkbox"/> Frontal <input checked="" type="checkbox"/> Group work <input type="checkbox"/> Pairwork <input type="checkbox"/> Individual work	
Learning methodology	<div style="display: flex; justify-content: space-between;"> <div> <input type="checkbox"/> Observing <input type="checkbox"/> Listening to the teacher or a guide <input checked="" type="checkbox"/> Taking pictures <input type="checkbox"/> Experimental <input type="checkbox"/> Playing educational games, role play <input type="checkbox"/> Self-learning <input checked="" type="checkbox"/> Contest? </div> <div> <input type="checkbox"/> Orientation <input checked="" type="checkbox"/> Collecting samples and analysing <input type="checkbox"/> Use of maps and navigation <input checked="" type="checkbox"/> Investigative performance <input checked="" type="checkbox"/> Other. Please, specify: sort into different categories. </div> </div>	
ESTEAM mobile app challenges	<div style="display: flex; justify-content: space-between;"> <div> <input checked="" type="checkbox"/> Take a photo <input type="checkbox"/> Questions and multiple-choice answers with pictures and/or texts <input type="checkbox"/> Write text answer to match a set of possible written answers <input type="checkbox"/> Write or draw on photo taken <input type="checkbox"/> Make a simple drawing </div> <div> <input type="checkbox"/> Make a short film <input type="checkbox"/> Mark a GPS point on the map with picture and/or comment <input type="checkbox"/> Find out what you are holding? <input type="checkbox"/> Answer a set of questions, to find out what it is <input checked="" type="checkbox"/> Other: sort into different categories (boxes). </div> </div>	
Additional knowledge, skills and competences	<div style="display: flex; justify-content: space-between;"> <div> <input checked="" type="checkbox"/> Teamwork <input checked="" type="checkbox"/> Problem solving <input checked="" type="checkbox"/> Decision making </div> <div> <input type="checkbox"/> Development of independent thinking <input type="checkbox"/> Other. Please, specify: _____ </div> </div>	
Multi-sensory contents	Visual, tactile, auditory, kinaesthetic	
Teaching aids	TeachOut app Smartphone	
New terms	Microplastics	

6. CHAPTER: PILOT TESTING ACTIVITIES

6.1. OVERVIEW

From May to December 2018, we pilot tested the TeachOUT application on mobile phones, and the paper version. The testing took place in all three participating countries in the ESTEAM project. In Slovenia, the testing took place in Črni Vrh nad Idrijo, where the contents of the application were tested on students of the Črni Vrh Primary School, and on future science teachers coming from the University of Ljubljana. In Norway, the students of the Husabø Ungdomsskole Elementary School participated in the testing, which took place in the vicinity of Egersund, which is a part of the Magma UNESCO Global Geopark. In Portugal, the testing was done by pupils from the Agrupamento de Escolas Jose Silvestre Ribeiro Primary School. It was held in Monsanto, which is part of the Naturtejo UNESCO Global Geopark.

The aim of the testing was to gain as much feedback as possible on how students and future teachers were able to tackle the tasks in the TeachOUT application (both electronic and paper version). We were interested to see if the participants had difficulties in understanding the individual tasks. Would they welcome some hints to help solve the tasks? Would they like to learn the results of other teams at the end of the game? Were the tasks difficult to complete? Were they fond of learning in nature? We were also interested to see if their knowledge of the subject matter was better after the finished activity compared to the one that was discussed in the classroom. Furthermore, we wanted to hear their suggestions for improving the content. At the end, we also asked the participants about their most and least favourite task.

6.2. TeachOUT PAPER VERSION TESTING – STUDENTS

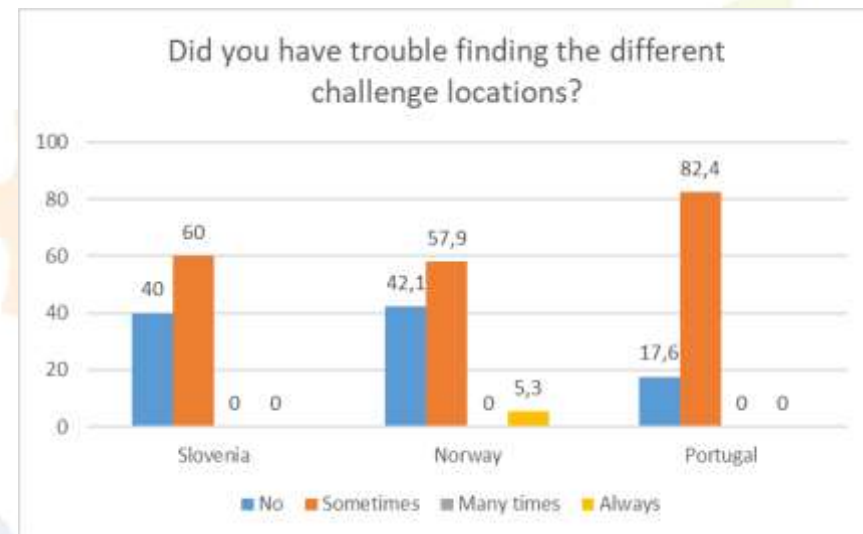
46 pupils have answered the questionnaire. The exact number of pupils per country is listed in the table below.

Slovenia	10
Norway	19
Portugal	17

Did you have trouble finding the different challenge locations?

More than 42% of Norwegian and 40% of Slovenian pupils didn't have trouble finding different challenge locations. Only 17,6% of Portuguese pupils didn't have trouble but more than 82% of Portuguese pupils sometimes had trouble finding different challenge locations. 40% of Slovenian and 57,9% of Norwegian pupils sometimes had trouble and 5,3% of Norwegian pupils always had trouble finding different challenge locations.

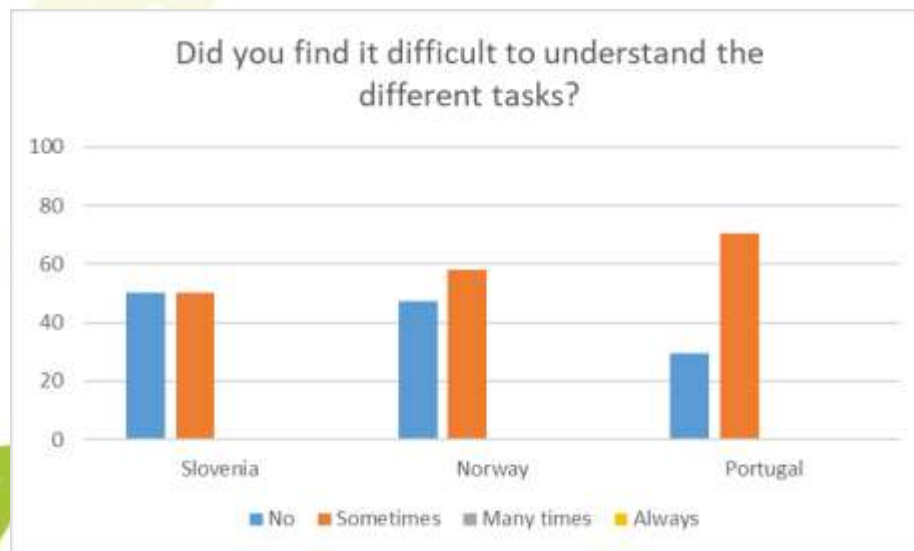
	Slovenia	Norway	Portugal
No	40	42,1	17,6
Sometimes	60	57,9	82,4
Many times	0	0	0
Always	0	5,3	0



Did you find it difficult to understand the different tasks?

Half of Slovenian and approximately, half of Norway pupils sometimes found it difficult to understand the different tasks meanwhile more than 70% of Portuguese pupils sometimes found it difficult to understand the different task.

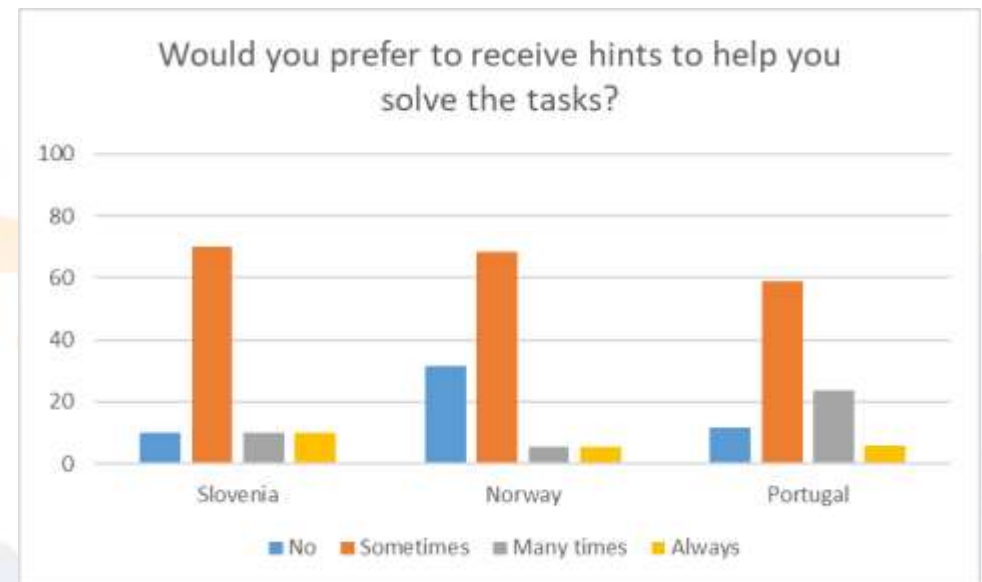
	Slovenia	Norway	Portugal
No	50	47,4	29,4
Sometimes	50	57,9	70,6
Many times	0	0	0
Always	0	0	0



Would you prefer to receive hints to help you solve the tasks?

70% of Slovenian, 68,4% of Norwegian and 58,8% of Portuguese pupils sometimes prefer to receive hints to help them solve the tasks. 31,6% of Norwegian pupils wouldn't prefer to receive hints to help them and 23,5% of Portuguese pupils would prefer to receive hints to help them solve the tasks many times.

