



Guide for Outdoor Teaching in Natural Sciences

ESTEAM Methodology
TeachOUT - Outdoor Science Game



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Editors:

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

Idrija Heritage Centre (Slovenija): Mojca Gorjup Kavčič, Nina Erjavec,

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

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

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

Univerzitet o Ljubljana (Slovenija): Andrej Šmuc, Tomislav Popit

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

Text and photos by: ESTEAM team

Frontpage and design: OblikovANJA računalniško oblikovanje ANJA GOLOB s.p., Mojca Gorjup Kavčič

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Preface

The ESTEAM project is co-financed by the ERASMUS+ programme of the European Union. It started in September 2016 and will be closing in August 2019. Idrija Heritage Centre is the coordinator of the project. The project started with a consortium of 8 partners. Due to different circumstances some of these fell off during the project. At the end of the project the partners in the project are

Slovenija:

- Idrija UNESCO Global Geopark/Idrija Tourism Board (former Idrija Heritage Centre)
- Črni Vrh Elementary School
- University of Ljubljana, Faculty of Natural Sciences and Engineering

Portugal:

- Naturtejo UNESCO Global Geopark (Naturtejo, Empresa de Turismo, EIM)
- Agrupamento de Escolas José Silvestre Ribeiro, Idanha-a-Nova

Norway:

- Magma UNESCO Global Geopark

Iceland:

- Locatify ehf

The main goal of the ESTEAM project has been to improve the quality of teaching through an innovative method that links national curriculum goals in natural and social science education with the development of a mobile teaching application for smartphones. This step by step guide will help improve skills and competencies about educational methods in science teaching, provides training and guidance in the introduction of new technologies into learning processes and science teaching processes, and provides expert ICT step by step guidelines. Thus, the guide will help teachers to learn about designing lessons in science based on the latest innovative practices.

Welcome to the world of TeachOUT!

The ESTEAM project

The ESTEAM project is a result of the need and desire of natural science teachers to move their education out of the classroom. In surveys carried out as part of the project, local teachers in Norway, Slovenia and Portugal agree on having too little time and not enough aids to get the kids out! In the surveys, the pupils expressed almost unanimously that being taught outdoors, with the possibility of multi-sensory learning, is something they miss – in all three countries.

Technology evolves fast these days, and the children growing up today have never seen a world without smartphones, the Internet and easy access to the digital world. This is a challenge for schools and teachers. Quite often the pupils have to teach their teachers new technology, and that makes teachers hesitant when it comes to using technology as a didactic tool in teaching.

TeachOUT is a tool for teachers, aiming to make technology and outdoor education a more frequent part of education. Interested teachers can get their own account in the TeachOUT CMS. This gives them the opportunity to create tasks connected to their curriculum, and to move teaching outdoors. It is also possible for teachers to let the pupils do their own research and make trails for each other. Research shows that pupils learn even more when they try to teach something to others.

If they wish to, teachers can access the scoreboard after finishing a trail and announce a winner. For teachers, the scoreboard will be useful for getting feedback on which subjects the pupils master and which they need to repeat and study more. By looking at the photos in the scoreboards after finishing a trail, the teachers can make sure all participants have been taking the photos they were supposed to, and the teachers can add or withdraw points if answers stand out in one way or another.

The TeachOUT app can also be used by geoparks or other institutions aiming to educate both adults and children. Getting immediate feedback on your answers is good motivation, and working as teams will motivate and increase learning outcomes.

Presentation of wider context about teachers' beliefs about ICT/digital technologies and pedagogy in combination with ICT

The presence of digital technologies has profoundly changed almost all aspects of our lives: the way we communicate, the way we work, the way we enjoy our leisure time, the way we organise our lives, and the way we source knowledge and information. It has changed how we think and how we behave. Children and young adults are growing up in a world where digital technologies are present everywhere. They do not and cannot know any different. This does not mean, however, that they are naturally equipped with the right skills to effectively and conscientiously use digital technologies.

Digital technologies are the future; this cannot be avoided. And they are present in all aspects of life.

Also, in education, new needs have emerged, especially on the educators' side. As the teaching professions face rapidly changing demands, educators need and require an



increasingly broad and more sophisticated set of competences than before. In particular the presence of digital devices and the duty to help students become digitally competent requires educators to develop their own digital competence. On International and national level, a number of frameworks, self-assessment tools and training programmes have been developed to describe the facets of digital competence for educators and to help them assess their competence, identify their training needs and offer targeted training. Analysing and clustering these instruments, this report presents a common European Framework for the Digital Competence of Educators (DigCompEdu – <https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/european-framework-digital-competence-educators-digcompedu>). DigCompEdu is a scientifically sound background

¹ Photo: Kids playing games on mobile devices (Source: Shutterstock)

framework which helps to guide policy and can be directly adapted to implement regional and national tools and training programmes. In addition, it provides a common language and approach that will help the dialogue and exchange of best practices across borders. The DigCompEdu framework is directed towards educators at all levels of education, from early childhood to higher and adult education, including general and vocational training, special needs education, and non-formal learning contexts. It aims to provide a general reference frame for developers of digital competence models, i.e. member states, regional governments, relevant national and regional agencies, educational organisations themselves, and public or private professional training providers.

That the changes are necessary, has also been proven through research carried out as part of the ESTEAM project, where the needs of teachers and pupils were studied, as well as the national curricula. The analysis and research were published in an E-book with the title "Research of National curricula in natural science teaching in Portugal, Norway and Slovenia – Results of analysis with guidelines", that represents Intellectual Output 1 of the project. The results show that teachers only rarely or never use tablets or mobile phones during classes (and also at home) while pupils are already using them all the time. This problem is also apparent in the teaching methods, where again pupils and teachers are on complete opposite grounds, because teachers mostly use standard methods which pupils do not appreciate. They prefer new ones (like apps, group work and so on), but these are not preferred by teachers.



² Photo: Pupils watching a short animation about protecting nature (Source: Idrija UNESCO Global Geopark)



Furthermore, it is often said that teachers and educators too often focus on the development of the cognitive competences of their pupils, while they neglect the social, emotional and physical development of pupils as well as their contact with themselves and with nature. From the personal interviews it was seen that teachers face too many organisational problems when trying to carry out outdoor teaching (such as lack of time, lack of time for accompanying pupils outdoors, lack of motivation etc.). The results of the research of the needs of teachers and pupils are appealing. The majority of all pupils and teachers have less than 5 days of outdoor activities per year. But everyone would love to do them more.

Some countries in Europe are already in the process of reforming the educational system, as they are aware that outdoor mobility and outdoor learning are very important for the psycho-physical development of pupils, which means, among other things, that a minimum number of days that teachers and pupils have to conduct outdoors should be legally introduced. On the other hand, learning and outdoor activities are also a counterweight to tablets, computers, and televisions.

