RESEARCH OF NATIONAL CURRICULA IN NATURAL SCIENCES TEACHING IN PORTUGAL, NORWAY AND SLOVENIA

Results Analysis with Guidelines

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

WELCOME!

This E-book will present 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. On the basis of the analysis the basing guidelines will be present that will form the foundation for the creation of teaching material and mobile platform (for the **ESTEAM project – Enhancement of School TEAching Methods by linking between schools, experts and geoparks in the combination with outdoor activities and ICT Technologies**). We tend to help teachers to learn about designing lessons in science based on last innovative practices.

ESTEAM team

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1. CHAPTER

INTRODUCTION

The ESTEAM project is co-financed by the ERASMUS+ programme of the European Union, it started on September 2016 and will run in 36 months. The coordination of the project will be done by the Idrija Heritage Centre, which is the coordinator of the Idrija Geopark activities.

The association of the seven partners comprises three UNESCO Global Geoparks (Idrija Geopark, Magma Geopark and Naturtejo Geopark), two schools within the Geopark areas, the University of Ljubljana-Faculty of Natural Sciences and the Engineering-Department for Geology and a company specialised in ICT called Locatify.

The schools will be the focus of this association and their selection was based on the teachers' experience & expertise in natural sciences and other subjects as well as their connection with the Geopark goals in sustainable education.

The Geoparks' partners are part of the official UNESCO programme called IGGP. All the Geoparks have strong skills in the field of education and they have been cooperating with the selected schools in developing teaching programmes for pupils, 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 (with a main focus on geology) in schools. They were invited as experts and as an educational support on geology and also other contents on the school programmes in order to share best practices on methods & practical exercises, games and possible ways of interpreting difficult geological contents for elementary school pupils.

ICT enterprise Locatify was chosen due to its vast experience in order to develop solutions requirements in the project and previous work done in this field, as well as for the company staff and their ideas and preparation to cooperate through the whole project.

The ESTEAM project comes out from the personal experience and needs of science teachers. We know that learning programs and the learning process are getting more and more comprehensive, fast and demanding.
The traditional way of teaching is slowly losing its force. 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 the use of digital learning is also increasing, especially when combined with field teaching.
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 the development of mobile teaching/users experience platform (ICT) in combination with outdoor activities. Additionally, developments and findings will result in a guide for Teachers of Natural Sciences – ESTEAM Methodology Step by Step Guide.
The general objective is to improve the teaching process combined with ICT technologies and outdoor activities.

The specific objectives of the ESTEAM project are the:
-research of the National Curricula of the project countries with the list of suggested programmes and tools for designing lessons;
-creation of 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 ICT field;
-development of a mobile teaching/users experience platform;
-design of a guide for teachers 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 both teachers & pupils;
- Increase foreign languages skills for both teachers & pupils.

The following activities will be carried out in the project:

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

The implementation of the project on a transnational basis is necessary due to a higher results level and to achieve the initial goals of the project. Partners from three 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 linked by the unique natural heritage of the three Geoparks. The implementation of the project on a transnational basis will, thus, emphasise the visibility of the Geoparks' territories, their relevance in preserving natural heritage within the EU & the importance of interpreting the heritage to the general public. The transnationality involved in the project will contribute to a wider scope of results disclosure. Due to the transnationality, foreign language knowledge will improve & the 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 in educational institutions.

1.1. IDRIJA HERITAGE CENTRE (IDRIJA UNESCO GLOBAL GEOPARK) - Slovenia

Idrija Heritage Centre (IHC) is a public institute, which coordinates the system of management, conservation and promotion of the heritage in Idrija region and the conditions for interpretation and sustainable tourism development. IHC operates and coordinates the Idrija UNESCO Global Geopark activities, under the UNESCO IGGP Programme. This public institute is the major tourism organisation in the Municipality of Idrija, responsible for designing and marketing tourism attractions, informing about tourism supply and its promotion, co-designing Slovenian tourism offer and promoting the development of tourism activities. IHC had eleven employees in 2016. Idrija Geopark, which covers the whole Idrija Municipality with 294 Km^2 and around 12,000 inhabitants, is coordinated by the IHC. The three main fields of activities of Idrija Geopark are geoconservation, education and sustainable development of rural areas (through geotourism). In the field of education the Network of Schools in Idrija Geopark was established in 2012, which includes four primary schools in the area (namely Idrija Primary School, Spodnja Idrija Primary School, Črni Vrh Primary School and Cerkno Primary School). All Schools have a 9^{th} grade programme according to the Curriculum of the Republic of Slovenia.

Idrija Geopark has created twenty-two theme trails (hiking or cycling), which connect natural and cultural heritage as well as tourist offer in different areas of the Geopark (accommodations, guest houses, sports activities, museums in rural areas, etc.). Some of these trails are especially appropriate for school groups, because of their length and contents (natural and cultural heritage). Some programmes have already been carried out and tested.

1.2. ČRNI VRH ELEMENTARY SCHOOL - Slovenia

Črni Vrh Primary School is a small public school in a rural area, which has a significant importance for the local community since it is geographically separated from any major economic centres.

Life on the Črni Vrh plateau has been evolving under the influence of its geographical isolation from bigger economic centres, its poor public transport structure and other geographical features (undulating terrain at the altitude between 650 and 1100 metres, karst surface, water shortage, high altitude and harsh climate conditions). All these features have left a hallmark in cultural heritage, which is also preserved by the Črni Vrh Primary School.
This school is professionally connected to The National Education Institute of the Republic of Slovenia through different development projects. Through this connection they enrich the professional skills of their employees who seek for modern paths in education.

In spite of the school's small size or maybe because of it, it is very active when it comes to public education programmes and other extracurricular activities, which broaden our syllabus and connect the school with parents, villagers, society and other active public institutions in the Municipality of Idrija. The activities and sources that it has collected so far are a very good basis for developing teaching modules, which are structured upon the knowledge of the local characteristics placed in a global space. Črni Vrh Primary School can and knows how to connect all social groups within the local community.

This school has also created a forest educational trail, which is now a working part of Idrija Geopark. In a very small space it appealingly presents a tight connection between nature and Man and it is an excellent example of a good educational practice. The educational trail is a model of our work quality and gives visitors an opportunity to learn from it. The trail has been developed as a didactic tool and it emerged from the needs of modern teaching practice and the necessity of field teaching.

1.3. NATURTEJO EMPRESA DE TURISMO EIM (NATURTEJO UNESCO GLOBAL GEOPARK) - Portugal

Naturtejo is a non-profit, public intermunicipal organisation responsible for the management of the UNESCO Naturtejo Global Geopark, under the UNESCO Programme. The organisation was established in 2004 with the aim of organising the regional tourism sector and to foster tourism development of partner municipalities and local enterprises for the social and economic sustainable diversification of the area, based on natural (geological), cultural and historical heritage. This is managed through heritage research and conservation planned with municipalities, educational activities for local schools and from abroad, consulting and support to private entrepreneurs. Currently, the partners represent seven municipalities that administrate the total area of Naturtejo Geopark (5,050 km^2, more than 5% of the national territory), involving 93,000 inhabitants, and 24 private enterprises as associate partners. The daily intervention of Naturtejo in land management and planning with local authorities is related with the protection, raising awareness and valuing of geological heritage. This is achieved in strict connection with other related natural and historical-cultural heritage, through the educational programmes and the organization of local tourism under a Nature Tourism strategy for the region. Naturtejo Geopark Educational Programmes are developed by the Educational Office and provide a strong social output, in direct collaboration with local schools throughout the school year and moving thousands of pupils towards natural landscapes every year. The Routes of the Geopark are already being promoted in several countries of Europe through international tourism operators, and examples of the best sustainable tourism practices have already been awarded by international organisations several times, such as the *Skal International Ecotourism Award*.

Naturtejo Educational Office runs educational activities that involve about 3,000 students and teachers every year, from local schools to other regions and foreign schools, from nursery schools to senior universities.

1.4. AGRUPAMENTO DE ESCOLAS JOSÉ SILVESTRE RIBEIRO - Portugal

The municipality of Idanha-a-Nova is one of eleven municipalities belonging to the district of Castelo Branco, located in the Portuguese countryside. It has an area of 1,412 km^2 and is bordered with Spain. It is one of the least populated districts of the country, due to the exodus to coastal towns and to different countries in Central Europe. With a low population density, it has a high rate of elderly population.