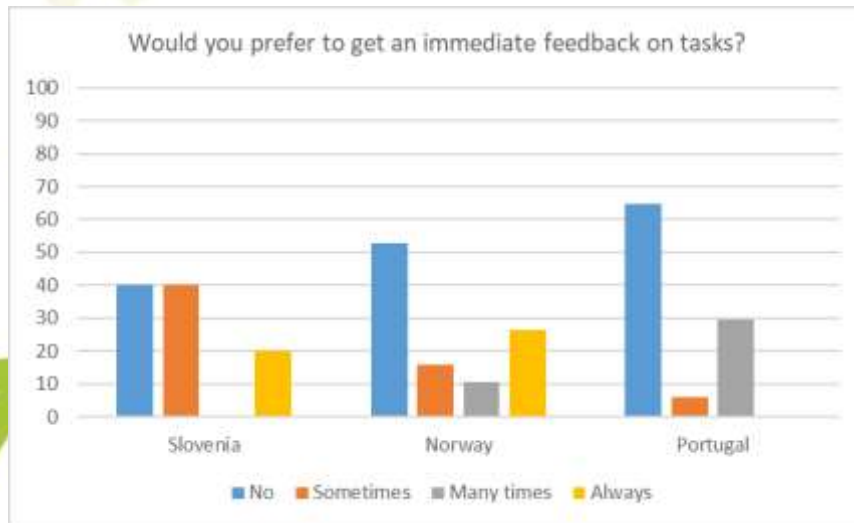
	Slovenia	Norway	Portugal
No	10	31,6	11,8
Sometimes	70	68,4	58,8
Many times	10	5,3	23,5
Always	10	5,3	5,9



Would you prefer to get an immediate feedback on tasks?

64, 7% of Portuguese pupils, 52,6% of Norway pupils and 40% of Slovenian pupils wouldn't prefer to get an immediate feedback on tasks. They would sometimes prefer to get an immediate feedback on tasks. 40% of Slovenian, 15,8% of Norwegian and 5,9% of Portuguese pupils. 10,5 % of Norwegian and 29,4% of Portuguese pupils would prefer to get an immediate feedback on tasks many times. 20% of Slovenian and 26,3% of Norwegian pupils would always prefer to get an immediate feedback on tasks.

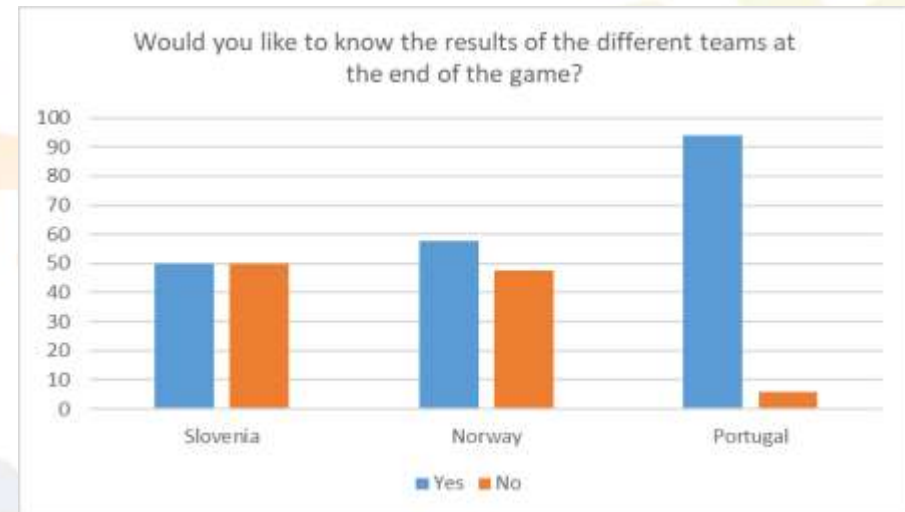
	Slovenia	Norway	Portugal
No	40	52,6	64,7
Sometimes	40	15,8	5,9
Many times	0	10,5	29,4
Always	20	26,3	0



Would you like to know the results of the different teams at the end of the game?

50% of Slovenian pupils, 57,9% of Norway pupils and most of Portuguese pupils would like to know the results of the different teams at the end of the game.

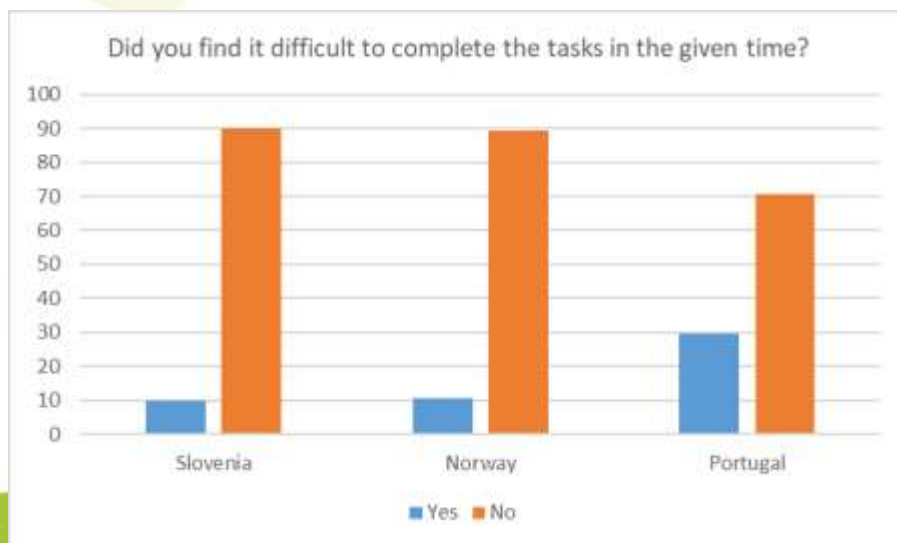
	Slovenia	Norway	Portugal
Yes	50	57,9	94,1
No	50	47,4	5,9



Did you find it difficult to complete the tasks in the given time?

10% of Slovenian pupils, 10,5% of Norway pupils and 29,4% of Portuguese pupils found it difficult to complete the tasks in the given time.

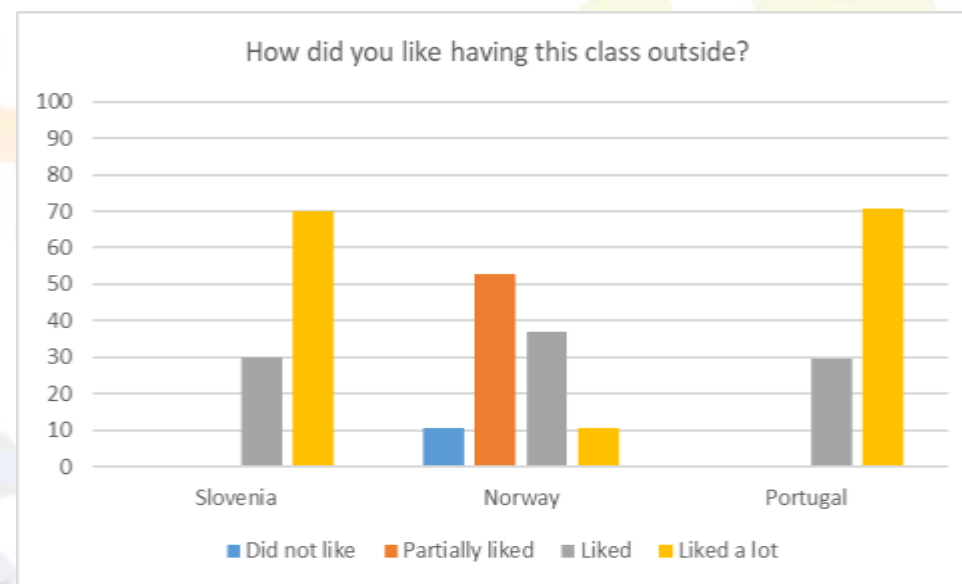
	Slovenia	Norway	Portugal
Yes	10	10,5	29,4
No	90	89,5	70,6



How did you like having this class outside?

70% of Slovenian pupils and 29,4% of Portuguese pupils liked a lot having class outside with a difference of only 10,5% of Norwegian pupils. 30% of Slovenian, 36,8% of Norwegian and 29,4% of Portuguese pupils liked having class outside. More than a half of Norwegian pupils partially liked an 10,5% did not liked having this class outside.

	Slovenia	Norway	Portugal
Did not like	0	10,5	0
Partially liked	0	52,6	0
Liked	30	36,8	29,4
Liked a lot	70	10,5	70,6

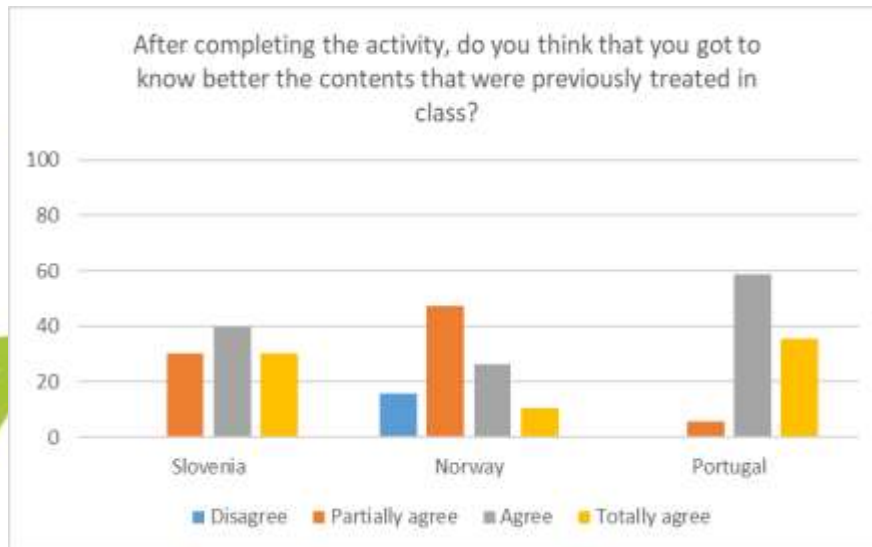


After completing the activity, do you think that you got to know better the contents that were previously treated in class?

After completing the activity, the 70% of Slovenian pupils, 36,8% of Norway pupils and 94,1% of Portuguese pupils agreed or totally agreed that after completing the activity they got to know better the contents that were previously treated in class.