Outdoor learning helps pupils to:

- develop their language and communication skills,
- develop self-control,
- learn about decision making and problem solving,
- work out ways to get on with other children,
- become more independent, improve their self-confidence and self-esteem,
- learn about the outdoors, the weather and the seasons,
- cope better with stress,
- develop the ability to persist,
- develop their immunity,
- get over some of their fears,
- test their abilities,
- use and develop their imagination.

³ Photo: Observing and taking photos of granitic boulder with a mobile phone (Source: Naturtejo UNESCO Global Geopark)



technologies and outdoor activities) and to raise engagement and motivation for natural science teaching/learning with attractive contents and tools for pupils. An important objective of the project was also the increased level of digital competences for teachers and pupils.

The final result of the three-year work is the Mobile TeachOUT application that brings together all of the above, and the "**Guide for teacher in natural science education – ESTEAM methodology Step by step guide**" for teachers who choose to use the application in teaching.

All these issues and the need for change inspired the ESTEAM project applicant to connect learning through digital technologies and outdoor activities. Besides understanding the characteristics of the curricula for natural science and technology (NST) in European countries, the main objective of the project is to acquire innovative, quality, optimized natural sciences teaching methods and introduction of new tools, offering new approaches and teaching processes (active pedagogical methods with digital

⁴ Photo: Pupils active in nature on an educational trail, using a TeachOUT mobile application (Source: Magma UNESCO Global Geopark)

Review and summary of O1 and O2

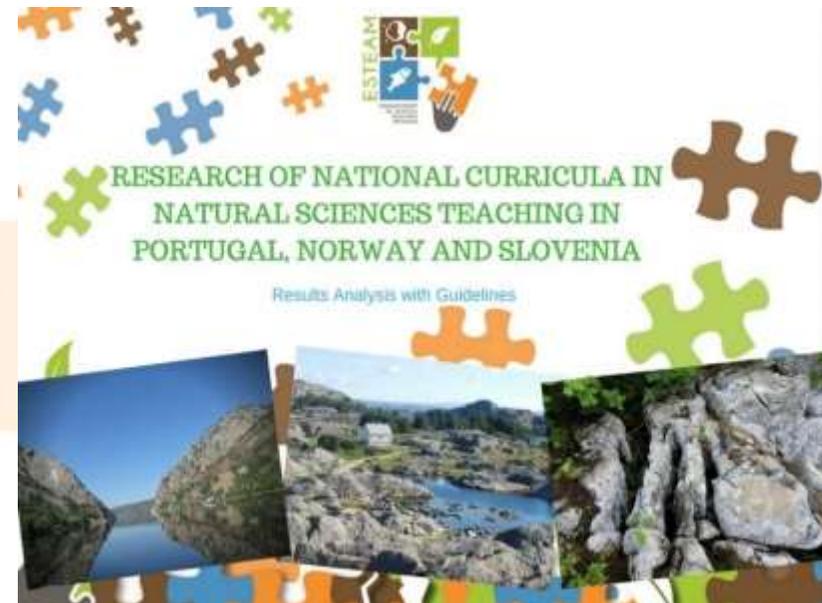
Within the ESTEAM project (*Enhancement of School TEaching Methods by linking between schools, experts and geoparks in the combination with outdoor activities and ICT technologies*) three main outputs were foreseen:

- Output 1 – Research of national curricula in natural sciences teaching in Portugal, Norway and Slovenia,
- Output 2 – Development of teaching methodology: mobile teaching/users experience platform TeachOUT and
- Output 3 – Guide for teachers in natural science education – ESTEAM methodology Step by step guide.

In these three consecutive steps, the project partners firstly researched the needs of teachers and pupils in the field of natural science teaching (NST). Secondly, the TeachOUT application was created based on the findings of that research. Finally, a Step by step Guide for teachers (final users) was prepared.

Activities for preparation of the **Output 1** document, held in three UNESCO Global Geoparks in the three countries involved in the project (Slovenia, Portugal and Norway), included an online survey with questionnaires addressed to pupils, teachers and future natural sciences teachers, and personal interviews with teachers. In the research of national curricula on natural sciences in the participating countries, the subjects where natural sciences are taught are: natural sciences, biology, geology, physics, chemistry and geography. How many subjects and how the natural sciences are spread among the subjects, varies between the countries. 792 participants answered the online questionnaire, and 4 personal interviews were carried out with

teachers in each geopark. All the findings about learning objectives, current skills and competencies of educational methods in natural science teaching, the opinions of pupils on the methods of science teaching and suggestions for improvement were presented in the e-book with the title "**Research of National curricula in natural science teaching in Portugal, Norway in Slovenia – Results of analyse with guidelines**". The e-book was finalised in April 2017 and is available on the ESTEAM project website (www.esteemproject.eu/intellectual-outputs).



⁵ Photo: Cover page of the Output 1 document "**Research of National curricula in natural sciences teaching in Portugal, Norway and Slovenia, Results Analysis with Guidelines**"

The results of the analysis within the Output 1 made the basis for the creation and development of the teaching material and the mobile platform itself, which was the second output, **Output 2**, in the ESTEAM project – "**Development of teaching methodology: mobile teaching/users experience platform**". The project partners developed the content for the mobile application in three selected topics: 1 – The impact of humans on Earth; 2 – Ecosystems; 3 – Geology, which were also selected in accordance with the priorities of teachers and pupils in all three countries.



However, the results of the activities within the Output 2, was the application with the name **TeachOUT – Outdoor Science Game**, which is a comprehensive educational application for natural science teaching (NST).

The TeachOUT app allows teachers to formulate tasks, add multisensory content (from treasure hunts, questionnaires, observations, listening, and filming to the study of maps), and to extend the usual classroom work to a classroom in nature. On the other hand, pupils get to learn about nature in nature, to take independent decisions, to observe the world around them, behave responsibly towards the environment, communicate with their classmates, participate in the group, use different sources of information to help them solve challenges, analyse their solutions and review and justify answers later in the classroom, think creatively and to use modern technologies in the learning processes.

⁶ Photo: Man depends on natural resources and influences nature by his activities (Source: Shutterstock)



In the e-book *Development of teaching methodology: mobile teaching/users experience platform*, the TeachOUT partners presented the process of creating a mobile application for teaching and learning natural science in elementary schools. The e-book includes also results from the testing of the prepared contents of the mobile application in paper version and in app version. The testing was done in order to gain as much feedback information as possible about how pupils and future teachers were coping with the tasks that were provided in the TeachOUT application (both in electronic version and in paper versions). We were interested to know whether the participants had difficulties in understanding the individual tasks, whether they would

welcome help (hints) to solve the tasks, whether they would like immediate feedback on the individual tasks, whether they wanted to know the results of other teams at the end of the game, whether it was difficult to complete the tasks, and whether they liked learning in nature. The general findings of the testing were that pupils had little problems with finding locations in nature; they liked immediate feedback; their understanding of the subjects was better, and their motivation increased. The pupils like learning in nature a lot. However, the testing has led to interesting findings, as well as some useful suggestions for improvements and updates.