The Grouping of Schools named after an important Portuguese politician and historian, is an educational territory of priority intervention and aggregates all establishments of pre-school education and basic and secondary education of the public network. It comprises seven nursery schools, five primary schools and the José Silvestre Ribeiro Basic and Secondary School, the headquarters of the Grouping, where the 2nd and 3rd cycles of basic education and secondary education are offered, including professional courses. The school population is composed of 840 students.

In its strategic vision, this grouping of schools seeks the involvement of the community and the establishment of partnerships for joint actions and projects, aiming at improving the public service it provides to the community. Therefore, it contemplates the development of projects, actions and activities that contribute to the promotion of the school results, the integral formation of students and equal opportunities, the improvement of the students' permanence rates in the system and the will to deepen the relations with the community and with other institutions whose contributions are an added value to their mission.

The school is the right place to test through practice any educational project. It is the bond between the experts developing the pedagogical strategies under the current Erasmus+ project and their implementation in the classroom, adapting to local circumstances and many problems that are typical of Portuguese rural areas. This also concerns the large geographic dispersion of students and schools that is of great interest for the project. The teachers engaged in the project are from the Sciences and Technology Departments, with several years of experience planning classes in Natural Sciences (Biology and Geology).

The application of new technologies in the classroom is fundamental for a region that still has some difficulties in accessing internet and where many young people are still not really aware of the opportunities they can get in their homeland if they use new technologies of communication to increase their knowledge about the world and to get the right benefits.

1.5. MAGMA UNESCO GLOBAL GEOPARK - Norway

Magma Geopark is a company owned mainly by public institutions including municipalities, counties, museums, outdoor organizations and some private companies working in the field of tourism. Magma was established in 2006 as a regional development project. The area of Magma (2,329 km^2) covers the territory of 5 municipalities in South West Norway. Magma is located southeast of Stavanger about one hour by car or train. Magma aims to promote its unique geological and cultural heritage to help develop and sustain the Region. In 2009 a non-profit public/private share company with the name Magma Geopark AS was established and in 2010 Magma became the second Scandinavian member of the European and Global Geoparks Network which are supported by UNESCO. The new strategic business development plan (2010-2021) for the Dalane region (comprising four of the five municipalities covered by Magma) envisions Magma as a major regional initiative in the field of tourism. Magma is one of the tourism lighthouses in the Rogaland County and in its strategic tourism plan for 2016-2020, and has got a tourism prize for its work with theme tourism in 2015. The main areas of Magma activity are: developing and promoting the 46 Geopark sites for tourism and educational purposes, developing new tour packages for tourists and school classes, supporting educational work with local and nursery schools and organising events.

Since the beginning Magma has been strongly cooperating with the University of Stavanger and its International Hotel and Tourism Leadership members and other stakeholders in order to improve the strategy in the tourism field and strengthen the partnership in several project applications.

1.6. HELVIK SCHOOL AND LAGÅRD SCHOOL - Norway

Magma Geopark has 7 secondary schools in its area. Two of these schools have been chosen to be pilot schools.

Hellvik school is a small public school in rural area, which is of significant importance for the local community since it is geographically separated from any major economic centres. The school teaches grades 1 to 10 and the kids' age goes from 6 to 15 years. There are about 10 kids in each grade which means a number of about 30 students from 12 to 15 years old. The school is near the coastline and in the the area of a very poor fertile moonrock Anorthosite, thus providing a very characteristic landscape around the school. The school is also situated close to a 2 km-long esker named St. Olav Serpentine and a large stone quarry. The school is the centre of many activities in the small community of Hellvik with 800 inhabitants in the Eigersund municipality. The school is very active when it comes to public education programmes and other extracurricular activities and is using the outdoor landscape in some of its activities. In the past Hellvik was a fishing community but today the only industry of some size is a house element factory.

Lagård school is a school in the town of Egersund and closer to the economic centre of Eigersund municipality. Egersund is a small town with 10,000 inhabitants. Lagård school teaches grades 8 to 10 with about 30 students in each class. Some of its outdoors activities are visiting the areas around but it's also active in visiting neighbour municipalities. The school is situated in the anorthosite moon rock area and is also close to a large basaltic dyke and a jotunittic dyke. In a biking distance it is also possible to visit Magma abounding Titanium mines and the coastline sites named Eigerøy Lighthouse, Ytstebrød and Auglend. These coastal locations tell us about the magmatic history of the area with magma chamber activities with inclusions, magmatic breccia's and dyke features like chilled margins, bridges etc. The area also tells the story of climate changes with whale backs, crescent-shaped mark, glacial striations, drumlins and moraines.

1.7. UNIVERSITY OF LJUBLJANA – Faculty for Natural Sciences – Geology department – Slovenia

University of Ljubljana (UL) is a public autonomous educational, scientific research and artistic institution of Higher Education with a very rich tradition. It is the oldest and the biggest university in Slovenia. It was established in 1919 and it encompasses 26 full members (3 art academies and 23 faculties) and 3 associated members (National University Library, University of Ljubljana Central Technical Library, University of Ljubljana Innovation-Development Institute).

UL is very active in international education and research. It has 286 research groups with over 3,000 registered researchers (548 ESR). UL has 175 research programs, 228 basic and 88 applied research projects, 27 post doc projects and 39 targeted research projects (CRP) and 7 technological platforms. In the period 2007-2013 it was involved as a partner or coordinator institution in 160 FP7. In 2013 UL cooperated in 421 running international projects, including 108 running FP7 projects and more than 310 other educational and research projects financed by EU Community programs (TEMPUS, ERASMUS; Leonardo da Vinci, DAPHNE, SafeInternet, eLearning, eTEN, Lifelong Learning Programme and many more).

University of Ljubljana is already involved in the majority of foreseen activities of the ESTEAM project. Based upon previous research and expertise (national and EU, research and applicative projects) UL is providing an important knowledge framework necessary to develop the ESTEAM project.

1.8. LOCATIFY EHF - Iceland

Locatify Ltd. is a privately held Icelandic SME company established in 2009. *Locatify* specialises in innovative technologies for delivering location based content to smartphones and tablets utilizing the technologies available on the device and making them available and easy to use for the customers.

Locatify's customers are in the fields of tourism, education and entertainment. They use the Locatify Creator CMS (Content Management System) for managing the content and publish apps branded for the customer. *Locatify* continuously maintains and extends the Creator CMS platform with new technical innovations for delivering location-based content.

With this system users can easily create tours and games for indoor or outdoor use, such as guides, walking trails and treasure hunts. With the treasure hunt game elements, players get challenges on their smartphone at the right location.
Locatify's team consists of five employees; a web-designer, programmers and a marketing manager, all committed to deliver the solutions for publishing interactive content and games for mobile devices.

The Company is the main leader for the developing of the ICT instruments: Database, Web Page, E-learning platform and educational games apps.

2. CHAPTER

DESCRIPTION OF

THE UNESCO GLOBAL GEOPARKS

2.1. IDRIJA UNESCO GLOBAL GEOPARK

With its natural and cultural heritage, **Idrija UNESCO Global Geopark** represents one of the most valuable and interesting areas in Slovenia. Idrija Geopark is located at the junction between two gigantic mountain ranges: the Dinarides and the Alps. It includes the entire Municipality of Idrija with an area of 294 km^2. The territory is characterized by exceptionally diverse land forms with deep gorges, high karst tablelands and mountain tops.

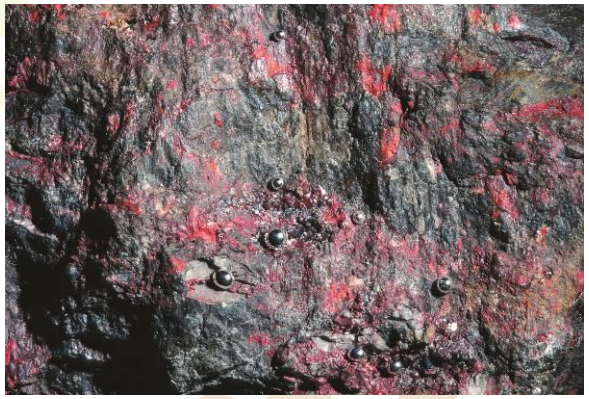
The Idrija mercury ore deposit is the most valuable and unique geosite in the Idrija UNESCO Global Geopark. It has also gained international repute and professional significance. That is primarily due to the conditions in which it was formed, its exceptionally rich and unusual ores, geochemical and mineralogical compositions, and the extraordinary transformations into its extremely complex present day state.