30% of Slovenian pupils, 47,4% of Norway pupils and 5,9 % of Portuguese pupils partially agreed and 15,8% of Norway pupils disagreed that after completing the activity they got to know better the contents that were previously treated in class.

	Slovenia	Norway	Portugal
Disagree	0	15,8	0
Partially agree	30	47,4	5,9
Agree	40	26,3	58,8
Totally agree	30	10,5	35,3



OPEN TYPE QUESTIONS

Favourite tasks

Slovenia

Favourite task of Slovenian pupils was entrance to the cave and cave (Hrvatova cave). The pupils also mentioned writing the story, man and environment (človek in okolje) and the task number 7.

Norway

Most of the pupils preferred the task involving making a movie. 4 pupils answered "I don't know", 2 of them liked taking photos of different rock formations.

Portugal

Favourite task of 41,2% of Portuguese pupils was going to the top of the Inselberg (at the castle and its surroundings) (7 answers). 29,4% of them chose finding the way, exploring the wilderness and seeing beautiful landscapes (5 answers). 17,6% of pupils favourite task was to identify minerals (at the boulders) (3 answers) and 11,8 % of pupils favourite task was to identify plants (native plants): 2 answers. Pupils also mentioned: Working in the rain, collecting (water) samples, taking pictures, making a movie and also all the tasks.

What was the most difficult task to complete?

Slovenia

- Writing the story (3 answers)
- Fossils (3 answers)
- Who lives in this house?
- The task number 5

Norway

- 10 pupils said "I don't know"

- 3 pupils said “the task by the viewpoint”
- 3 pupils said “making the movie” (because of laughing too much!)
- 3 pupils said “task 3”.

Portugal

- Finding some locations (Q4 native plants): *5 answers*
- Finding some locations (Q2 granite boulders): *5 answers*
- Complete task (Q8 making the video): *1 answers*
- The tasks at the Castle: *2 answers*
- The pupils also mentioned:
 - The tasks at the Castle because of the rain and thunders.
 - Finding some spots.
 - Naming the rock (granite).
 - Wandering in the path, fear of falling.

Suggestions for improvement

Slovenia

- Nothing (4 answers)
- Nothing, because I liked everything.
- To write on the phone and not manually
- To talk more
- With fewer tasks
- To go by bike

Norway

Most of the pupils said that it was ok, but some gave concrete feedback:

- Easier trail
- Better map
- Pupils would like to choose their own group

Portugal

Most of the pupils liked the tasks. They also had a few comments and suggestions:

- Should have more time (and more questions) to complete the course – make it an all-day adventure: *7 answers*
- Should have more hints (help find spots): *4 answers*
- Should be a clearer path: *4 answers*
- Should be less conducive??conductive? to accidents: *2 answers*
- The pupils also mentioned:
 - Not to go when it is raining
 - That the presence of a teacher is not required
 - That we should have made a stop at the pancake house. (And we should.

Short interpretation of the results

We divided answers into two different groups. The first group encompasses the questions that are directly related to the benefits of the use of modern technologies i.e. smart phones and apps. The second group are questions that are more related to a particular path and not directly linked to the use of apps.

The first group starts with the question about location. It is clear that at least at some point the pupils were lost and could not find the defined location. Here the benefits of using the GPS in smart phones are completely clear. The second ones relate to finding the right answer to a particular question. The situation is clear here: students would like to have available hints that would help them to solve the riddle. Here also the use of smart phone has benefits. What is interesting is that the half of the students are not interested into finding if the answer they provided is right. This could be related to the strong confidence or, hopefully not, ignorance. The same goes for the knowing the results of other teams. The Slovenians and Norwegians are divided into half for yes and half for no. But Portuguese students are crystal clear 94% of them would like to know how other teams performed. Perhaps the Portuguese are just more competitive.

The second group relates to particular paths and general benefits of outdoor activities. The time given for the completing of the whole trail was correct in all of the countries. Sometimes the pupils had problems with understanding the different tasks. So here is some room for improvement. But in general children like to have a class outside and acknowledge the better understanding of the subject in comparison to just here about it in the classroom. And the suggestions of them were, well, sometimes useful, but sometimes just childish complaining.

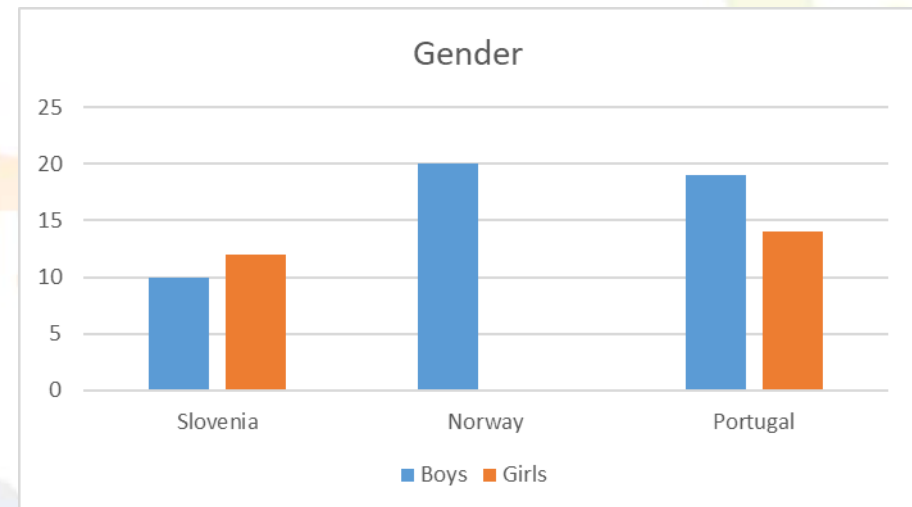
6.3. TeachOUT APP TESTING – STUDENTS

75 pupils have answered the questionnaire. The exact number of pupils per country is listed in the table below.

Slovenia	22
Norway	20
Portugal	33

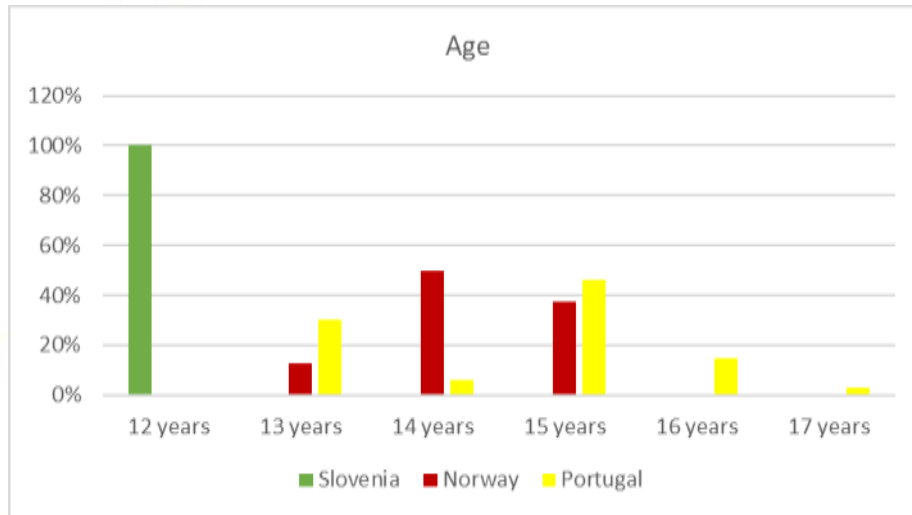
Gender of pupils per country

	Slovenia	Norway	Portugal
Boys	10	20	19
Girls	12	0	14



Age of pupils per country

	Slovenia	Norway	Portugal
12 years	100%		
13 years		12,50%	30%
14 years		50%	6%
15 years		37,50%	46%
16 years			15%
17 years			3%



Did you have trouble finding the different challenge locations?

100% of Slovenian pupils and 67% of Portuguese pupils didn't have trouble finding different challenge locations. Only 18% of Norwegian pupils didn't have trouble but more than 71,7% of Norwegian pupils sometimes had trouble finding different challenge locations. 5,15% of Norwegian pupils many times and 5,15% always had trouble finding different challenge locations.

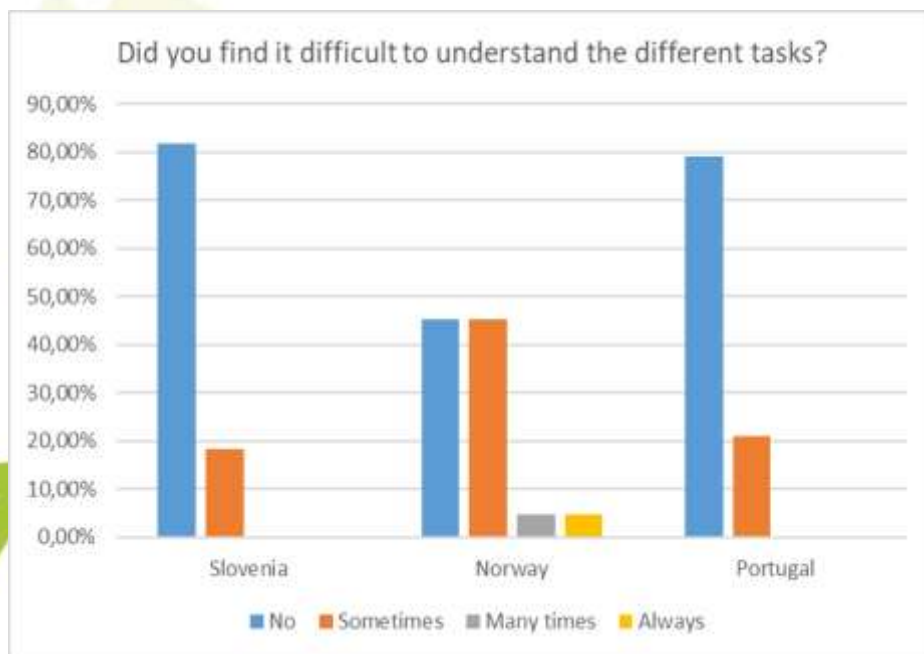
	Slovenia	Norway	Portugal
No	100%	18,00%	67%
Sometimes		71,70%	33%
Many times		5,15%	0
Always		5,15%	0



Did you find it difficult to understand the different tasks?