With the document "**Development of teaching methodology: mobile teaching/users experience platform**", we, the partners, wish to convey our experience with designing a methodology that combines classroom and outdoor learning with modern ICT technologies, to the final users of the mobile application, and also to provide the users with the tools that we used to achieve this. The e-book is published online (www.esteamproject.eu/intellectual-outputs).

Both of the two previous activities served as input information in the preparation of the Output 3 document, the e-book titled "**Guide for teacher in natural science education – ESTEAM methodology Step by step guide**". This current document has been prepared for teachers who decides to use the new TeachOUT app in their classroom with their pupils. Like the previous two outputs, Output 3 is also published online (www.esteamproject.eu/intellectual-outputs).

⁷ Photo: Observing the chemical reaction of weak acid with the limestone (Source: Idrija Heritage Centre Archive)

Teaching methodology

Man is a being who is constantly learning, and learning is a process that does not take place only at school, but practically at every step. Learning begins right after birth. We acquire knowledge and experience, intensively, from everything around us, at home and outside in nature, starting well before entering school. Upon entering school, the period of planned learning in the classroom begins, which should in no way be the only place to acquire knowledge. Especially in recent times – being well aware that young people do not spend much of their free time outside – learning in nature should become an important complement to the traditional approach to learning.

By combining a traditional learning environment – the classroom – with an expanded and enriched learning environment – nature – pupils are sure to excite more curiosity, interest, motivation and inspiration for exploring and finding new skills. In nature, acquired knowledge is not based only on theoretical starting points and facts, but also on direct multisensory experiences, occurrences, experiments and research in general. Physical movement also has a positive effect on health, development, concentration, and consequently also on learning.

The teacher has long lost the status of being the primary source of knowledge and discovery. Time has brought an endless number of possibilities for acquiring facts, information and various data from a wide variety of sources. So, the time of frontal teaching of children has also passed. The teacher's role is the role of a moderator on the way through a difficult transitional forest of a wide variety of information, on the way to the targeted goal, which is

formal knowledge. Formal knowledge is the end goal of the state, who with the implementation of lesson planning and curricula has acquired a systematic insight into the citizens' knowledge.

Within these frameworks, teachers have a wide variety of options or freedom on the road to set goals. We choose to use teaching methods that correspond to a group of learners in a certain environment and time. Modern methods aim primarily to employ pupils and encourage them to find and choose new values in the global world. Therefore, a modern teacher does not associate teaching with the accumulation of new concepts that students understand as an abstract, but with new skills, new "know hows".

Assuming that the basic teaching modes go as follows:

- transfer of knowledge (enables accumulation of knowledge, factography, reproduction),

- promoting development (enables the development of intellectual potential, raising awareness)

- guidance in detection (enables the construction of knowledge, responsibility, initiative)

- developing skills (training, procedural knowledge),

then the contemporary teacher dedicates the least amount of time to transferring knowledge and focuses primarily on the other three modes of teaching. Modern teaching methods combine the characteristics of the last three teaching modes.

- Learning in nature – fieldwork

Pupils in nature observe, perform experiments, record measurements, sort, regulate data, etc. In doing so, they develop their potentials, they are aware of nature, they develop responsibility for nature and their peers, develop the ability to find solutions in unforeseen situations, and develop the skills of observation, experimentation, etc.

- Work in the laboratory

Laboratory work promotes the development of a scientific method as a form of problem solving and develops the pupils' sense of accuracy, systematics, observation, etc. It is suitable for getting to know new concepts, developing skills and forming standpoints.

- Resource management, analysis and discussion

The method develops in pupils the understanding of complex relationships, the formation of opinions and the taking of independent decisions. This is a method where students exchange ideas, talk about experimental results, or plan new activities. The discussion takes place according to the teacher's instructions; it can happen unpredictably. Group discussion develops the ability for leadership and critical thinking among pupils, develops a sense of teamwork and is very suitable for changing attitudes through a democratic dialogue.

- Play roles

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

Choosing any of the four basic modes requires a teacher to reflect on the activities of the learner on the way to the desired goal.

In particular, the field of science with all subgroups must be the one that is taught in direct relation to the source of knowledge, namely the nature itself. We know that nature makes the best classroom. It is concurrently also the most unpredictable and changing classroom.

- We can link all of the above to the TeachOUT application, justifying the use of this application. The application is a tool for learning about nature in nature. It allows the pupils to independently decide on the execution of tasks and makes them accustomed to environmental observation and responsible behaviour.
- Working in groups enables them to communicate and cooperate among their peers in making common decisions. It makes them accustomed to teamwork, which will be the basis for the development of science in the future.
- The application connects working in nature with working with resources. It allows for the pupil to find appropriate answers through a source that is accessible in the application.
- By using the application, we enable the students to learn 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, because the application enables the production of a recording, which can later on be analyzed. Through analysis we can learn about any new facts.
- When using the application, we develop the ability to handle mobile phones and tablets as educational means. By doing so, we connect

modern technology with learning and allow children to consider possible shortcomings and developments in the future.

- The application enables us to link all the advantages of working in nature with the progress in the field of digitalization.

Just like children are researching areas of interest, teachers are constantly looking for the most effective methods for achieving quality knowledge and skills. The TeachOUT application is one of the steps in the constant process of changing and improving teaching as such.

Features of educational activities in nature, preparation and how to motivate pupils to work in the field

Presentation of the characteristics of the implementation of educational activities in nature

Science education should integrate activities in the various learning environments (classroom, field, museum / interpretation center and laboratory). The teacher should use the different environments in order to be complementary, aiming at the connection between activities carried out indoors (classroom, laboratory, museums / interpretation centers) and outdoors (nature). Geosciences have enormous value as a didactic resource. In our daily life we live surrounded by geological elements, as for example the stones used in our house or school. For a first contact with geology activities, these are basic locations. But for the meaningful learning of geosciences, direct contact with geodiversity is essential, whether in formal or non-formal activities. In this sense, field trips allow geodiversity to have a very significant educational value. The field / nature is the center of activities where you can teach the scientific method and truly understand how scientists (e.g. biologists and geologists) build scientific knowledge about Earth's history and the evolution of life.

The field is the ideal place where you can create situations / problems and learning strategies that allow them to be solved. This presupposes that pupils participate actively in their own learning. The field outputs are central, since they allow the following: connection with the natural environment, which allows the pupils to understand the environmental variables; identification and knowledge of geodiversity and local / regional biodiversity through direct contact with rocks, fossils, minerals, rivers, lakes, soils, landscapes, flora and

fauna, etc.; an integrative perspective of the processes of nature and of this as a whole. Thus, the activities developed during field trips allow the pupils to interpret nature, to appreciate it, to love it, to respect it, to care for it and to enjoy it in a more conscious way.