Water has always been an important factor in shaping the land. It contributes to the diversity of this terrain with numerous springs, rivers and karst features. In a relatively small area, visitors have the opportunity to observe different rocks – from the oldest Carboniferous shales, formed almost 300 million years ago, to the youngest 35 million-year-old Eocene flysch. The area is characterized by thrust faults, a consequence of Tertiary tectonic activity which began at the end of the Eocene Era. The consequences of thrusting and present day erosion conditions also provide large tectonic windows situated within deeply cut gorges. Of the numerous faults striking NW-SE, in the so-called Dinaric direction, the most important structure is the Idrija fault, which crosses the whole Idrija region.

The Idrija Mercury Mine was responsible for the development of the region through the centuries. Today, the mine is closed but it has left an outstanding cultural and industrial heritage which is the main theme of the Geopark. It is one of the oldest and largest mercury mines in the world and is the main contributor to the history of Idrija Town. Antony's Main Road, the oldest part of the mine, is opened to visitors. The main purpose of this show-mine is to preserve the phenomena of the Idrija mercury ore deposit "in situ" and especially the drops of native mercury trickling, tear-like, from the black shale in amounts that are not found anywhere else in the world. Antony's Main Road uncovers the geological diversity, enhances opportunities for research, study activities and education. It also provides opportunities for the development of environmental-friendly tourism, as well as revealing the value of the mineralogical and natural wealth and geological heritage to various target groups. In addition, a rich geological collection of minerals and fossils and the story of the origins of the mercury ore deposits in the mine's geological collection is available in the Municipal Museum exhibits and geological collection close to Francis's Shaft.
In addition, there are numerous historical and technical monuments devoted to mining in the town, retelling the story of the region's 500-year-long history of mining and development.

In the vicinity of Idrija, Zgornja Idrijca Landscape Park boasts countless geological and botanical attractions. One of the important natural features, also located in the Landscape Park, is Wild Lake, an extremely complex natural phenomenon, which features a lake, a spring and an underground cave all in one place. Their formation was strongly influenced by tectonic forces and karst processes.
In Idrija, the production of lace is a century-old tradition. Through such work, the women and girls of the mining families provided a modest but important additional income. Today, Idrija lace is an integral part of the Slovenian cultural heritage. The women of Idrija are also experts in culinary delicacies, the best known being the Idrija žlikrofi.

The uniqueness of its mercury heritage has also been recognised by UNESCO with an inscription on the **UNESCO World Heritage List**.



2.1.1. EDUCATIONAL ACTIVITIES IN IDRIJA UNESCO GLOBAL GEOPARK

Idrija, with its mercury heritage, the Anthony's Main Road and the Idrija Municipal Museum, has always been a place for schools to visit. Unfortunately, the rural areas were often not included in the schools field trips, because of the lack of school programmes, incoherence and lack of promotion.

Since the establishment of Idrija UNESCO Global Geopark much attention is paid to cooperation with local schools and creating programmes also in rural areas and natural and cultural heritage of the area, that are specially adapted to the national curriculum for three school year periods (1st three years period - 1st to 3rd grade; 2nd three years period - 4th to 6th grade and 3rd three years period – 7th to 9th grade).

At the moment, Idrija Geopark systematically devises and carries out the following teaching / educational programmes:

a) **»Počitnikarija« summer workshops for children**, who spend their holidays at home. We started this initiative in 2012 and since then we offer each year 5 - 6 workshops to children. Educational workshops are always carried out in the field on the geopark trails and they include geology, nature, culture, science, etc. and are included into the “Počitnikarija” summer programme for kids of a Friends of Youth Association, which is offered to all local elementary schools. In the past years we have carried out treasure hunts, volcano workshops, sports games, orientation in nature, arts & crafts workshops, etc.

b) **Network of Schools in the Idrija Geopark** is a network of four local primary schools (Idrija, Spodnja Idrija, Črni Vrh nad Idrijo and Cerkno). The successful co-operation with schools started in 2013 and has been preserved. The idea behind the network is that each year one school organizes a theme day for the 7th grade pupils together with the help and co-operation of the Idrija Geopark and external staff. Each year 10 workshops have been prepared for pupils together with the teachers of the organising school. Each child attends

two workshops in a day. In the past years workshops such as bird-watching, drawing patterns for lace making, treasure hunt with the Turf Hunt App, observing rocks and other natural and cultural heritage, knowing about ecology and eco-houses, visiting honeycombs and drawing a beehive panel, making products with flax and getting in touch with flax production, making products with wool felt and many others have been carried out.

c) **Pedagogical programmes for elementary schools** go hand in hand in school subject's curriculum for primary school triads in the Republic of Slovenia. They are mostly composed of the previously carried out and tested programmes, some of them are prepared especially for some schools according to their needs. The programmes are annually promoted in the leaflet »Geo-experience for Small and Big Explorers«, distributed to all Slovenian primary schools. A detailed description of primary school programmes is additionally available on the Idrija Geopark's website (http://www.geopark-idrija.si/si/geopark/22/izobrazevanje/). With the purpose of interpreting and making difficult contents understandable to children, we designed toy characters, a girl called Živa (means "live" like a mercury – only liquid metal at the room temperature) and a boy - Tonček (Tony) - named after Anthony of Padua – protector against accidents in the mine, which are already included in some programmes, activities and educational products/articles as well. Those two characters will be developed in the future, specially adapted to particular age groups of children (especially pre-schoolers and 1st three years period of elementary school).

On special occasions, e.g. EGN Week, DEKD (Days of European Cultural Heritage) or Children's Week, a selection of programmes is offered to local schools free of charge.

<u>Previous experience of teaching throught modern ICT technologies</u>

In the year 2016 we carried out the "educational" treasure hunt with the application Turf Hunt, which has included different cultural sites in the town of Idrija. On the way, pupils read about the history and culture of the sites and discovered little details, which are usually unnoticed. The activity was very well welcomed by the pupils as well as by the teachers of local schools.

2.2. NATURTEJO UNESCO GLOBAL GEOPARK

Naturtejo UNESCO Global Geopark is located in central Portugal near the eastern Portuguese-Spanish border. The Naturtejo's territory comprises 5,050 km^2 and includes 7 municipalities: Idanha-a-Nova, Castelo Branco, Proença-a-Nova, Oleiros, Penamacor, Vila Velha de Ródão and Nisa. The management structure of the Naturtejo Geopark – "Naturtejo – Empresa de Turismo" (Tourism Company) - is an intermunicipal major stateowned company with 7 public institutions and 24 private enterprises, established in 2004. Since 2006, the Naturtejo Geopark belongs to the European Geoparks Network and to the Global Geoparks Network under the auspices of UNESCO.

Naturtejo UNESCO Global Geopark offers a vast and rich Natural, Historical and Cultural Heritage, natural destinations, more than 17 geomonuments that put in context 600 million years of Earth's dynamics, protected areas due to their biological diversity, Schist Villages, Historical Villages and 70 classified monuments, reporting an ancient unity between Man and Nature.

In this area ruled by a cultural heterogeneity based on historical and ecological criteria, Geology appears as a levelling element, since the geological evolution of this region was ruled, in general, by the same fundamental stages which, through millions of years have shaped the landscape. The elements that have built it are over a major Proterozoic basement (Beiras Group); numerous residual relieves, being the most renown the Ordovician quartzitic crests and the late-Variscan granite inselberg; intramountain basins with alluvial to fluvial coarse sediments deposited during the Alpine Orogeny; hydrographical nets deeply carved during the climate crisis of the Pleistocene and induced by important neotectonics in the fragile domain, which framed the landscape in a block succession and provides the thermal richness of the region.