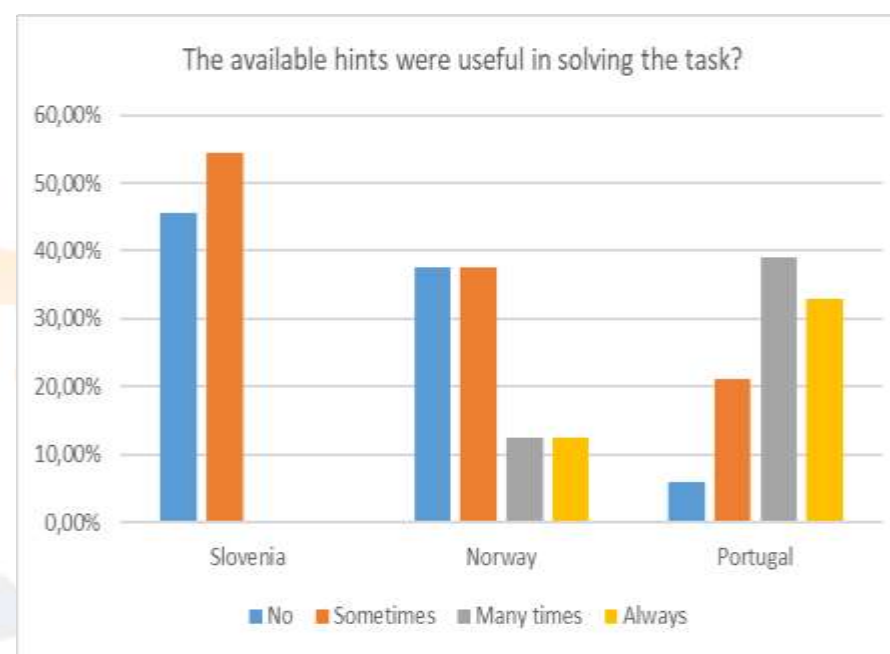
18,20% of Slovenian, 21% of Portuguese and almost half (45,3%) of Norway pupils sometimes found it difficult to understand the different tasks meanwhile more than 80 % of Slovenian and almost 80 % of Portuguese pupils no found it difficult to understand the different task.

	Slovenia	Norway	Portugal
No	81,80%	45,30%	79%
Sometimes	18,20%	45,30%	21%
Many times	0	4,70%	0
Always	0	4,70%	0



The available hints were useful in solving the task?

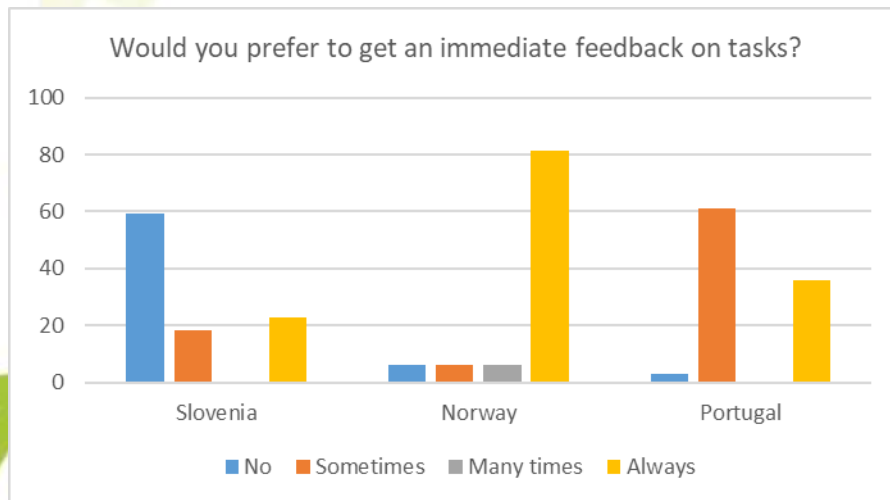
	Slovenia	Norway	Portugal
No	45,50%	37,50%	6%
Sometimes	54,50%	37,50%	21%
Many times		12,50%	39%
Always		12,50%	33%



Would you prefer to get an immediate feedback on tasks?

59,1% of Slovenian pupils, 6,3% of Norway pupils and 3% of Portuguese pupils wouldn't prefer to get an immediate feedback on tasks. 18,2% of Slovenian, 6,3% of Norwegian and 61% of Portuguese pupils would sometimes prefer to get an immediate feedback on tasks. 6,3% of Norwegian pupils would prefer to get an immediate feedback on tasks many times and 81,3% of Norwegian pupils would always prefer to get an immediate feedback on tasks.

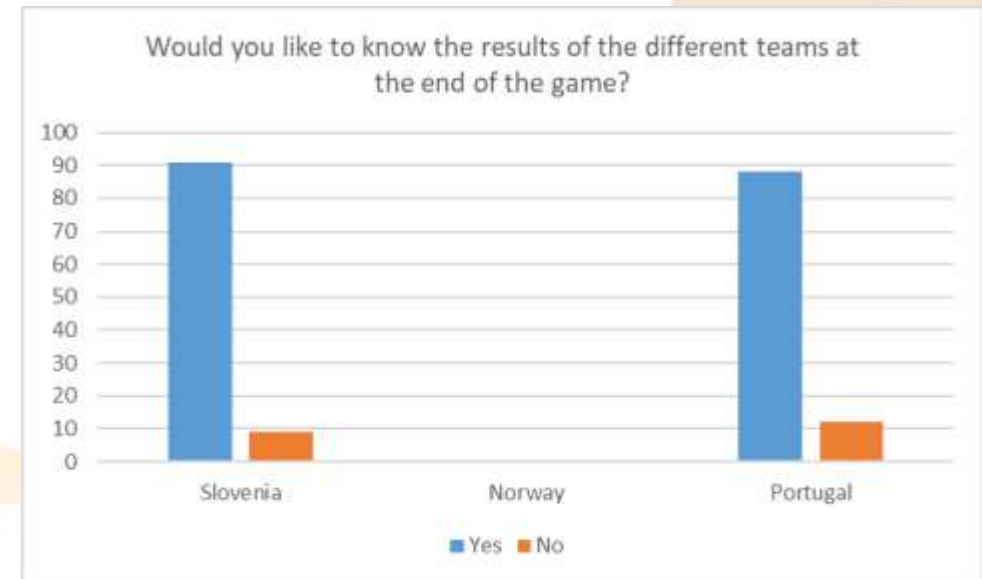
	Slovenia	Norway	Portugal
No	59,1%	6,3%	3%
Sometimes	18,2%	6,3%	61%
Many times	0	6,3%	0
Always	22,7%	81,3%	36%



Would you like to know the results of the different teams at the end of the game?

90,9% of Slovenian pupils and 88% of Portuguese pupils would like to know the results of the different teams at the end of the game.

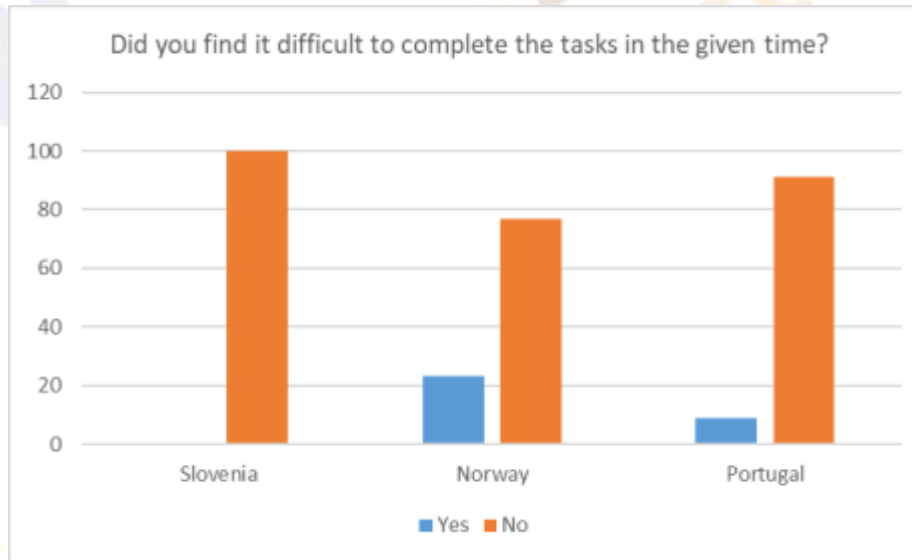
	Slovenia	Norway	Portugal
Yes	90,9%	no data	88%
No	9,1%	no data	12%



Did you find it difficult to complete the tasks in the given time?

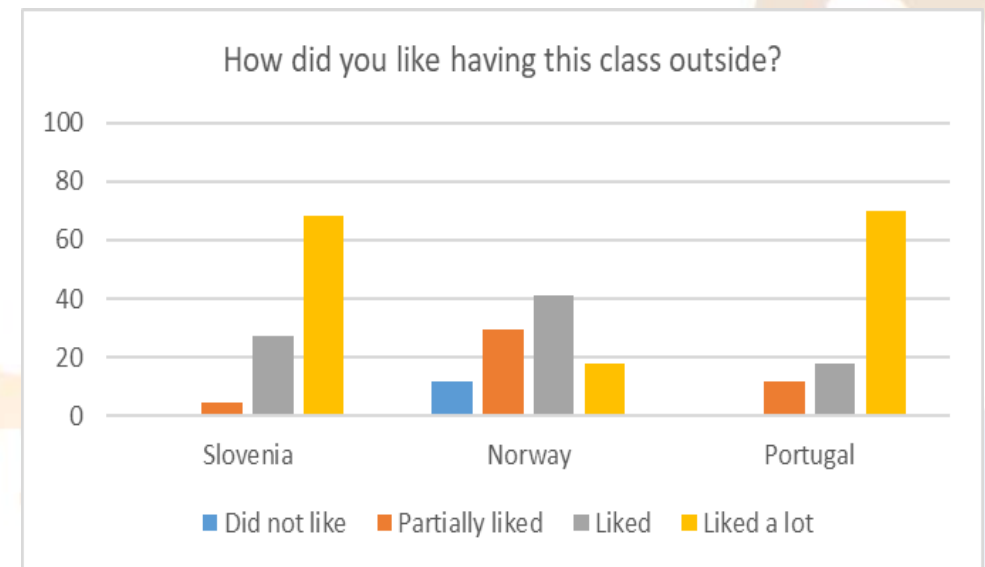
0% of Slovenian pupils, 23,4% of Norway pupils and 9% of Portuguese pupils found it difficult to complete the tasks in the given time.