Preparation and motivation of students to learn in the field / outdoors, examples of good practice: the case of Naturtejo Geopark – UNESCO Global Geopark

The three pillars of action of the UNESCO Global Geoparks are (geo)education, geoconservation and geotourism, aiming at the sustainable economic, social and environmental development of their territories. In order to have an effective conservation of the geological heritage, it makes sense to educate and sensitize the school public for conservation and respect for nature, in a holistic perspective. The most common geopark strategy combines pre-field activities, field output and post-field activities.

The Educational Service of the Naturtejo UNESCO Global Geopark was created in the 2007/2008 school year and include three types of educational programmes: "The School goes to the Geopark", "The Geopark goes to the School" and "Anim'A Rocha". These programs are organized for pupils and teachers from preschool to university institutions located in the territory of the geopark and the rest of the country, as well as from abroad. The activities are a complement to the curricular programs of the disciplines of geosciences, biology, environmental education, history, geography, tourism, rural development, Portuguese language, citizenship education, territorial planning, protected areas, physical education, etc. Usually, the activities are interdisciplinary. The monitors are technicians of the Naturtejo Geopark staff or freelancers with superior scientific-pedagogical qualification in geosciences

and/or geological heritage and/or biology or geography. Currently there are 25 partners of educational programs, such as interpretation centers, museums, tourism animation companies, ONGAs for Environment, a teacher training center, private companies, protected areas, research centers, universities / higher schools, etc. There are integrated in the educational programs: 13 geo-monuments (of 176 geosites inventoried), 10 museological spaces, 8 pedestrian trails of geological interest and 1 route of boat / kayaks.



8

⁸ Photo: Ichnological Park of Penha Garcia, one of the 17 geo-monuments.



9

⁹ Photo: Interpretation Center of Biodiversity "Idanha Lands"



10

¹⁰ Photo: Boat trip at Portas de Ródão Geomonument

A website was created in 2011 regarding the educational service of the geopark, "Geonaturescola". This website and leaflet are specific for dissemination and booking of educational programs, which includes educational resources for teachers (www.geonaturescola.com).



11

In Naturtejo Geopark, nature lessons / field trips are the kind of activities most developed and are considered fundamental in the educational service. The Field Trips / interdisciplinary nature classes that integrate the Naturtejo Geopark Educational Programs allow participants to enter into direct contact with the natural environment, where they can learn about geosites and practice nature sports. The various activities allow students to recognize the importance of conserving these key spaces for understanding the evolutionary history of life and of the planet Earth itself.

In the educational program "The school goes to the Geopark" there are 13 interdisciplinary field trips of half a day or 1 day, distributed among the 7 municipalities of the territory of Naturtejo Geopark. These field trips can be combined into educational programs lasting two or more days, including workshops or other "à la carte" activities.¹²



¹² Photo: Promotional leaflet of the educational programmes.

¹¹ Photo: Website of the educational service (www.geonaturescola.com).



13



14



15

The educational program "The Geopark goes to school" is directed at geopark schools, free of charge, and there is also a field trip "Geodiversity around our School" and 8 proposed workshops.

The educational program 'Anim'a Rocha' is also aimed at pupils from the territory of the geopark and consists of annual projects (pre-field lessons at school, field trips, workshops, exhibitions of works resulting from the projects); activities to explore exhibition; activities to celebrate environmental and other theme days (International Earth Day/National

13 Photo: Field trip A/C

14 Photo: Field trip J

15 Photo: Field trip E

Geological Heritage Day, International Tree Day, Native Forest Day, Environment Day, World Children's Day, etc.); school competitions on environmental themes and seminars / presentation of the works; activities included in the schedule of the Festival of Landscape / Week of European Geoparks.



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In order to prepare and motivate the students before the field work and before the field trips (at pre-field lessons), the geopark offers several educational resources to teachers and students:

- Teachers' guides related to each of the field trips, with themes, contents and concepts to be addressed (www.geonaturescola.com)
- Multimedia resources: visits to the mines of Segura and Monforte da Beira
- Geological map simplified
- National exams with geopark geodiversity issues
- Book "Fossil Route: Questions and Answers"
- Hobbies (soups of letters of various themes)
- Scientific papers and scientific information related to each field trip
- Samples of geopark rocks, fossils and minerals
- Forms of silicone fossils and molds of fossils
- PowerPoint presentations
- Documentary "We are the Ponsul River"
- Game "Domino Geopark Naturtejo"
- Game "Roll, roll the Trilobite"



17

17 Photo: Educational game Naturtejo UNESCO Global Geopark

Among the educational resources created by the geopark and used during field classes / workshops in nature within the educational programs of Naturtejo Geopark can be cited:

- Illustrated schemes in size A3.
- Models created with common materials, to explain concepts or geological processes (models of trilobites, *Cruziana*, synclinal, anticlinal).
- Fieldguides/work-sheets for students.
- Guides/Worksheets to explore exhibitions.
- Games (puzzles of geopark's simplified geological map and geomonuments, puzzles of each municipality geopark's geological map, geo-monuments puzzles, memory games, matching games).
- Identification guides for plants and birds.
- "Module of teaching of geosciences in the field: geoparks and geosites".
- Samples of native plants of the geopark.
- Memory games (autochthonous geopark plants, Palaeozoic animals).
- Nature colour palette game.
- Game "Trilobites fishing". Game "Geological time", puzzle of the geosites of Penamacor, puzzles of the geodiversity of Penamacor.



18

During activities carried out in nature, students can have an active role in improving environmental quality, namely

18 Photo: Educational game Naturtejo UNESCO Global Geopark

by collecting waste and planting or sowing native species in the territory of the geopark. In the annual educational projects, pupils are also invited to interpret and value the natural and historical-cultural heritage of their geopark, elaborating works throughout the school year for this, which are then presented to the school community and the population in general.

The most frequent activities for teachers are seminars, in the context of educational projects in which the geopark is involved ("Geoschools" and "ESTEAM Project – New Technologies, new methodologies: Presentation of the TeachOUT App"), field trips, accredited training courses (e.g. "Fieldwork in Naturtejo Geopark", "Naturtejo Geopark as an educational resource", environmental education conferences (XVIII Conference of the Portuguese Association of Environmental Education – Educational Landscapes, XV Conference on Conservation of Nature and Environmental Education of FAPAS).