A territorial unit as large and diverse in terms of geological and geomorphological evolution of the landscapes, their biodiversity, history, its architecture, traditions and customs of their people that enriches the immaterial heritage widely shown in language, art and music. More than 170 geosites that characterize the Geopark as well as the biodiversity and historical and cultural heritage, are values to be preserved through local people's action and the union of public and private actors, in order to nurture and preserve what we have of more genuine and authentic. Goals such as sustainable development, training, conservation and scientific development, education, exploring methods and organising activities to each and everyone, communicating knowledge and the practice of environmental and cultural concepts, are all so fundamental when defining the groundwork of Naturtejo Geopark.

Geology brings to many the explanation of the natural phenomena that enrich municipalities, neglected until the creation of the Geopark (such as the granite morphologies or the ancient mining areas) or admired only by specialists (like the ichnofossils of Penha Garcia and the Portas de Ródão epigenic valley), allowing economically profitable preservation and usufruct measures. On the other hand, regional geology interacts with several other cultural aspects: constructions and their implementation were conditioned since Pre-history by basic needs intimately related to the geological substrate; tending the flock and agriculture – traditional activities – are conditioned by the morphology of the ground, soil types and water availability; the millenary mining activity settled and left traces in a manly agro-pastoral culture; the abundance of etiological legends and reference to the "cult of Stones" and the "cult of Waters" in popular Christian Church, still so much present among the population.

The main task of the Geopark is to assess and conserve the sites that provide key-testimonies of the Earth's history, to induce geosciences, promote geo-education, geo-tourism and regional sustainable economic development. The wonderful geomorphological, geological, palaeontological and mining heritages are monuments with both regional and international geological relevance. Examples of that are the wonderful exposures of trilobite trace fossils in the Penha Garcia Ichnological Park, and the impressive quartzite gorges of Penha

Garcia, Malhada Velha, Portas do Ródão and Almourão. Further attractions include the huge roman gold mine of Conhal do Arneiro, the gigantic meanders of the Zêzere river and the strange granite morphologies of Serra da Gardunha and Monsanto. In addition to the geomonuments, Naturtejo Geopark also includes environmentally and ecologically significant areas. The Biosphere Reserve of Tejo/Tajo International, the Tagus International Natural Park, Portas do Ródão Natural Monument, some areas in municipalities (sites in Gardunha, Nisa and S. Mamede) and important bird sanctuaries (Penha Garcia-Toulões and the quartzite range of Ródão) are in the scope of the Natura 2000 Network. The rich cultural history of this region is revealed by hundreds of archaeological sites, the highest concentration of Templar castles in Portugal, dozens of churches and manor houses and a total of 70 protected monuments. There are also the historical villages of Monsanto and Idanha-a-Velha, the latter being the most precious testimony of a powerful Roman-Visigoth Civitas. The old ways of living are a witness of the unique variation within a borderland culture and are deeply rooted in the ancient landscape. The prize for the “the most Portuguese village” awarded to Monsanto and the Slate Villages are symbols of this well preserved ethnographic richness. The municipality of Idanha-a-Nova, one of the seven Municipalities of the Naturtejo Geopark is included in the Creative Cities Network of UNESCO, in the field of Music. Geopark Naturtejo Meseta Meridional offers one of the thickest trekking networks in Portugal. Amongst the geological wonders there are Fossils, Mines, Boulders and the Cobbles trails, as well as the Gardunha and the Secrets of the Almourão Valley footpaths. Along the Fossils trail and in Portas do Ródão Natural Monument there are Climbing schools which provide activities such as climbing, abseiling on the quartzites, horse riding along old smuggling routes that cross the Penha Garcia Syncline, all guaranteed to raise adrenaline levels. Visitors of the Tagus International Natural Park are amazed by the immensity of one of the most important wildlife sanctuaries in Europe. The quiet waters of Tagus river offer beautiful boat trips departing from Vila Velha do Ródão to explore the gorge of Portas do Ródão, the nesting areas of gryphon vultures and the Tagus rock art. Water which has travelled deep in the Earth might be peacefully enjoyed in the magnificent thermal spas of Monfortinho and Fadagosa de Nisa.

2.2.1. EDUCATIONAL ACTIVITIES IN THE NATURTEJO UNESCO GLOBAL GEOPARK

In 2006 the Naturtejo Geopark became part of the European and Global Geoparks Network under the auspices of the UNESCO. To achieve one of the most important missions of a geopark – promoting geo and environmental education for sustainability – the educational programmes of the Naturtejo Geopark were created in the school year of 2007/2008. In order to preserve geological heritage we must educate and raise the scholar public's awareness for the preservation and respect of nature/wildlife within a holistic perspective. Thus, with the goal of approximating schools and calling the educational community's attention for the natural and cultural treasures from Naturtejo UNESCO Global Geopark, a set of Educational Programmes were created. To conceive the mentioned programmes, one has regarded the curricula from the Portuguese Ministry of Education with the aim of complementing them and providing teachers and pupils with useful tools.

Three types of educational programmes were created: "Geopark Goes to School", "The School Meets the Geopark" and "Anim'A Rocha". In the first programme, the Geopark's team goes to a school and operates activities inside the classroom or in an outdoor area near the school building. In the second one, the teachers and their pupils go to specific places of the Geopark and take part in field trips organized by the Geopark trained staff. In the third one, the activities are free and organized only for the pupils and students from the territory of the Geopark and the aim is to motivate the Geopark schools for the finding of geodiversity and biodiversity around the schools through field and classroom activities.

The programmes are addressed to teachers and pupils from the Nursery School level, the 1st, 2nd and 3rd levels of Primary School; the Secondary level, the Professional Teaching and also from the University. Those schools belong to the Geoparks' territory, to the rest of the national territory and from abroad. Therefore, there is an urge for an adjustment and adaptation of language and scientific content to the school level.

The monitors of the Educational Programmes are qualified technicians with a superior scientific and pedagogic formation in Geosciences, Biology and/or Geological Heritage. Despite the focus on geosciences, the programmes approach is a multidisciplinary one, once Biology, Wildlife Preservation, History, Geography, Physical Education, Nature Tourism and Culture, among others, are also mentioned subjects.

The educational programme "Geopark Goes to School" include a workshop to make replicas of fossils, another seven different workshops and the field trip "Geodiversity around our school". Currently, the Educational Programme "School Meets the Geopark" comprises 13 interdisciplinary field trips: A – "In the fossils trail of Penha Garcia searching for the trilobites trace fossils"; B- "In the granitic inselberg of Monsanto"; C- "The Penha Garcia fossils and the residual blocks"; D- "The Natural Monument of Portas do Ródão and the Tagus valley" ; E- "Forest in the Life Science Centre, the Secrets of the Mourão Valley and the fossil trunks on the Tagus House of Arts and Culture"; F- "Meeting the singular granitic forms of Castelo Velho at Serra da Gardunha (Gardunha's Mountain Ridge)"; G- "Exploring the trails that lead to the roman gold mine of Conhal do Arneiro"; H- "Searching for the Waters"; I- "Searching for the Rocks"; J- "Nature Conservation on Tagus International Natural Park"; K- "Mining territories of the municipality of Idanha-a-Nova"; L- "Bio and geodiversity of the Erges canyon at Segura"; M- "Geodiversity at the Linx Lands". The field trips can last half a day, one or two or even more days, if they are combined. The field trips include 13 geomonuments, 8 pedestrian trails, 1 boat trip at river Tagus and 10 museums/interpretative centres. The Anim'A Rocha educational programme is addressed to schools from the Naturtejo territory. Those schools are able to develop their annual Educational Projects, are invited to participate actively in

contests, in celebrations of environmental theme days and in the activities of the European Geoparks Week.

The Naturtejo Geopark also organises activities addressed to teachers such as field trips, seminars, workshops and training courses.

Different Educational resources are available: puzzles of the geomonuments and of the geological map; collections of rocks, fossils and minerals of the geopark; worksheets for pupils to fill in during field trips and in exhibitions; Teacher's guides for the field trips and exhibitions; silicone fossils casts, 3D models of Trilobites and Cruziana fossils, storybooks for kids, virtual resources about mining heritage, pedagogical games, songs and educational books for teachers.
The Naturtejo Geopark Educational Service counts on 25 partners to implement the activities such as protected areas, Organizations for environmental protection, Interpretative centres/Museums and private companies.