	Slovenia	Norway	Portugal
Yes	0	23,4%	9%
No	100%	76,6%	91%



outside. Almost 30% of Norwegian pupils partially liked an 11,7% did not liked having this class outside.

	Slovenia	Norway	Portugal
Did not like	0	11,7%	0
Partially liked	4,5%	29,3%	12%
Liked	27,3%	41%	18%
Liked a lot	68,2%	18%	70%



How did you like having this class outside?

Almost 70% of Slovenian pupils and 70% of Portuguese pupils liked a lot having class outside with a difference of only 18% of Norwegian pupils. 27,3% of Slovenian, 41% of Norwegian and 18% of Portuguese pupils liked having class

After completing the activity, do you think that you got to know better the contents that were previously treated in class?

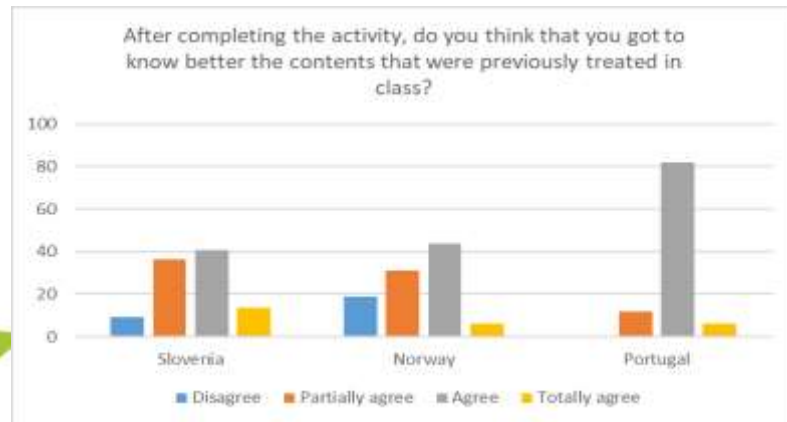
After completing the activity, the 54,5% of Slovenian pupils, 50,1% of Norway pupils and 88% of Portuguese pupils agreed or totally agreed that after

completing the activity they got to know better the contents that were previously treated in class.

36,5% of Slovenian pupils, 31,3% of Norway pupils and 12% of Portuguese pupils partially agreed that after completing the activity they got to know better the contents that were previously treated in class.

9% of Slovenian pupils, 18,8% of Norway pupils disagreed that after completing the activity they got to know better the contents that were previously treated in class.

	Slovenia	Norway	Portugal
Disagree	9%	18,8%	0
Partially agree	36,5%	31,3%	12%
Agree	40,9%	43,8%	82%
Totally agree	13,6%	6,3%	6%



OPEN TYPE QUESTIONS

Favorite tasks

Slovenia

Favorite task of Slovenian pupils was entrance to the cave (Hrvatova cave) (5 answers); taking pictures (11 answers). The students also mentioned: All the tasks.

Norway

31% of the pupils answered task no 1, but because of technical issues the pupils just got to do 3 out of 6 tasks - so this answer does not reflect the entire trial.

Portugal

- Going to the top of the Inselberg (at the castle and its surroundings): 9 answers
- Find the way, exploring the wilderness, see beautiful landscapes (the path): 8 answers
- Identify minerals (at the boulders): 3 answers

The students also mentioned: Working outdoors (in a group, raining); Taking pictures; Making a movie; All the tasks.

What was the most difficult task to complete?

Slovenia

- Nothing (5 answers)
- Walking (1 answer)

Norway

Most of the pupils answered no. 4 here. That has nothing to do with the task at no. 4, but it has all to do with the fact that none of the groups could open task no. 4 on the trail. So they all ended the game there.

Portugal

- Finding some locations: *4 answers*
- Overall orientation: *4 answers*
- Complete task (Q8 making the video): *3 answers*
- The tasks at the Castle: *4 answers*

The students also mentioned:

That it was difficult to walk on the wet rocks

That it was forbidden to overtake other teams

That there were 2 spots that were very hard to find (thus the necessity to have a *skip button*)

Most of the students didn't find any difficulty on the tasks

Suggestions for improvement

Slovenia

- More explanations about the area
- More difficult tasks
- Groups are too close to each other
- More experiments
- Doing tasks without a teacher
- With drinks
- More games
- I would like to take video

Norway

Lots of creative input here, but mainly:

- "don't put tasks in the ocean"
- "don't make us do this in the winter - it is ok in the spring or in the summer"
- "make all posts work"

Portugal

Most of the pupils liked the tasks (funny and interesting).

They also had a few comments and suggestions:

- Should have more time (and more questions) to complete the course – make it in a different location, in a new location: *8 answers*
- Should have been given more time to do the path: *2 answers*
- Should be better GPS accuracy: *2 answers*
- The students also mentioned:
The annoying long videos;
That the presence of a teacher is not required;
That the pancake house was closed! (postponed activity!)

What is the most interesting aspect of using the TeachOUT app in this pedagogical activity (field output)?

The app (use and features) that the students highlighted:

- Playing games with friends and teachers outside (field and village): *6 answers*
- The possibility to see the other teams in the map: *5 answers*
- Using the mobile phone to learn thing: *3 answers*
- They don't get lost (they have a map): *2 answers*

- The students also mentioned:
The funny emojis & songs;
The «find the treasure» type of game;
That it was a whole afternoon without classes!

What was the TeachOUT app feature that you find less interesting?

- The app icon isn't really interesting (!)
- The battery consumption
- The gps accuracy

What was the TeachOUT app feature that you find most interesting?

- The images, the sounds, the emoji's, the songs
- To have everything on the phone
- The map
- To be able to track the other teams
- To draw on the pictures
- The clues and the questions
- The not need of internet
- The information about the places and rocks/species
- The app itself

Observation

Slovenia

We tested our educational trail with the app with 22 pupils from 6th and 7th grade.

The trail is partially situated on the road to the village nearby, so there is occasional traffic. As the children that tested the trail are about twelve years old, we had to accompany them all the time while testing the app. We put them into small teams.

Pupils were really motivated having the class outside and they really liked using a mobile phone for this educational occasion. As they were under constant teacher's supervision, they did not find it difficult to find different challenge locations and to understand the tasks. There was no need for hints in solving the tasks, because it was easier to ask the teacher. They did not have the opportunity to compete with other teams for the same reason.

Mostly students agreed that the contents, that was previously treated in class, was understood better after using the app on field. Students especially liked the cave on the trail and regarding the type of exercises, they liked all of the tasks, but especially taking pictures.

Pupils in Slovenia would like to receive more information about the trail, which the teacher can include in the description of the trail. They would like to have more difficult tasks and tasks that include experiments and more games. Due to a constant teacher's supervision students missed some freedom doing the tasks and the competition with other teams. They do not really care about getting an immediate feedback but at the end of the game they would like to compare their results with other teams.

Portugal

The TeachOUT application test was held at Monsanto in November 2018. The group of students who previously tested the paper version was invited to participate in this second test of the future TeachOUT application. The goal of this

second test was to evaluate the performance of the application and compare the degree of student satisfaction between the two tests.

To the initial group was added a second batch of students with about 15 students belonging to the 11th grade. The total number of students was 33, of which 19 were male. The average age was amplified, as a result of the increase in the group, and came to be about 14.5 years.

The initial test corrected some aspects (functional, only), but the original design of the path was maintained. The feedback from the students on the first test was very favorable. In this second exercise the results were (still) better.

Regarding the course presented, the questions developed and the challenges proposed, the students' opinions were very positive. The students considered it relatively simple to find the points with the challenges and to correctly interpret the tasks they had to perform and the issues they had to solve.

The presence of specific clues, somewhat less abundant in the paper version, were considered relevant and decisive in the interpretation of the route to be covered. The few difficulties encountered in defining the path and realizing the full range of challenges, difficulties mentioned in the first test, were thus corrected.

As for the immediate information on the correct execution of the questions and on the positioning and results of the other teams, attributes that were not verified in the paper version and that, now, in the application, are made available, were considered as important characteristics in the application's use level of satisfaction.

Although weather conditions were somewhat adverse, as the rain partially accompanied the works, about 90% of the students liked the varied challenges and continued to understand the field trips and outdoor tasks outside the classroom as an attractive and efficient method in Natural Science teaching.

Of the written opinions, there are very positive references about the diversity of themes, questions and challenges presented, the advantages of exploring nature and finding the right way, being in contact with striking landscapes and using the mobile phone in a school context to take photographs and make videos. The

references to the difficulty in running the course in situations of some danger, derived from the humidity on the rocks, was one of the few negative aspects mentioned.

The outdoor action was enthusiastically welcomed again and the possibility to treat the subjects in a playful way and to require teamwork and the mobilization of knowledge and skills not always able to be used in the classroom were once again eloquent aspects to the importance of these activities.

Norway

We did this testing in proper Norwegian autumn weather; heavy rain, slippery and muddy trails, strong wind and 5 degrees. I really admire these boys for not giving up, but keep going to get to the end of the train; real Vikings!

We downloaded the trail on Wi-Fi in the classroom. I suspect that this is the reason why the boys had difficulties finding the GPS points, because I found all of them very easily, but I was connected to 4G all the time. Also; there are a lot of trees on this trail. That may affect the GPS signals. Even if they walked very slowly, and stood for a long time waiting at each point, some of them didn't get the GPS point/task. Task no 4 was lost to all groups (showed in the sea!), and therefore none of them got to finish the trail.

Regarding the odd results in our questionnaire: apparently a couple of the boys did not get the fact that they should just choose one option on each question.

Comparison of the results of the analyses between the TeachOUT mobile application and the paper version (the questionnaire)

Pupils from Slovenia and Portugal had fewer problems with the use of the mobile application for finding a single point or location compared to the paper version. Norwegian pupils did not recognize this difference. The number of those who had no problems was smaller than in comparison with the paper version while the number of those who had occasional problems with finding a location was higher than compared to the paper version.