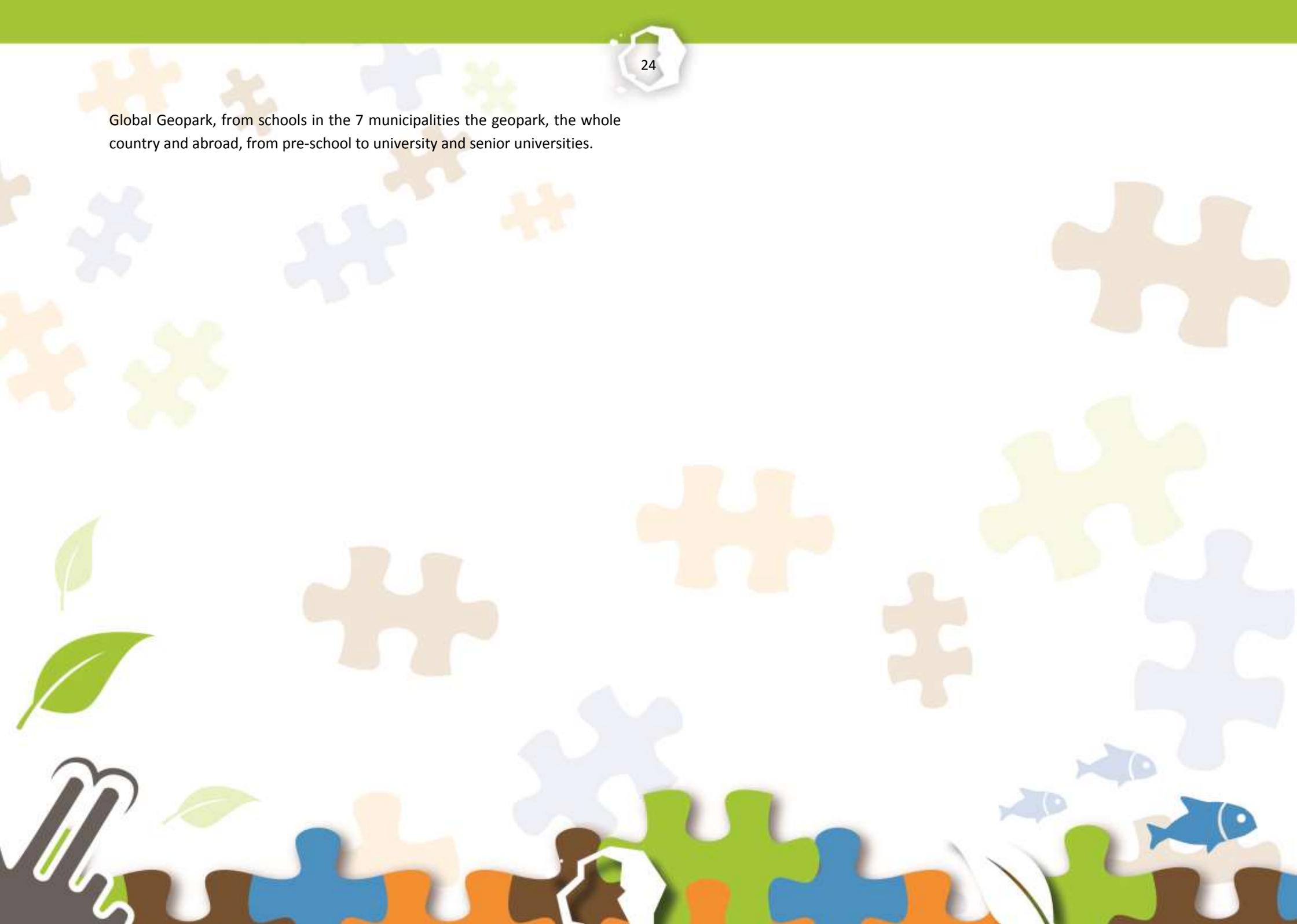


The ESTEAM Project with the TeachOUT Mobile Application: Outdoor science game (which can be used interdisciplinary) and the Step-by-Step Guide to the ESTEAM Methodology for Teachers is an excellent contribution to innovation in teaching methodologies using technologies such as computer, smartphone and tablets in pre-field, field and post-field class. This methodology and app are now available for teachers and monitors of the Naturtejo UNESCO Global Geopark to make students more participatory and constructive of their own learning through a fun game, while they are enjoying nature. The geoparks of the UNESCO Global Geoparks Network can thus have a new educational tool for their educational activities.

The Agrupamento de Escolas José Silvestre Ribeiro, from Idanha-a-Nova, the other Portuguese partner of the ESTEAM Project, has actively participated with its students (from pre-school to upper secondary education, from 3 to 18 years old) and teachers in the educational programs of Naturtejo Geopark, since the beginning. Several annual projects have been developed over the years (eg: "Rivers Project at Ponsul", "Meet your geopark", "Know the Geomonuments of Naturtejo Geopark located in your county", activities for planting native species during the Week of the Native Forest, collection of waste, school competition on environmental themes, workshops on fossil replicas, training courses accredited for teachers, among others. From the school year 2007/2008 to 2018/2019 (May) a total of 33 527 students and teachers participated in activities of education in geosciences for sustainability promoted by the educational service of the Naturtejo UNESCO

²⁰ Photos: Workshops for presenting the TeachOUT App to teachers at the Agrupamento de Escolas de Idanha-a-Nova and at Monsanto village.

Global Geopark, from schools in the 7 municipalities the geopark, the whole country and abroad, from pre-school to university and senior universities.



Pilot testing – cases and user experience

Slovenian School

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 close to school. As the children that tested the trail are about twelve years old, we had to accompany them all the time while testing the app. For this reason children missed more freedom while working on field.

The pupils were really motivated having the class outside and they especially liked using mobile phones for the educational purpose. Working in small teams and teams competing with each other made this learning experience really challenging. Even if the trail is quite long pupils did not find it difficult to find different challenge locations and to understand the tasks. Some pupils also used hints when solving the tasks.

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

According to the survey that was made right after the pilot testing pupils would like to receive more information about the trail, which the teacher can include in the description of the trail within the app. They would like to have more difficult tasks, tasks that include experiments and more games. According to the survey, immediate feedback and comparing your score with others is very important and motivating.

Portuguese School

The TeachOUT application test was held in Monsanto in November 2018. The group of pupils who initially took the test using the paper version was invited to participate in this second test of the future TeachOUT application.

The main goal of this second test was to test some of the characteristics and potentials of the application and to make a comparison with the dynamics, the results and the degree of satisfaction of the participants in the first test. To the initial group was added a second batch of pupils with about 15 pupils belonging to the 11th grade. The total number of pupils was 33, of which 19 were male. The mean age increased 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 was maintained. The feedback from the pupils on the first test was very favourable. In this second test the results of the proposed survey showed higher contentment and a higher level of satisfaction.

Regarding the questions and challenges provided, the feedback was very positive. The pupils considered it relatively simple to find the points with the challenges and to correctly interpret the task they had to perform and the issues they had to solve. The presence of specific hints along the route, somewhat less abundant in the paper version, was considered very important and decisive in the interpretation of the route to be travelled. The few difficulties encountered in determining the path and realizing the full range of challenges, difficulties that had been mentioned in the first test, were thus

corrected. The different types of questions – and especially the images, sounds and videos presented in the app that occasionally appear along the course – made the challenges much more interesting and were extremely well received by the different participants. The assignment of scores in the immediate and the information of the correct question, in the event of a mistake, was extremely well accepted by the players.