A preliminary analysis of the statistic data collected since the school year of 2007/2008 shows that 28,771 students and teachers coming from Portugal and from other countries such as Spain, Germany, Brazil, the United States, England, Italy, Chile, Mexico, and Japan have participated in these programmes. In 2010/2011 a "new vision of school" named Geonatureschool included the educational programmes as well as the new ones. The physical space of this school is the 5,050 km^2 of the Geopark territory. In February 2011 a website dedicated exclusively to the Geonatureschool was created – http://www.geonaturescola.com - also accessible through the homepage of the Naturtejo Geopark. The website has already had 164,128 visitors. In 2008, the Naturtejo Geopark Educational Programmess were awarded the 2008 Ecotourism Prize, within the Educational-Media Programmes, by SKAL International, one of the biggest Travelling and Tourism Professional Associations.

Previous experience of teaching by using modern ICT technologies

Between 2010 and 2013 Naturtejo Geopark was one of the 7 organizations partners on the "Geoschools Project – Teaching Geosciences in Secondary Schools", a European Union project supported by Lifelong Learning Programme which brings together geoscientists from universities, museums, geoparks, teaching training institutions and educators which can best "translate" geosciences into a language and learning opportunities that can be easily understood by school students. The key results at the end of the project were: a curriculum comparison research; an interest research; a school geosciences dictionary (lexicon); teaching modules on specific subjects; an interactive website and an e-Newsletter. The module produced by Naturtejo Geopark "Teaching Geosciences in the field: "Geoparks and Geosites" was tested by teachers and students and was a success. All the key results of this project are available on http://geoschools.geol.uoa.gr/.

In the year 2012, as a final project of the course some students from the Higher Education School of Technology of the Polytechnic Institute of Castelo Branco have cooperated with Naturtejo Geopark in the creation of two virtual visits to old mining areas of the Geopark: "Virtual Visit to Segura Mines" and "Virtual visit to Monforte da Beira in the Iron Age". These visits can be done by accessing the link: http://www.naturtejo.com/geopark-virtual.php.

2.3. MAGMA UNESCO GLOBAL GEOPARK

Magma Geopark is the second designated UNESCO Geopark in Norway. The geopark area is situated in southwest Norway and extends over 2,329 km^2. The story began as early as 1.5 billion years ago when red-hot magma and sky-high mountains characterized the region. Through millions of years, glaciers helped to form the characteristic landscape that we have today.

Although the magma has cooled down and solidified and the mountains have been worn away, the area offers a glimpse into the roots of an ancient mountain chain. Here is a rock type called anorthosite that is more common on the moon than on Earth. This unique area provides high-value heritage in local, national and international contexts.

Magma Geopark has a strong tradition in mines, some of them were the only source of income for the local inhabitants and are now highlights in Magma Geopark. The Gursli mine molybdenum mining took place from 1915 to 1919. Molybdenum is a metallic element whose most important use is to strengthen and harden steel. The mine at Gursli was active to supply molybdenum for steel production during World War I. In 1917 there were about 100 employees at Gursli; at peak times there were up to 160 men processing the ore. After the war the price of molybdenum crashed and the mine closed in 1919. Visitors can still find remains of the many buildings constructed at lake Gullvannet during the active period at an outdoor museum of mining culture.

Another important mine is located at Blåfjell, the Blue Mountain, where up to eight mines were active during the 19th century. Here you will see the old mines surrounded by picturesque nature. Mining of ilmenite took place at Blåfjell from 1863 to 1876, and a total of 90,000 tons of ore were exported during those years. The mineral ilmenite is an important raw material for the production of titanium dioxide. Titanium dioxide is used as a white pigment in paint, plastic and paper, but also as an ingredient in cosmetic products, including suntan lotion and makeup, as well as in medicine and even as an additive ingredient in some food – where it is known as E171. A railway was built between Blåfjell and Rekefjord to transport the ore to the coast for shipping. This old railroad is now a walking and cycle path with impressive scenery.

Magma Geopark is working towards 46 Geopark sites, divided into geological, historical and cultural, and geological/cultural. Those 46 sites are planned to open to the public by 2020. Some other examples of our sites are; St. Olav's serpent, a fantastic glacial ridge (esker) that meanders through the landscape; the Gloppedal scree that represents one of the largest landslides in Europe; Eigerøy lighthouse with a walk through part of a huge magma chamber in a coastal landscape; Hellersheia anorthosite landscape with huge blocks and caves; Storeknuten where you can see where magma entered Europe's largest layered intrusion huge coastal caves cut out of solid rock at Brufjell; and Flekkefjord old railroad.

Magma Geopark is promoting both geological and educational tourism offers for visitors and schools and providing many outdoor activities: climbing, kayaking, canoeing, cycling and hiking.

Magma Geopark is working on sustainable development of the local communities within many projects both national and international aimed to increase the visibility and the economy of the area.

The main two projects we are working on are: GEOfood and geoVR. GEOfood is a brand that is used by many European UNESCO Geoparks as a quality brand. The GEOfood project aims to create a tourism possibility that links together local food and the geological heritage, creating packages for tourists who can taste and buy local products labelled as GEOfood. (see www.GEOfood.no).

The geoVR project is setting up an innovative virtual reality concept that offers the user an incredible experience of being part of the wide cultural – geological phenomena. GeoVR is much more than simple virtual reality: geoVR gives the possibility to visit places around the Globe with animations, videos and pictures that point out specific hot spots (geosites, cultural items, etc.) provided with tailored educational contents. GeoVR combines virtual technology with an educational purpose and a creative approach. (see www.geoVR.no). Magma Geopark will open the visitor centre in October 2017.

2.3.1. EDUCATIONAL ACTIVITIES IN MAGMA UNESCO GLOBAL GEOPARK

Magma Geopark has been working in education since 2010. Magma Geopark is not running a fix based educational programme. We offer activities on the web page that schools and teachers can book directly.

a) **Magma Geopark excursion guides**

- Magma Geopark developed an excursion guide available for teachers, students and visitors that gives detailed information about the geological processes of the area. This is a professional guide developed for high school students/ bachelor students.

Free Download at:
https://issuu.com/magmageopark/docs/excursion-guide

- Magma Geopark has developed a simple story line that connects the main plate tectonic events in the World within the European project Drifting Apart.

Free Download at:
https://issuu.com/saragentilini/docs/drifting_apart_storyline_mgp_copia

- Magma has developed many free leaflet available online and in the Magma Geopark office, an info centre that allows students and teachers to get information on the main facts of the locations/sites.

Free Download at:
https://issuu.com/home/publications

b**) Treasure Hunt for Schools**

MGP has developed two apps: Magma Geopark and Global Georoutes, both available for free in the Apple and Android market. Both Apps provide tourists with educational games and audio guides based on GPS points. Through the Apps kids learn about the local heritage having fun and the audio guide is very useful to get information about the sites. The MGP apps also provide information concerning the geological and cultural heritage, accommodation, camping, info points, museums and cultural points of interest, restaurants and cafés, shopping and transportation facilities. The Global Georoutes App aims at promoting itineraries in the Geopark connected with interactive educational tours to discover the geological and cultural items. The App gathers together Geoparks and potential Geoparks in order to value the geological/cultural history.

https://play.google.com/store/apps/details?id=com.locatify.guide.geoparks
https://itunes.apple.com/bb/app/global-georoutes/id905305741?mt=8

Play treasure hunt games in Magma Geopark using your mobile device with GPS and maps. Discover treasure locations, solve challenges and earn a score. Play solo or compete in a multiplayer game with your colleagues.

How to play Treasure Hunt? Download the game before starting the tour. The game will show treasure locations around the area. The idea is to follow the application map to find the treasures, solve challenges, and then move on to the next treasure. In the end the game gives you a score but if you are part of a multiplayer game, it gives you the overall result of the game.

Are you working for educational institutions? It is possible to create your own treasure hunts to match your student groups curriculum and learn about natural sciences, history and culture out in the nature using mobile devices.

Treasure Hunt is possible to download from Google Play and App Store. If you are interested to purchase a license for educational institutes, contact us.

c) Archaeological Laboratory

With this educational package for school groups, kids can be archaeologists for one day! The Archaeological laboratory is suitable for Primary School groups, children from 8 to 12. Kids work in groups and experience different practical activities linked with the archaeologist tasks.