When asked if pupils had had difficulties in understanding the individual tasks, it turned out that they generally had fewer problems with solving the tasks via the TeachOUT application than with the paper version. This difference was particularly evident with Slovenian and Portuguese pupils. Rare students sometimes had trouble understanding the tasks, while occasional problems more frequently appeared in the paper version.

When asked if they would welcome hints to help solve their tasks, almost 60% - 70% of pupils from all three countries occasionally wanted some hints with the paper version. With the TeachOUT application on mobile phones, this ratio was somewhat different. Almost half of Slovenian students did not need any hints, while the other half would welcome occasional tips. Norwegian learners mostly did not need any hints or needed them sometimes, while almost 40% of Portuguese students often needed a hint and over 30% always needed a hint to help them solve their tasks.

Norwegian and Portuguese pupils answered that they would welcome an immediate feedback on a particular task when using the TeachOUT application, but less so with the paper version. In case of Slovenians, the result was quite the opposite. With the TeachOUT application, almost sixty percent of them thought they did not need any feedback. In case of the paper version, this ratio was 40%.

We did not get any feedback from Norwegian students when asked if they wanted to find out the results of other teams at the end of the game. The reason for this is unknown, but it is most likely of technical nature. We think that this question

was not visible in the poll sheet so the Norwegians skipped it. In case of Portuguese and Slovenian students, they mostly wanted to find out about the mobile phone application results of other teams. With the paper version, only half of Slovenian students wanted to learn about the results of other teams

When asked if it had been difficult to complete the assignments, most participants answered that the tasks were not difficult in either case.

When asked about whether they had enjoyed learning in nature, there were no significant differences in answers regarding the use of the TeachOUT application on mobile phones and the paper version. Slovene and Portuguese pupils respectively loved learning in nature, while the Norwegians were less enthusiastic. Following their observations, they had problems due to bad weather, rain and wind. This was probably the reason why they were less keen on learning in nature at that moment. Nonetheless, more than forty percent were very much fond of and almost twenty percent of Norwegian students liked learning in nature with help of the TeachOUT application.

After completing the activity in nature, the knowledge of the subject matter that had been discussed in class was better for most Portuguese students. More than 80% of them agree, and 6% strongly agree that their knowledge of the subject matter that had been discussed in class was better. Compared with the paper version, the results were even slightly higher than with the TeachOUT application. Thirty-five percent of Portuguese students strongly agreed that their knowledge of the subject matter that had been dealt with in class was better. The comparison of the results of the analyses between the pupils who used the mobile application, and the pupils who used the paper version was not significantly different.

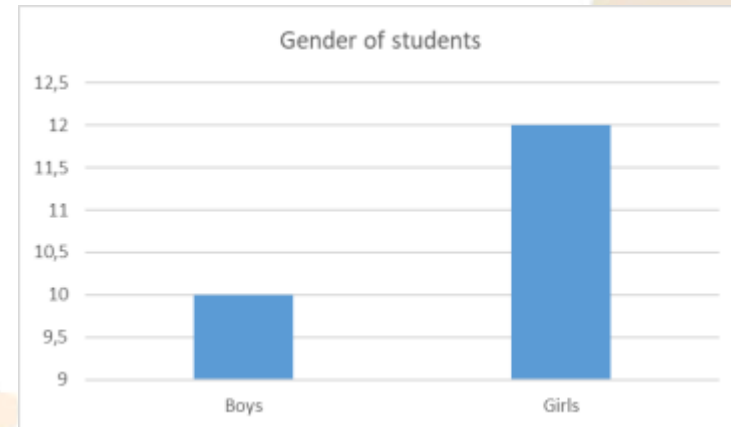
6.4. TeachOUT APP AND PAPER VERSION TESTING – FUTURE TEACHERS

Prospective Slovenian teachers from the University of Ljubljana tested the TeachOUT application on mobile phones, as well as its paper version. The testing took place at the educational trail in Črni Vrh nad Idrijo. The aim was to gain as much feedback as possible on how future teachers were coping with the tasks that were included in the TeachOUT application (both electronic and paper version). We were interested to see whether the participants had difficulties in understanding the individual tasks. Would they welcome hints that would help them solve the tasks? Would they welcome an immediate feedback on a particular task? Would they be interested to learn about the results of other teams at the end of the game? Was it difficult to complete the task? Were they fond of learning in nature? Finally, after the completed activities, we wondered if their knowledge of the subject matter was better than when discussed in class. We were also keen to hear suggestions for improving the content. At the end, we asked the participants about their most and least favourite task.

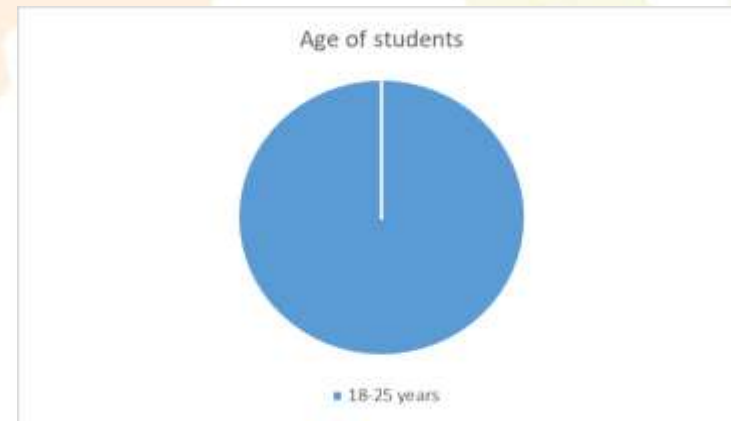
Twenty-two students altogether answered the questions, 10 of whom were male students and 12 were female students.

Interviewee Gender

	Number of students
Male	10
Female	12



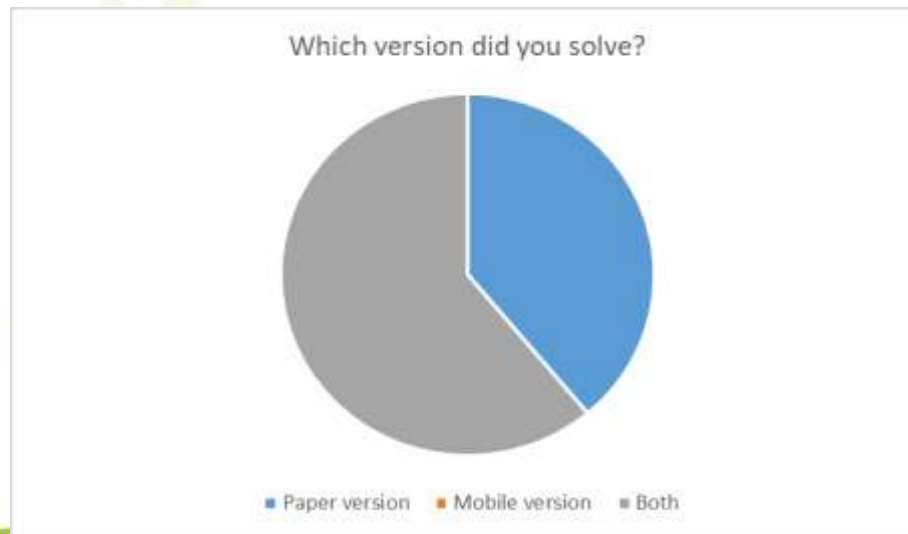
Age of Students



Which version did you solve?

38.9% of students solved the paper version and 61.1% solved both versions.

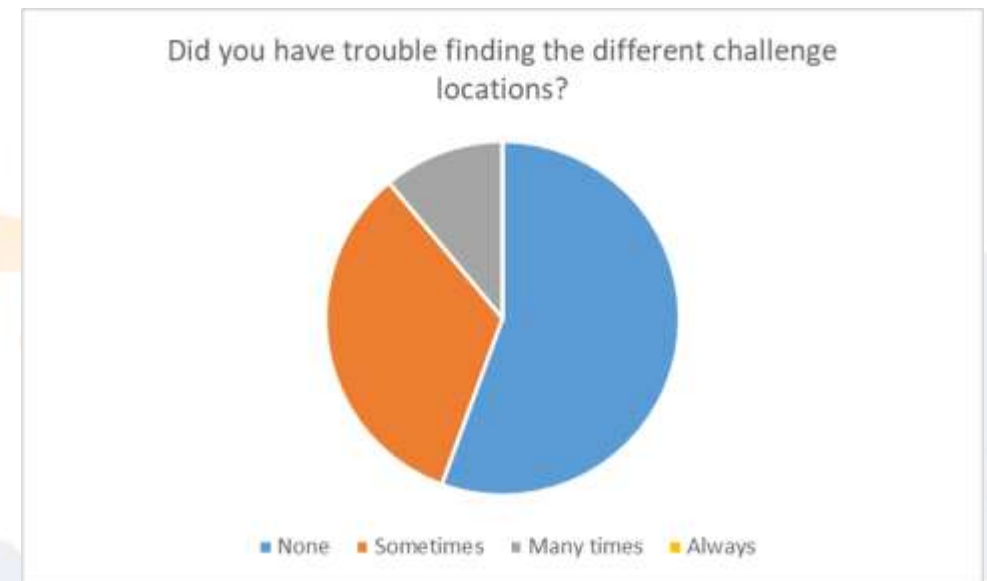
Paper version	38.90%
Mobile version	0%
Both	61.10%



Did you have trouble finding the different challenge locations? (Choose the appropriate option).

56% of students didn't have trouble finding the location. 33.3% of students sometimes experienced troubles and 11.1% of students often had troubles.

Troubles with finding location	
None	56%
Sometimes	33.30%
Many times	11.10%
Always	0%
	100%

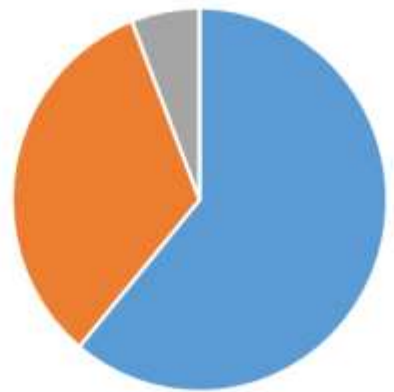


Did you find it difficult to understand the different tasks? (Choose the appropriate option.)