After the challenges were over, the comments were very positive. Most of the pupils showed interest in repeating the adventure and taking on more challenges elsewhere. A less positive aspect worth mentioning was some difficulty in moving along the route, sinuous and rocky in part, while handling the mobile phone, increasing the risk of falling and damaging the device. The pupils mentioned some difficulty in finding some of the points, due to poor definitions of their location provided by the GPS services of the electronic device. The most positive aspects were the dynamics created, the playfulness, the ease of use, the possibility to approach different themes from different disciplinary areas, the understanding of the subjects and the comparison of results and answers. The players understood and liked the fact that they could instantly know the location of the opposing teams and the different scores. The idea of *learning while playing* is present throughout the analysis of the various opinions.

Norwegian School

We tested TeachOUT with 20 pupils, all boys, from 9th and 10th grade in an area called Hestnes in Egersund, Norway. This is a 4-5 km trail close to the sea, through varied landscape with marked routes and short distance to their school, Husabø ungdomsskole.

The weather was typical Norwegian autumn weather; hail, rain and heavy wind, and a couple of the pupils lost motivation quite early because of this. We organized the pupils in groups of about 4 to 5 boys in each group. They downloaded the app and started the trail while still connected to the Wi-Fi in their classroom. There were three teachers present, and we tried to split and cover the entire trail to make sure that the pupils would get assistance if needed.

TeachOUT worked well up until location no 4. For some reason this location was located at sea. We later discovered that this was a bug in the app, and the developers fixed it, but for the pupils this killed a lot of the enthusiasm for the app. They got frustrated when they could not continue on the trail, and they missed out on the last three locations.

All in all, the first official testing of TeachOUT at the Hestnes trail went ok, but the bug connected to the 4th location caused a bit of frustration. We also experienced some difficulties with the app on a few of the pupils' phones and with their connection to the GPS. For that reason, we had to split up the groups without functional phones and divide those pupils among the other groups. This caused too large groups, and too many non-participative pupils. However, the pupils were positive to more testing, and they have tested TeachOUT at numerous occasions later on and in different areas of Magma Geopark. Now they know that it works, and also how it works, and we consider it a useful didactic tool for our local teachers.



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21 Photo: Testing Norway

22 Photo: Testing Slovenia

23 Photo: Testing Portugal

Possibilities for presentation and transmission of natural science using ICT technology

It is a well-known fact that modern ICT technologies play a vital role in teaching/learning process at all stages of education and thus markedly improve the quality of pedagogical work. Even more, the new teaching/learning environments CANNOT be created without use of ICT technologies. The resort to new ICT technologies in the teaching of natural sciences like for example geology arise from the extensive use of computers, smartphones and tablets and in particular from the omnipresence of internet and satellite data. In an educational perspective, they bring several advantages. However, there are also disadvantages, or rather dangers, involved.

The main advantages are related to:

- The fast availability of large amounts of in-depth information, thus allowing the teacher to spare time and to check information *hic et nunc*.
- They allow useful and complicated simulations in order to present complex ideas and paradigms that would be almost impossible for pupils to grasp without the aid of ICT.
- They also make visual and interactive explanations possible, which is difficult with the classical book-based instruction, especially when dealing with the newest research.
- Least but not last, they can transmit to sectors of the population who were previously on the margins, and in this way offer extraordinary opportunities for social and economic mobility.

The possible dangers are related to the;

- Risk of completely replacing the direct physical experiences, which are fundamental for a pupil in order to grasp the way in which natural sciences (especially geology, chemistry, physics and biology) are developed.
- A massive resort to ICT risks preventing the pupils from maintaining direct contact with the nature, rather inducing them to think that the whole reality is a virtual reality and not a natural one.
- Excessive use of computers, phones and tablets represents a possible addiction to the gadget and implies postural and visual problems.
- So called "McDonaldization of the science" i.e.: the problem of fast-learning, meaning that education might be offered in a quick manner, with some sort of miraculous recipes, which makes the learning easy, pleasant and possible to obtain almost without pain and study.

Nevertheless, we believe that the possibilities for presentation and transmission natural science using ICT technologies should evolve into the follow directions:

- simulations and animations to address areas of difficulty in conceptual understanding and the possibility of interpreting rare and complex geological phenomena,
- to produce tools that can show certain objects/phenomena that cannot be usually observed,
- teachers need to develop knowledge on how to integrate ICT technologies into their teaching and to increase access to existing material,

- related to the previous: better and more efficient use of ICT by making the process less complex, with tools and software ready for everyday practical use,
- the ICT tools should be attractive for learners and encourage them to express interest in natural sciences,
- the ICT tools should increase popularity and stimulate the creation of interactive websites on the Internet that increase the pupils' interest in natural sciences,
- implementing communication technologies should improve the learners' communication with the teacher and environment,
- the process of designing new educational software should devote more attention to creativity and original tasks,
- the ICT technology should be confirmed with the curricula and perhaps guide into upgrading them, designing new educational software and should increasingly focus on the national languages.

Some of the best educational apps for natural sciences currently available are:

- **EarthViewer** allows users to explore the Earth's geological past, present and future.
- **WWF Free Rivers** is a neat educational tool, showing the powerful impact river systems have on nature and human civilization and how we can damage or preserve these vital natural systems.
- **Earthquake** is a popular geological app which let you know about earthquakes based on multiple data sources. It allows you to get info about both the latest and old earthquakes from all over the world.
- **Biology**, a useful app for biology teachers; however, this is more of an interactive tool allowing the pupils to answer questions, play

games and follow other prompts in order to explore each mammal's various features.

- The **Chemistry** app guides pupils through experiments and provides additional information about the make-up of molecules.
- The **Kamencheck** app is developed at the University of Ljubljana and is actually a key for determining the different types of rock. It is an e-learning tool that will contribute to improving the quality of the teaching of geological contents within natural science subjects in the formal school system.

Tutorial for teachers to make treasure hunt games for smartphones to use in outdoor field trips with students

What's the ESTEAM project about



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To make tools that the teachers can use to gamify the field trip learning experience for their pupils:

- Make treasure hunts on our cloud-based platform
- Games with content that fit the learning curriculum
- Gamify the learning experience with challenges and problem solving
- Use the app as a learning tool on field trips
- Assimilate the results and share

How to participate

Sign-up to the ESTEAM Platform

1. Visit: <https://www.esteemproject.eu/teachout-contact>
2. Send the nearest contact person an email requesting access and include:
 - a. Some proof that you are an educator
 - b. What school you work for
 - c. Some relevant information as to how you would like to use the tool for education
3. Within a few days, you should receive an email with an access code and instructions for signing up to the platform. Then you sign up to the Locatify Creator CMS and log in using your code.