A presentation in the beginning of the workshop will describe archaeology as a science, the main tasks of archaeologists, duties and goals. The class will experience exciting archaeological excavations outdoors, using the real archaeologist tools: buckets, trowels, sieves, etc. The findings, replicas from the Stavanger Archaeological Museum will be documented accordingly in the excavation´s form. Kids will also document the findings through pictures and drawings.

After this, classes will be divided into three workshops entitled “Ancient writers”, “Tell me a story” and “Pottery Store”. One workshop lasts 40 minutes and all the groups rotate in turns to attend all the workshops. In the end of the laboratory each young archaeologist has completed all the activities. During the first workshop, “Ancient writers”, kids learn how to write Hieroglyphs, Cuneiform writing, Greek alphabet and Latin. Kids are provided with papyrus sheets, clay and wax tablets to experience the real writing process. Within “Tell me a story” kids need to write their own archaeological adventure, taking inspiration from some clues provided by the teachers. The best story can be published, for example, in the school´s newspaper. The “Pottery Store” teaches kids to create small scale vases and bins with the use of clay and fibres from nature reproducing ancient techniques.

3. CHAPTER

CURRENT METHODOLOGY IN TEACHING NATURAL SCIENCES IN ELEMENTARY SCHOOLS

3.1. SLOVENIA

Natural sciences curriculum of primary school in Slovenia deals with the nature of substance, life, and the universe as a whole. Its content provides students with knowledge of different scientific subjects and improves observation skills. The lesson structure and the teaching methods should not be limited to an isolated list of facts only, but it must offer dynamic engagement leading to knowledge, involving observation, experimentation and theory. That way students can develop an indepth insight of scientific processes as well as a critical perception of conclusions and interpretations.

The selection of various teaching methods, such as direct explanation of the contents, laboratory work and field trips make students familiar with scientific research and skilled in data observation, analysis and interpretation. Teachers use several didactic methodologies in Natural sciences teaching, such as:

- Laboratory work
- Research in nature including solving worksheets or not
- Project work
- Investigation tasks
- Debate
- Explanation and demonstration
- Mindmaps
- Use of graphs
- Practical workshops (chemical structure of matter, particles in different aggregate states, construction of organs to simulate their operation…)
- Presentations
- Working with texts from classbooks and other written sources
- Studying internet sources
- Using ICT (information and communications technology)
- Multimedia

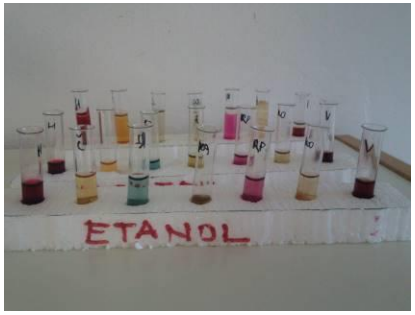
All natural sciences derive from nature, and therefore nature is the best classroom. If possible, nature itself is used for this purpose, or we bring it into the classroom in various ways. This can mean collecting material, which is used for **observation, measurement, editing or research**. We use a collection of rocks, herbarium, samples of water for different analysis or microscopy, vivariums with pets or specimens of wild animals which we return to the wild after observing them. Furthermore, we can make various substances with the hand-made atoms or molecules. Drawing the observed material is also an important way of understanding the structure of matter or living beings as well as the ecosystem as a whole. We can make a videoclip of an event or object of our cognition. We can make one ourselves, or even more important is the availability of Internet resources and the use of modern technologies. In teaching we use the method of **working with textbooks** or other written resources.

To understand the characteristics and to be familiar with the laws of substance conduct it is important to have more experience with the material. Therefore, l**aboratory work** is also necessary to develop the skills to handle the material.
We also use the method of **demonstration**. This is associated with observation and simultaneous **interpretation**. Constant mental interaction between the teacher who is a mentor and a guide and students as active learners is necessary, even in the case of interpretation of the demonstration.

Since the teaching and learning of science is more interesting and more lasting, it is important **to select and change teaching methods** depending on the content and depending on the characteristics of the group of students in front of us. In order to acquire experience as well as to expand your knowledge of the methods and approaches in natural sciences, it's important to apply different thesis and research questions in both field and laboratory practical and theoretical work. This contributes to the development of creativity, critical thinking, interest in and active participation whenever natural sciences knowledge and skills are applied. It's important to offer a variety of learning environments, e.g.,

fieldwork, lab experiments and visits to museums, as they considerably add value to the teaching of natural sciences and convey a sense of wonder, curiosity, eagerness and enchantment. The ability and expertise in comprehending different kinds of natural sciences texts, methods and technological solutions is an excellent basis for any additional studies and lifelong learning, at work or in your spare time.

To sum up, **active teaching methods** are essential in natural sciences teaching. Based on experience we can clearly state that these methods are more effective than others. **Just as nature and its fatcs are diverse, so should be our teaching.**



3.2. PORTUGAL

The Portuguese Educational System is organized in levels of education, training and learning: pre-school education and school education. Pre-school education is optional and is intended for children aged between 3 and 6 years old, the age of compulsory enrollment. School education is divided into three levels:

- Basic education (or Middle School), which comprises three sequential cycles in a total of nine years, the first cycle with four years, the second cycle with two years and the third cycle that lasts three years;
- Secondary education (or High School) comprising a cycle of three years;
- Higher education, which includes university education and polytechnic education.

The 1st cycle of basic education is given by one teacher and aims at the development of basic skills in Portuguese Language, Mathematics, Environment Study and Enrichment Activities. Natural Sciences are treated in the scope of the Environment Study, together with contents of History and Geography.

The 2nd cycle is organized by disciplinary areas and the 3rd cycle is divided into several subjects. Natural Sciences is a formal subject in both cycles to ensure a general formation common to all students, providing the acquisition of basic knowledge that allows studies continuity. The instruction is identical for all pupils up to the 3rd cycle of basic education, except for those with learning difficulties who need special education such and have specific guidelines.

In the Secondary Level of Education pupils have to choose an area of education to continue their studies, leaving this way the previous uniformity. The types of subjects comprise four different groups of scientific and humanistic courses: Sciences and Technologies; Visual Arts; Socio-economic Sciences and Social and Human Sciences.

The national curriculum of basic education, which includes the 1st, 2nd and 3rd cycles, is organized in a perspective of scientific literacy, aiming at the

progressive development of skills in the areas of knowledge, reasoning, communication and attitudes. Thus, the curriculum is organized into four general themes that are repeated in each of the cycles, which foresees an organization of the basic education curriculum in a spiral form. These themes are addressed in an integrated way in all cycles, which allows the development of skills in a progressive way throughout basic education.

The curricular guidelines propose the organization of Natural Sciences teaching in the 3rd cycle of Basic Education in three themes: *Earth in Transformation*, *Earth's Sustainability* and *Better Living on Earth*. Each theme retrieves scientific content from other themes in an interdisciplinary approach, in which Science, Technology, Society and Environment are the integrating and globalizing axis of knowledge acquisition, as recommended in the curricular guidelines. These themes are developed over the course of each year in Natural Sciences classes which has a workload of 135 minutes per week, separated in two days.

In most situations, the teaching of science is characterized by the transmission of knowledge where the teacher stimulates the debate in the classroom and the pupil assumes, above all, a more passive role, being called to participate through questions and observations throughout different tasks. The tutorial role of the teacher, who exercises his authority through his scientific knowledge overlaps the pupil's role in this methodology of presentation of themes and subjects.

In order to make classes more dynamic and learning more attractive, the Natural Sciences teacher uses diverse didactic methodologies that, in addition to conveying the scientific knowledge defined by the national curriculum objectives, provides pupils with the related and progressive construction of knowledge, as well as the increase of creative ability and autonomy.

This way, the teacher uses several teaching tools such as the analysis of texts and other documents in the coursebook, the accomplishment of worksheets in group or individually, the use of audiovisual means, such as the projection of schemes, graphs and images on a white board with the following debate, video observation and general debate on the issues raised, small presentations to be shown by pupils in class to their peers, the use of different multimedia aids such as the interactive whiteboard and other computer material to search for online contents in order to reinforce contents.

Laboratory experimental and investigation type activities are also common practices. Occasionally, field trips are carried out to natural sites or scientific institutions, which facilitate pupils' interaction with real situations and allows them to explore the environment through a multidisciplinary approach, expand the knowledge acquired in the classroom context, and not only being restricted to the sequence of contents of the school curricula.