5.9% of students often found it difficult to understand individual tasks. 33% of students sometimes had troubles while 61.1% of students had no troubles at all.

No	61.10%
Sometimes	33.00%
Often	5.90%
Always	0

Did you find it difficult to understand the different tasks?



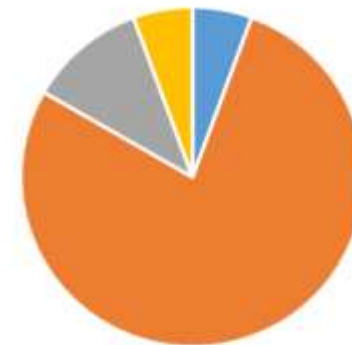
■ No ■ Sometimes ■ Often ■ Always

Do you think you would prefer to receive hints to help you solve the tasks?

As many as 77.8% of students felt they would sometimes welcome hints to help them solve the tasks. 5.6% didn't need them at all, and 5.6% felt they would always need them. 11.1% of students felt they would often welcome hints, which would help them solve the tasks.

No	5.60%
Sometimes	77.80%
Often	11.10%
Always	5.60%

Do you think you would prefer to receive hints to help you solve the tasks?



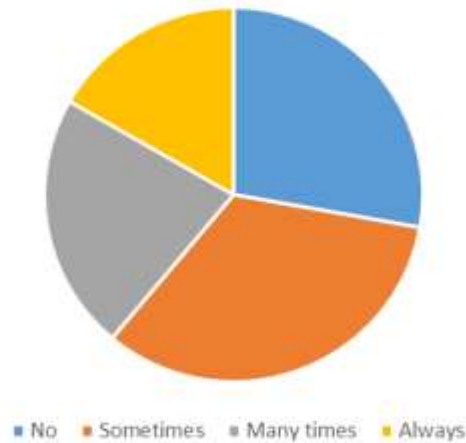
■ No ■ Sometimes ■ Often ■ Always

Would you prefer to get an immediate feedback on tasks?

The answers to the question if they preferred to get an immediate feedback on tasks were almost divided in quarters. 27.8% wouldn't prefer to get them, 33.3% would sometimes prefer them, 22.2% would prefer to get them many times, and 16.7% students felt they would always welcome an immediate feedback on an individual task.

No	27.8%
Sometimes	33.3%
Many times	22.2%
Always	16.7%

Would you prefer to get an immediate feedback on tasks?

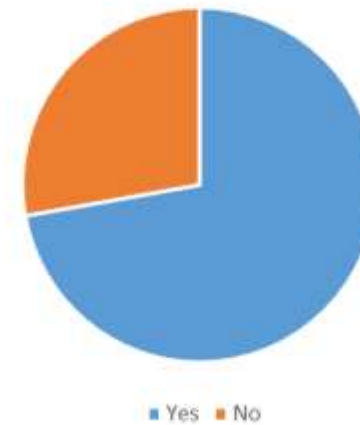


Would you like to know the results of the different teams at the end of the game?

72.2% of students wanted to know the results of other teams at the end of the game, while 27.8% had no such desire.

Yes	72.2%
No	27.8%

Would you like to know the results of other teams at the end of the game?

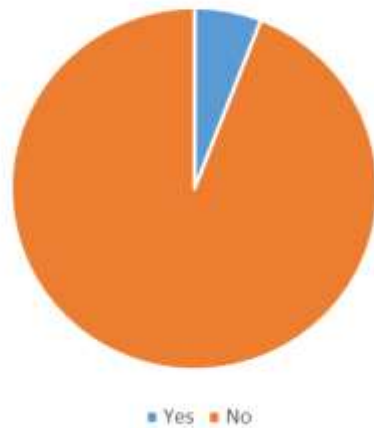


Did you find it difficult to complete the tasks?

As many as 94.1% students felt that the tasks weren't difficult to complete.

Yes	5.9%
No	94.1%

Did you find it difficult to complete the tasks?

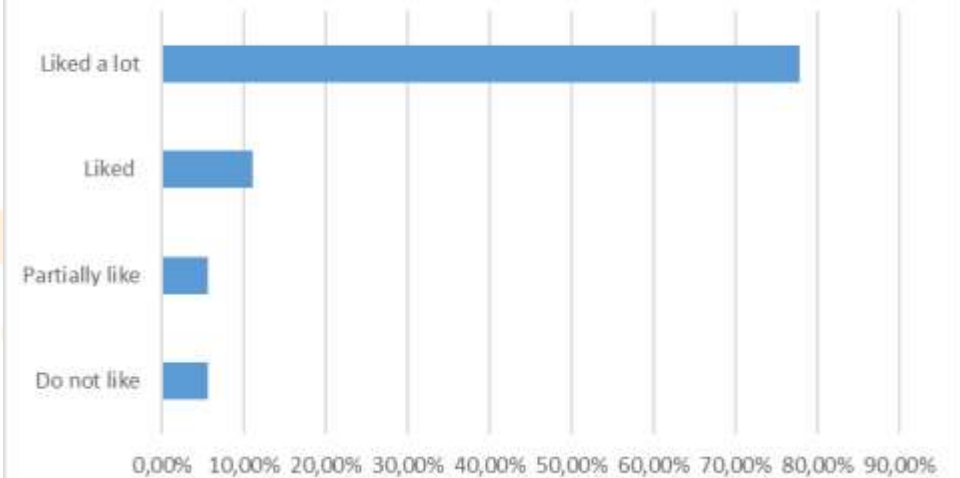


How did you like having this class in nature?

Almost 90% of students liked or liked a lot having class in nature. 5.6% of students partially liked it and the same percentage of students didn't like it.

Do not like	5.60%
Partially like	5.60%
Liked	11.10%
Liked a lot	77.80%

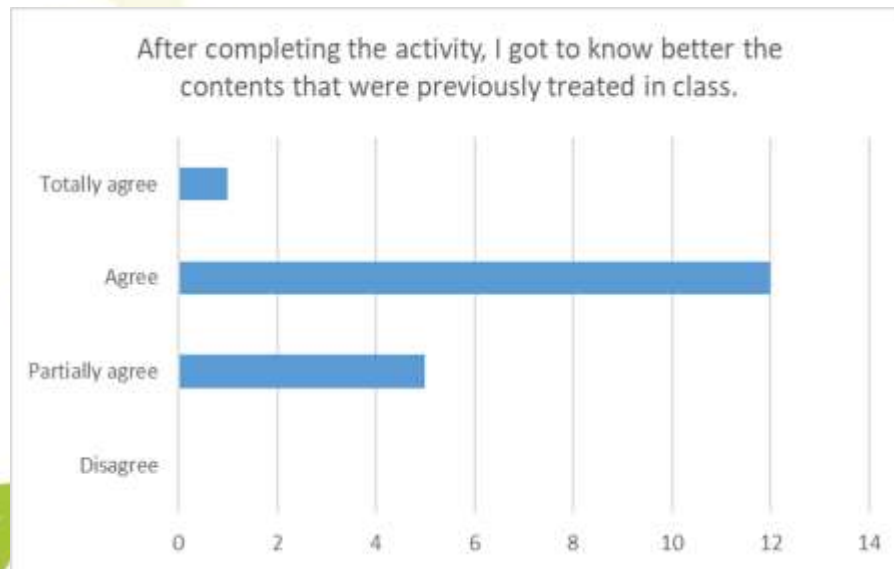
How did you like having this class in nature?



To what degree do you agree with the following statement: After completing the activity, I got to know better the contents that were previously treated in class.

12 students agree with the statement that after completing the activity they got to know better the contents that were previously treated in class. 5% of students partially agree, while one student totally agrees with the statement.

Disagree	0
Partially agree	5
Agree	12
Totally agree	1



Which was your favourite task?

Which was your favourite task?

Hrvatova cave: 5 answers

Fossils: 3 answers

All tasks that required taking photos: 2 answers

Karst phenomena: 1 answer

All tasks: 1 answer

The task which involved the experiment where we had to define whether the rock was limestone or not.

Conclusions

The future teachers tested the paper and the electronic version of the app. Most of them did not have any problems finding a location. A third encountered occasional difficulties in finding a location. Only rare participants often experienced problems.

The future teachers mostly did not have any difficulties in understanding individual tasks; nonetheless, most of them believe they would sometimes welcome tips to help solve tasks. Answers to the question whether immediate feedback on a particular task would be welcome in their opinion, were diverse and divided approximately in quarters. Some teachers always wanted feedback, some wanted it often, some rarely and some did not wish for it. Most students wanted to learn the results of other teams at the end of the game, while more than a quarter of them did not want this. Almost everyone thought that it was not difficult to perform the tasks and that they very much liked or liked learning in nature. Students agreed or partly agreed with the assertion that their knowledge of the subject matter that had been discussed in class was better after the completion of the activities in nature.

6.5. OVERALL TEST RESULTS

We analysed the results of the testings of the TeachOUT application, carried out by primary school students in all three participating countries: Slovenia, Norway and Portugal. The testing was carried out both on mobile phones and on paper. In addition, we also carried out an analysis of the results of the testings, which were carried out by future teachers from the University of Ljubljana. The future teachers as well tested the mobile and paper version of the TeachOUT application. The testing has brought some interesting findings, as well as some useful suggestions for improvements and updates.

We found that when using the TeachOUT application on mobile phones, students had much less trouble finding a single point or location as compared to the paper version of the questionnaire. The result of the Norwegian pupils was quite the opposite. They did not recognize this difference. The number of students who did not have a problem with the use of the TeachOUT application on mobile phones was smaller than the number of those who used the paper version. The number of those who sometimes had problems finding a location was bigger than the number of students who used the paper version. In general, the students were more likely to solve problems via the TeachOUT application on mobile phones than via the questionnaire. This difference was particularly evident in Slovenian and Portuguese participants. Rare students sometimes had difficulty understanding the task, while occasional problems were more frequent with the paper version.