Start making games

Once you have received the invitation and signed up – prerequisites

Making games in the cloud:

Hardware: Windows, Mac or Linux PC

Browser: Chrome or Safari (*Internet Explorer browser is not recommended!*)

Network access required to connect to the cloud service for making games

Playing a game with a smartphone:

Apple iPhone or iPad with iOS 9 or later

Android phone or tablet with Android 7 or later

GPS reception for location reading

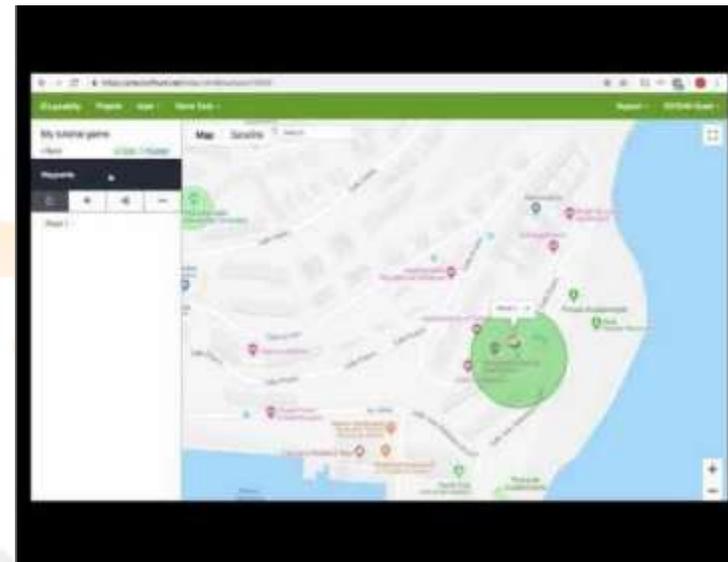
Download app named: TeachOUT

Network required to: download games, see scoreboard and upload results

Network not required: while playing the game, as content is pre-downloaded

How to make a game and play it Video tutorials in 7 chapters

1. Log in and make your first game
2. Add treasures and content
3. Add question challenges
4. Add photo and draw challenges
5. Prepare game for publication to app
6. Publish and run the game
7. Results after playing the game



Log in and make your first game

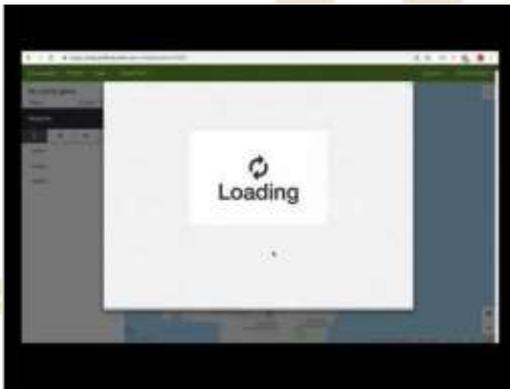
- Visit www.locatify.com and log in with your credentials.
- Create your first minimal game with one simple treasure location.
- Publish your game for testing without going the actual trail.
- Download the TurfHunt app to test the game (TurfHunt is only used for testing the game, the TeachOUT app is used for playing the released game).

Click [HERE](#) to watch a Videoguide No. 1!

Add treasures and content

- Add more treasure locations to the game.
- Fill each treasure location with simple content or use a template with formatted content.
- Draw a path on the map for the pupils to walk.
- Add a hidden treasure that only shows after another treasure is discovered.

Click [HERE](#) to watch a Videoguide No. 2!

**Add question challenges****Multiple choice answers:**

- Question and answers can have picture, text or both.
- One answer is correct.

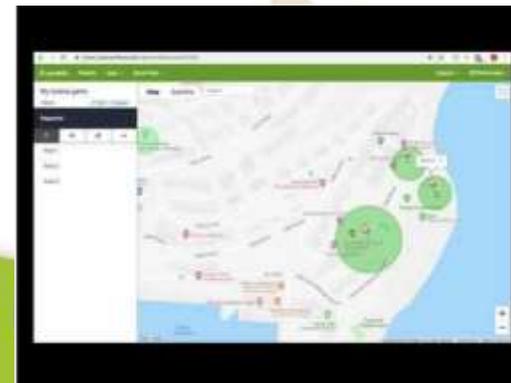
Written answers:

- Question has text, picture or both.
- Written answer correct if it matches one of possible answers.

Question tree with multiple-choice:

- Answer can lead to another question.
- Picture and text or both for question and answers.

Click [HERE](#) to watch a Videoguide No. 3!



Add photo and draw challenges

Add photo challenges:

- Plain photo
- Draw on photo
- Decorate photo with images

Add draw challenges:

- Draw on a blank canvas
- Draw on an image

Simple memory game pairing challenge

Click [HERE](#) to watch a Videoguide No. 4!

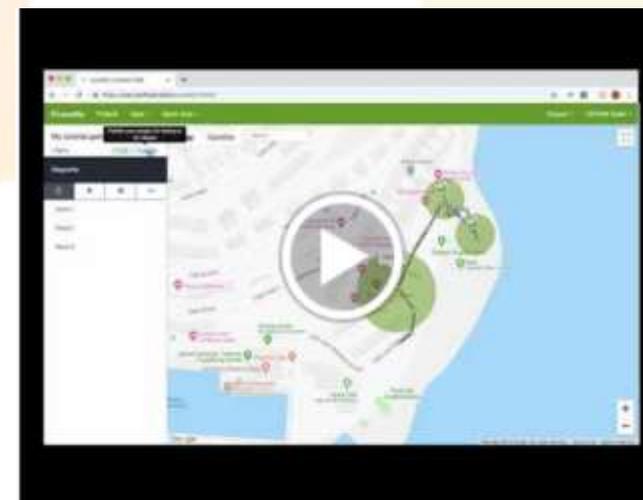
Configure your game for publication

Add content about the game:

- Game name, description, logo
- Directions for starting the game
- Game over message

Configure game settings:

- Location
- Start from the CMS



More:

- Coupon rewards
- Custom map
- Export game

Publish for testing again, and test the game

Click [HERE](#) to watch a Videoguide No. 5!

Publish and run the game**Publish the game to the TeachOUT app:**

- Publish for 6 hours
- Create game instance

Game tools in the CMS:

- Invitation code
- Scoreboard
- Observer
- Send a message to players

Open the TeachOUT app:

- Delete the test game and refresh
- Download and join the published game

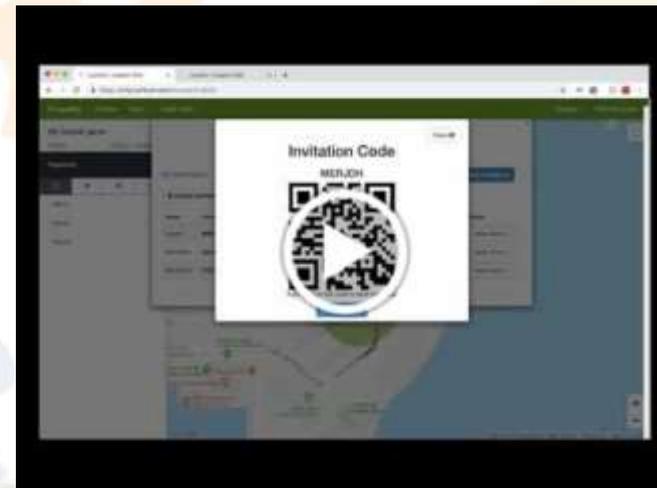
Click [HERE](#) to watch a Videoguide No. 6!