Lessons with about 24-28 pupils are taught in regular classrooms or in specific laboratory rooms, linked to the Natural Sciences department. Laboratories are maintained by Natural Sciences teachers concerning its organization and acquisition of materials. They generally have collections of biological and geological samples, diverse equipment, glassware, instruments, apparatus, chemical reagents, safety material, etc. Laboratory practices are carried out with the help of the teacher and according to a defined protocol with the participation of pupils, properly equipped with a white smock and other safety equipment.

There are several teaching materials available on online educational platforms, such as documents, presentations, protocols, worksheets, etc. Schools have internet in all classrooms, in the school library and in other school facilities. Classrooms have a white board that allows writing and many others are provided with an interactive whiteboard. They have a computer with internet connection and a link to the school online platform where pupils and teachers can have debate blogs and make available different documents and information.

In recent years there has been a difficult and gradual introduction of new technologies in the classroom, such as the use of devices with online connection (smartphone and tablet), namely in practical and laboratorial activities, content research, image sharing, information supply, etc.

The evaluation of knowledge and skills is carried out throughout the year in three moments. This assessment is carried out after periods of about two/three months. Classes start in September and the first evaluation is in December. The second term runs from January to March and the third and last term from April to June. There is a school break of about two weeks between terms. This assessment is, therefore, continuous and the pupil's work during the course activities is considered. The evaluation criteria take into account the knowledge and skills acquired and the set of attitudes and values shown by pupils; the relative importance of each parameter varies in each level of education. In Natural Sciences there are parameters directly related to the practical ability to develop tasks in the laboratory, in research and during the accomplishment of experimental work.

End of term grading varies between 1 (Poor) and 5 (Very Good or Excellent) in the 2nd and 3rd cycle of education. In secondary education a 20-point grading scale is used. At the end of each cycle there are national exams that may be relevant to the continuity of each pupil's studies. In Basic education, the exams evaluate knowledge in Portuguese Language and Mathematics and there are still benchmark tests in other areas, such as Physics and Chemistry and Natural Sciences. In secondary education exams take place in most subjects.

Natural Sciences is considered a very interesting subject by most pupils. At the lower levels, pupils demonstrate involvement and dynamics in dealing with scientific contents and achieve a relative intellectual success. In Secondary education Natural Sciences are separated into Biology and Geology contents and this subject is important for pupils who intend to continue their studies in universities, especially in similar areas or in courses related to Medicine.

Experience has shown that carrying out practical activities and outdoors activities such as field trips to places of scientific interest, and the use of different technologies contributes to raise interest, enhances working dynamics and academic results.

3.3. NORWAY

In Norway, the school system is organized in pre-school, primary, lower secondary, upper secondary school and higher education. Pre-school starts in kindergarten, and both pre-school and higher education is optional.

- Primary school is part of the basic education and comprises two sequential cycles, the first cycle being four years and the second being three years.
- Lower secondary school comprises a cycle of three years.
- Upper secondary school, also called high school, has a duration of three years.

The national curriculum is developed by the Ministry of Education and Research, and for Primary and Secondary school it comprises a core curriculum, a quality framework, subject curricula, and the distribution of teaching hours per subject. Furthermore, the subject curriculum lists objectives both in a working and social context, main subject areas, teaching hours, core skills, attainment targets and assessment.

There is a framework for all pupils in Norway of five core skills for basic learning at school, work and social life developed by The Norwegian Board for Education and Training. These five skills are speaking, reading, writing, numeracy and digital skills and are integrated in each subject's curriculum. The core skills are expressed differently in each subject.

The attainment targets are set as a competence pupils should have acquired after the second, fourth and seventh year of Primary school, Lower Secondary school, and Upper Secondary School.

“The researcher” (social sciences) and “the budding researcher” (natural sciences) is a part of the curriculum in all cycles. This provides a platform for pupils to ask critical questions, develop their own theories, discuss, observe, argue and present scientific knowledge through wondering, curiosity and creativity. It is integrated into the other main areas of each subject and aims at developing the pupils' core skills.

In primary and lower secondary school, the curriculum for all subjects is organised in themes that is repeated each year, allowing a repetitive learning spiral with the aim of activating already gained knowledge and developing competences in a progressive way. This is also valid for some subjects in the upper secondary school.

Primary school curriculum is based on developing pupils' basic skills in language, mathematics and natural sciences, social sciences and religion, gymnastics, and arts and music. They will be provided with knowledge about Earth, geology and geography through natural sciences (NAT1-03) and social sciences (SAF1-03), the latter being subdivided into three parts, namely history, geography (physical and human) and civic life. In the first years, natural sciences focus on the pupils to wonder on their local areas, while in the last year of Primary School pupils should already have basic knowledge of the main topics of the budding researcher, such as diversity in nature, body and health, phenomena and substances and technology and design. In Primary School, natural sciences are given a total amount of 328 teaching hours (60 minutes units). Similarly, for social sciences, during the first years, pupils focus on using their curiosity and creativity to find questions to local issues, while by the end of Primary School pupils are supposed to have gained basic knowledge about local and Norwegian history, local geography (both physical and human geography), and local civic life. The researcher is supposed to be included in all parts of the social sciences subject. This is given a total amount of 385 teaching hours.

In Lower Secondary School, the curriculum has the same basic subjects as in Primary School. In natural sciences (NAT1-03), the focus areas are still on the budding researcher, diversity in nature, body and health, phenomena and substances and technology and design. The total amount of teaching hours for

the three years is 249, which is the same amount of teaching hours also set for the social sciences. Social sciences (SAF1-03) curriculum has the same subdivision: researcher, history, physical and human geography and civic life, but the focus has changed from a local perspective to a national and international perspective.

In Upper Secondary School, pupils choose between different educational programmes, being the education programme (general studies) area for natural sciences and mathematics, or languages, social sciences and economy, or the vocational program for music, dance and drama, sports and physical education, or arts, crafts and design studies. Compulsory subjects vary within the different educational programmess, but all pupils, no matter what educational programme they choose, need to be through basic courses of languages (Norwegian, English and a second foreign language), mathematics, natural sciences, social sciences, history, geography and gymnastics. Geography (GEO1-01) has the aim of developing awareness on the relationship between nature and the human impact with the main topics of geographical sources and tools, landscape and climate, resources and industry, and demographics and development. The subject is set to 56 teaching hours (60-minute units) taken over one year. Natural sciences subject (NAT1-03) is different in general studies and vocational education programmes, where the first has 140 teaching hours over a course of a year, and the latter a total of 56 teaching hours. The number of hours is reflected in the curriculum, where the general studies programmes focus on the budding researcher, sustainable development, nutrition and health, radiation and radioactivity, energy sources for the future and biotechnology, while the vocational education programmes focus on the budding researcher, diversity in nature, body and health, and energy sources for the future. The general studies pupils have to choose some elective subjects after the first year. One of the subjects offered at an increasing amount of schools in Norway is geosciences (GFG1-01), which can be studied in the second year (geosciences x or geosciences 1) or in both second (geosciences 1) and third year (geosciences 2). Geosciences x amounts to 84 teaching hours a year, while both geosciences 1 and 2 amounts to 140 hours each year. The main topics of geosciences is a changing Earth, natural disasters, geosciences tools, geosciences research, climate change and geoscientific resources.

Natural sciences in both primary and secondary schools focus on experimentation and laboratory work. Many schools, mainly Lower and Upper Secondary schools, have a designated room for natural sciences with the needed equipment and educational models for laboratory work.

In both natural sciences (mainly Primary and Lower Secondary school) and geo sciences (Upper Secondary school) there is an increasing focus on bringing the pupils out of the classroom and getting their hands on experiments. It is also described as part of the curriculum for different age groups, where the focus is observing, gathering, explaining, examining, describing and later presenting data from field/geotopes.

In the last years, several Norwegian counties and municipalities have focused on making schools more technological. With digital skills as one of the core skills, the goal is to keep both schools and pupils updated on technology. Therefore, many schools have installed interactive boards in classrooms and all students must have access to the use of computers in Primary and Lower Secondary schools as a complement to coursebooks. In Upper Secondary schools, all pupils have their own or school-owned PCs to use in their everyday school. This is both to make communication between teacher-student and student-student easier, but also to make better use of digital teaching platforms, develop core skills, and digital assessment technology.