It turned out that when using the TeachOUT app on mobile phones, almost half of Slovenian students did not need any hints, while the other half would welcome them occasionally. Norwegian students mostly did not need a hint, or sometimes needed a hint, while almost 40% of Portuguese students often needed a hint, and over 30% always needed a hint to help them solve their tasks.

With Norwegian and Portuguese students, it became clear that instant feedback on a particular task was more welcome when using the app on mobile phones than with the paper version. The majority of Slovene and Portuguese students who used the mobile app wanted to learn about the results of other teams. They were also very fond of learning in nature, while the Norwegians were slightly

reserved due to bad weather. After completion of activities in nature, the knowledge of the subject matter that had been treated in class was better for most pupils from Portugal. In general, we can conclude that students loved using the TeachOUT app on mobile phones and they were highly motivated to use it.

The future teachers tested the paper version and the mobile app as well. Most of them did not have any problems finding a location and a third had occasional troubles. Only rare participants often had troubles. Overall, future teachers did not have trouble understanding individual tasks. Nonetheless, the majority of them felt they would welcome occasional hints to help them solve tasks.

7. CHAPTER: CONCLUSIONS

The ESTEAM project (Enhancement of School TEaching Methods by linking between schools, experts and geoparks in the combination with outdoor activities and ICT technologies) is a project, co-financed by the ERASMUS+ programme of the European Union. It started in September 2016 and will run for 36 months, ending in September 2019. The co-ordination of the project is run by the Idrija Heritage Centre, which at the same time is also the co-ordinator of the Idrija UNESCO Global Geopark activities. In addition, the partner consortium comprises: Naturtejo and Magma UNESCO Global Geoparks, two elementary schools within the Geopark areas (Črni Vrh nad Idrijo Elementary School and Agrupamento de Escolas José Silvestre Ribeiro, Idanha-a-Nova), the University of Ljubljana – Faculty of Natural Sciences and the Engineering – Department for Geology and a company specialised in ICT called Locatify.

The ESTEAM project aims at improving the quality of teaching/learning in the school system through an innovative method (teaching methodology, toolkit & users experience space (virtual & natural) that links National curriculum goals in Natural Sciences education with the development of mobile teaching/users experience platform (ICT) combined with outdoor activities. The general objective is to improve the teaching process combined with ICT technologies and outdoor activities. The target groups of the Project are Natural Sciences teachers, Future Natural Sciences teachers, Professors of didactics at Faculties, Pupils aged 12-15, Geopark staff and employees in educational institutions.

The first output of the ESTEAM project **(O1) – Research of National curricula with guidelines** has already been finalised and is available on ESTEAM project website (www.esteemproject.eu/intellectual-outputs). In the document the findings about learning objectives, current skills and competencies of educational methods in the science teaching, the opinions of pupils on the methods of science teaching and suggestions for improvement are presented.

On the basis of the analysis from the Research of National curricula with guidelines (O1) the teaching material and mobile platform started to develop and was finally comprised in a second output of the ESTEAM project **(O2) – Development of teaching methodology: mobile teaching/users experience platform**, the document you are reading at the moment. Partners would like to convey to you, our experience about designing a methodology that combines

classroom and outdoor learning with modern ICT technologies, and also to provide you with the tools that we used to achieve this.

The result of this activity is the application with the name **TeachOUT –Outdoor Science Game** that is a comprehensive educational application for natural science teaching based on the analysis of national curricula, the needs of teachers and students within the ESTEAM project.

The app TeachOUT allows **teachers** to formulate their tasks, adding many multisensor content (from hunting to treasures, questionnaires, observing, listening, filming to the study of maps) and extending the usual classroom work to a classroom in nature. On the other hand, **pupils** learn to learn about nature in nature, to take independent decisions, to observe the world around them, responsible behaviour towards the environment, communicate with their classmates, participate in the group, use different sources of information to help them solve the challenge, analyse their solutions and review and justify answers later in the classroom, creative thinking and to use modern technologies in learning process.

In this e-book (O2) partners present the process of creating a mobile application for teaching and learning natural science in elementary schools. After the short introduction (Chapter 1), the process of selection of three themes, we focused on, namely **geology**, **ecology** and **men&biosphere**, with short descriptions of these themes.

In the following Chapter 3 the ESTEAM teaching methodology is described, combining a traditional learning environment (a classroom) with an expanded and enriched learning environment (nature) and the benefits of combining these two aspects of teaching and benefits arising from the use of the **TeachOUT Outdoor Science Game App**.

In Chapter 4 the TeachOUT mobile App challenges are described, so teachers can easily deploy them in the games. The App provides teachers with the tools to make and publish treasure hunt games for smartphones for their pupils to enjoy on field trips. The games offer various challenge types for the pupils to solve on location using their smartphone, such as answering a set of questions to find out what the pupil is investigating, take a photo of specific subject(s), and the

possibility to decorate the photos by drawing on them or to put predefined graphics on them, drawing a simple photo on a predefined image or on a blank canvas, take a video or mark locations with a pictures, and also more traditional ones, such as multiple-choice answers to question, written answers to question, etc.

In the most extensive Chapter 5 the ESTEAM exercises are listed, developed by ESTEAM partners in three countries – Slovenia, Portugal and Norway, linked to three selected themes and according to a pre-defined template. The template can also serve the teacher to prepare contents for the App and the needs (such as photos, videos or audio tapes, etc.) the teacher needs to provide to make a trail/scientific game in the TeachOUT App. The template is available in the document as Annex 1.

The results of the testings, which have been done in all three countries (Slovenia, Portugal and Norway) with pupils and future teachers in two steps: i) paper version and ii) app version, are collected in the Chapter 6. Testing was done in order to gain as many feedback information as possible about how pupils and future teachers were coping with the tasks that were put in the TeachOUT application (both in electronic version and in paper). We were interested in whether the participants had difficulties in understanding the individual tasks, or would they welcome the help (hints) to solve the tasks, whether would like the immediate feedback on a particular task, whether they wanted to find out the results of other teams at the end of the game, or it was difficult to complete the task and whether they liked learning in nature, ... Questionnaire for testing is available in the document as Annex 2.

The general findings of the testings were that in pupils had little problems with finding out points in nature, they liked immediate feedback, the knowledge of the substance was better, and the motivation of pupils was greater. The pupils like the learning in nature a lot. However, testing has brought interesting findings, as well as some useful suggestions for improvements and updates that are described in the mentioned chapter.

If readers will decide to implement a curriculum with a mobile application, the **Guide for teacher in natural science education – ESTEAM methodology Step by**

step guide will be prepared as a third output (O3), also published on-line (www.esteemproject.eu/intellectual-outputs).

ANNEXES

Annex 1

ESTEAM – Enhancement of School TEACHing Methods by linking between schools, experts and geoparks in the combination with outdoor activities and ICT technologies

Development of exercises for outdoor activities - template

Selected theme	<input type="checkbox"/> Geology <input type="checkbox"/> Ecology <input type="checkbox"/> Men and biosphere	
Subtheme		
Class		
Learning goals		
Working methodology	<input type="checkbox"/> Frontal <input type="checkbox"/> Groupwork <input type="checkbox"/> Pairwork <input type="checkbox"/> Individual work	
Learning methodology	<div> <input type="checkbox"/> Observing <input type="checkbox"/> Listening to the teacher or a guide <input type="checkbox"/> Taking pictures <input type="checkbox"/> Experimental <input type="checkbox"/> Playing educational games, role play <input type="checkbox"/> Self-learning <input type="checkbox"/> Contest </div> <div> <input type="checkbox"/> Orientation <input type="checkbox"/> Collecting samples and analyzing <input type="checkbox"/> Use of maps and navigation <input type="checkbox"/> Investigative performance <input type="checkbox"/> Other. Please, specify: </div>	
ESTEAM mobile app challenges	<div> <input type="checkbox"/> Take photo <input type="checkbox"/> Questions and multiple-choice answers with pictures and/or texts <input type="checkbox"/> Write text answer to match a set of possible written answers <input type="checkbox"/> Write or draw on photo taken <input type="checkbox"/> Make a simple drawing </div> <div> <input type="checkbox"/> Make a short film <input type="checkbox"/> Mark a GPS point on the map with picture and/or comment <input type="checkbox"/> Find out what you are holding? <input type="checkbox"/> Answer a set of questions, to find out what it is </div>	
Additional knowledge, skills and competences	<div> <input type="checkbox"/> Teamwork <input type="checkbox"/> Problem solving <input type="checkbox"/> Decision making </div> <div> <input type="checkbox"/> Development of independent thinking <input type="checkbox"/> Other. Please, specify: </div>	
Multi-sensory contents		
Teaching aids		
New terms		

Description of exercise:

Scenarios for ESTEAM mobile app:

Aids for ESTEAM mobile app:

__ pictures, drawings;
please specify:

__ photos
please specify:

__ texts
please specify:

__ sound files
please specify:

__ video files
please specify:

__ other,
please specify:

Annex 2

ESTEAM – Enhancement of School TEACHing Methods by linking between schools, experts and geoparks in the combination with outdoor activities and ICT technologies**Evaluation questionnaire for pilot testing**

1. Gender:

- Female
- Male

2. Age:

- 12 let
- 13 let
- 14 let
- 15 let

3. In which country do you live?

- Slovenia
- Portugal
- Norway

4. Did you have trouble finding the different challenge locations?

- No
- Sometimes
- Many times
- Always

5. Did you find it difficult to understand the different tasks?

- No
- Sometimes
- Many times
- Always

6. Would you prefer to receive hints to help you solve the tasks?

- No
- Sometimes
- Many times
- Always

7. Would you prefer to get an immediate feedback on tasks?

- No
- Sometimes
- Many times
- Always

8. Would you like to know the results of the different teams at the end of the game?

- Yes
- No

9. Did you find it difficult to complete the tasks in the given time?

- Yes
- No

10. How did you like having this class outside?

- Did not like
- Partially liked
- Liked
- Liked a lot

11. After completing the activity, do you think that you got to know better the contents that were previously treated in class?

- Disagree
- Partially agree
- Agree
- Totally agree

12. Which one was your favourite task?

13. What was the most difficult task to complete?

14. Do you have any suggestions for improvement?



Co-funded by the
Erasmus+ Programme
of the European Union