After playing the game**App:**

- Look over the game after playing
- Scoreboard

CMS Game analysis:

- End game instance
- Edit scoreboard
- Export scoreboard to file
- Observer



CMS miscellaneous things:

- End game instance
- Question bank
- Start game made by another user

Click [HERE](#) to watch a Videoguide No. 7!

Thoughts and hopes for the future of TeachOUT

Feedback from Norwegian teachers participating in testing, multiplier events and workshops:

“Nice and useful course. I hope and believe we will use this actively at our school in the future.”

“The course suited me well because it was taken into account that we teachers are on different levels when it comes to technology. I felt like I was able to keep up with most things.”

“Very nice and inspiring presentation.”

“It is always nice to learn something new. I will use this in my teaching. Motivational course holder!”

Feedback from Slovenian teachers participating in testing, multiplier events and workshops:

“The application, developed within the ESTEAM project, seems to be an excellent upgrade of the school curriculum, as it combines elements that, in my opinion, are perfectly complementary, and each for itself and at the same time all together promote and bring positive effects to successful learning. I believe that the use of modern technology and the possibility for pupils to research independently and actively in the field increase the motivation, which is crucial for acquiring or consolidating the learning goals. In my work, the application seems to be most useful in social studies and science, since the contents offer more research work in the field and through different challenges; more possible ways of acquiring knowledge.” (Lidija Kacin, Primary School Idrija, teacher grade 5)

“I really enjoyed the training course and I would be glad to introduce the app in my class. However, it demands a lot of teacher’s time and hopefully there will be enough time for us to do the lessons in this way.” (Klavdija Pavšič Bajc, teacher at Primary School Idrija)

“In teaching, I often use different applications, and if the right application is used for real purpose, very positive results will be achieved in the selected activity. When using the TeachOut application, I would point out in vivo way of working in the first place, since learning in the classroom is similar to exploring the environment in vitro. The TeachOut application is designed specifically to transfer teaching outside the classroom to places in the nature where the "material" for learning is located.

Apps, however, have certain limitations, but they largely depend on our creativity. The main restriction is our mind." (Goran Bezjak, National Education Institute Slovenia, OE Nova Gorica)

Feedback from Portuguese teachers participating in testing, multiplier events and workshops:

Opinions were almost uniform in tone and expressed the idea that the workshop was *"very relevant to teacher training"* and was *"able to respond effectively to the challenges of our times and the interests of today's pupils"*. At the same time, they considered that *"it is very challenging because it allows the implementation of innovative educational practices, in order to make the teaching/learning process more effective"* and that it is *"an asset for any school subject"*.

As for the application itself, they understood that it constitutes a *"very interesting work tool for teachers and students"* capable of simultaneously dealing with *"themes from different curricular areas"*, reinforcing multidisciplinary. Some teachers expressed the impression that *"the application shows great potential"* and that *"it is pertinent, modern and motivating"*. The belief that it is a tool that meets the new forms of learning *"more interactive, dynamic and creative"* stands out.

Conclusion by a project leader

One of the basic tasks of the UNESCO Global Geoparks is the preparation and implementation of educational contents and programmes, and cooperation with schools and other educational and scientific institutions. In particular, geopark activities include the protection, preservation and education of nature, culture and the natural and cultural heritage.

In the EGN charter (http://www.europeangeoparks.org/?page_id=357) is listed:

5. A European Geopark has also to support education on the environment, training and development of scientific research in the various disciplines of the Earth Sciences, enhancement of the natural environment and sustainable development policies.

All participating geoparks in the ESTEAM project have already established cooperation with educational institutions, and all have implemented educational programmes for pupils before the project. That is why we regularly also observed problems of motivation among pupils and recognized the feasibility of outdoor programs in elementary schools. The fact is that the worksheets belong to the past and that modern digital technologies are inevitable.

From these experiences, the partners that later joined the ESTEAM project grew a desire to help solve these problems and offer teachers and pupils the opportunity to use an interesting, modern, and interactive learning tool.

Additionally, we wanted to offer them a learning tool that would partly be implemented in nature, in the open air.

All these assumptions and experiences were later confirmed by research and data analysis in the ESTEAM project. It turned out that pupils want to use modern digital technologies more in their learning. At home they all use it, but at school they do not. On the other hand, however, the teachers were less enthusiastic. We conclude that the reason for this is a lack of knowledge about digital technologies and the possibilities they offer, and also the fear of the unknown.



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²⁵ Photo: Teacher, designing a game on a trail for a TeachOUT App (Photo: Bojan Tavčar)

During the three years of intensive partner collaboration – partner meetings, discussions, brainstorming, web research, testing, evaluation, etc., the mobile application "TeachOUT – Outdoor science game" was developed in the ESTEAM project.

Our desire is that teachers and pupils use it in teaching and learning. Evaluation testing shows that the use of the TeachOUT mobile application is appealing to pupils as well as to teachers.

Of course, there are also concerns that originate primarily from lack of knowledge and fear of something new. As previously mentioned, digital technologies are here and cannot be avoided. We are convinced that we need to take a step further and start using these modern technologies and, above all, to learn how to use them. We must offer students quality content and quality experiences so that their learning is as interesting as possible and stimulates their curiosity.

All of us who work with educational institutions have a more important task to do, namely to teach critical thinking about online contents as well as how to separate quality educational and also non-educational tools (apps) from the poor ones.

We strongly hope that during our project, as well as after the conclusion, we have convinced you that we have made a good and quality learning tool, and that you will decide to take a step forward and create your games in the TeachOUT application in your own home environment.



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²⁶ Photo: Pupils learning in nature about the nature with the help of TeachOUT App and digital technologies (Photo: Bojan Tavčar)

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Contacts

Slovenia

Idrija UNESCO Global Geopark (Idrija Tourism Board)

Mestni trg 2

5280 Idrija

Slovenia

W: www.geopark-idrija.si, www.visit-idrija.si

E: info@geopark-idrija.si

T: +386 5 3734076

Portugal

Naturtejo UNESCO Global Geopark (Naturtejo, Empresa de Turismo, EIM)

Ed. Camara Municipal Praça do Município

6000-458 Castelo Branco

Portugal

W: www.naturtejo.com, www.geonaturescola.com

E: pergunta@geonaturescola.com

T: +351 272320176

Norway

Magma UNESCO Global Geopark

Elvegaten 23

4370 Egersund

Norway

W: www.magmageopark.com

E: cathrine@magmageopark.com

T: +47 51 22 55 05



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