Pupils are mainly assessed at the Lower and Upper Secondary school. By the end of the Lower Secondary school, pupils shall get an overall achievement assessment in all subjects. It is also possible for them to be selected for an oral examination at this point as part of the assessment. Further, in Upper Secondary school, pupils will get an overall achievement assessment after either the first or

third year, depending on the educational programme. Pupils will also be selected for an oral examination in one subject. The grading scale in Norway is based on the numbering from 1-6, i.e., grade 1 is a very low degree of competence in the subject (Poor) and 6 is an exceptional high degree of competence in the subject.
Both naturals science and social sciences are important subjects in the Norwegian school, from Primary to Upper Secondary school. Those subjects provide pupils with a basic understanding of the world we live in on a local, national, and international level. Pupils have the possibility to develop their interests through school, and in Upper Secondary school they choose among elective courses that will give them an even greater understanding. With an increasing focus on digital skills, research and the use of outdoor teaching, pupils learn about skills to use in their social and later work life, and they are given tools to acquire even more knowledge and understanding.

All the information is available on the webpage of The Norwegian Board for Education and Training (www.udir.no).

4. CHAPTER

NATIONAL CURRICULA RESEARCH

AND NEEDS

4.1. METHODOLOGY

This chapter results, on the one hand, from the desk research, analysis and comparison of the national curricula on Natural Sciences Teaching, mainly in the three countries of the three UNESCO Global Geoparks partners of the project and, on the other hand, from the analysis, comparison and the presentation of results of an on-line research addressed to pupils, teachers and future Natural Sciences Teachers, as well as personal interviews for Natural Sciences Teachers to understand the improvement necessities of the Natural Sciences learning/teaching process.

Initially, a generic and superficial analysis of the national curricula was carried out in the three participating countries in the project. The goal was to select the three topics / themes covered in Natural Sciences common to the national curriculum of the three countries, in order to use the contents of these topics / themes in the mobile application (App) that will be created during the project. The three topics / themes selected were: 1 – Impact of the Human on Earth; 2 – Ecosystems; 3 – Geology.

Afterwards, an in-depth research of the national curricula of the three countries involved in the project was carried out to identify the subjects whose Natural Sciences content is taught. The relevant data obtained during the research of the curricula were gathered in tables, one for each country. The three tables will be presented in subchapters 4.2.1, 4.2.2 and 4.2.3 and include the following items: subjects; students' age; themes and sub-themes; operational objectives; number of teaching hours; theme of the mobile application (App) to which the content corresponds.

Three questionnaires were jointly prepared by the project partners to be answered online. These were addressed to pupils and teachers of Natural Sciences of the Elementary schools belonging to the three countries involved in the project (and others) and to future teachers of Natural Sciences, who currently attend the University of Ljubljana. A questionnaire was also created in the form of a personal interview to be answered face-to-face by some Natural Sciences teachers from the three countries. The three questionnaires were put online by the University of Ljubljana and answered by accessing a link that was sent by email to possible respondents, but also made available on the project website (http://esteamproject.wixsite.com/mysite) as well as in the facebook page. The interviews were conducted in person and were addressed to a small number of Natural Sciences teachers from each of the three countries. The three questionnaires as well as the personal interview are attached to this ebook. The main topics of the questionnaires and interview are: National Curriculum goals; Methodology in Natural Sciences Teaching/Learning process; Skills and competences (in outdoor activities); Learning methodologies (in outdoor activities); Use of ICT Technologies; Cooperation with the geopark; Satisfaction and suggestions to improve Natural Sciences Teaching.

4.2. DESK RESEARCH OF NATIONAL CURRICULA

4.2.1. RESULTS OF DESK RESEARCH IN SLOVENIA

Today's Natural Sciences has taken time and effort to shape, through examination, study and the management of ideas, all in the pursuit of understanding the natural world around us. Throughout history people from different cultures wanted to learn about and comprehend the phenomena of the physical world they live in and the need of clarification.

Natural Sciences contents in the curriculum of Primary School enable understanding of life as a whole and also develop a positive attitude towards the environment. They provide students with some useful skills that are required for a normal life of an individual as well as the knowledge that is of wider importance for the community in which the individual lives and works, and the knowledge that is necessary for his intellectual growth.

In Slovenian elementary schools, according to the curriculum, pupils up to the 6th form require 90 minutes of Natural Sciences per week. Afterwards, in the 7th, 8th and 9th form, Natural Sciences contents split into more specific branches of science, such as Biology, Geography, Chemistry and Physics. Despite being taught as separate subjects the goal is to combine them both theoretically and practically.

Their contents are the basis for understanding the world and the laws of the processes taking place in nature and in the human community. They enable an understanding of the diversity of living nature based on the diversity of geology. Pupils, by acquiring knowledge of natural sciences from various sources, reveal the essence of the issues discussed, compare, critically accept and evaluate data and information, learn to analyse, relate and generalise. This provides them with a deeper understanding of the learning contents and an understanding of the codependence of Natural Sciences and sociological skills. This way, knowledge is not "superficial" because it does not originate only in the acquisition of isolated data, but it is rather useful and it can be applied in a number of new situations.

Being educated on and involved in nature helps one bolster the drive for the conservation of natural resources, protection of biological diversity and support sustainable development. Through Natural Sciences pupils and other students gain knowledge and build an approach that helps them acknowledge and examine how nature, individuals, technology, society and research are intertwined.

At this point it is also important to emphasise the role of the teacher as a leader and moderator of the learning process in terms of being familiar with the whole primary curriculum vertically and horizontally. Cross curricular links between school subjects are necessary for the understanding of life as a whole as mentioned initially. There is still a plethora of unanswered questions, due to the fact that science also delves into the unknown. Nature is one and only, constantly asking us questions and we keep on seeking for answers. The ways to the answers are different and therefore pupils should be skilled as well as encouraged to use different strategies and abilities to find those answers.

SUBJECT	AGE	THEME	(OPERATIONAL) OBJECTIVES	NO. OF PEDAG. HOURS	APP THEME
NATURAL SCIENCES	11	Living and non-living nature	Realise that water, ground, air, heat and light are parts of inanimate nature	3	2 - Ecosystems
			Make the distinction between animate and inanimate nature		2 - Ecosystems
			Learn about the plants, animals and humans as representatives of animate nature		2 - Ecosystems
			Understand the role of microorganisms in nature		2 - Ecosystems
	11	Substance	Understand the difference between rocks and minerals	12	3 - Geology
			Understand the processes that create rocks and explain the rock cycle		3 - Geology
			Recognise different types of rock in the formation, properties and possibilities of use		3 - Geology
			Understand the processes of the formation of soil (physical, chemical and biological weathering)		2 - Ecosystems
			Learn about soil properties and ingredients in the soil, which are essential for the growth of plants and development		2 - Ecosystems
			Recognise that besides economical criteria, also environmental criteria (e.g. air pollution, thermal pollution of water due to nuclear power plants, consequences of damming) should be taken into account when evaluating the effectiveness and consequences of the exploitation of natural resources		1 – Man's impact on Earth
			Understand that the extraction and processing of energy and other natural resources affect the environment (e.g. mines and quarries)		1 – Man's impact on Earth
			Learn how to conduct themselves with the appropriate contribution to protect the environment, while being aware of the significant impact of each individual on the environment		1 – Man's impact on Earth

	12	Ecology	Recognise that due to natural causes (e.g. floods, volcanoes) and human activities the concentration of substances (contaminants) in the water, air and ground increases, which adversely affects the organisms and thereby disrupts natural balance	10	1 – Man's impact on Earth
			Know about the main causes of pollution (surface water, groundwater, air and soil), the key pollutants, the effects of their actions on living organisms and the environment and ways and measures to reduce and prevent pollution		1 – Man's impact on Earth
			Understand the impact of different means of transport and communication on the environment (air, water and soil pollution) and organisms (e.g. noise)		1 – Man's impact on Earth
			Know about the reasons for the increase of gas emissions (carbon dioxide, methane, nitrous oxide) and the associated excessive warming (increased greenhouse effect), which reflects in the changing of climate and terrestrial and aquatic ecosystems		1 – Man's impact on Earth
	12	Structure and function of ecosystems	Upgrade the knowledge of the structure and function of the forest as an ecosystem (for example: mixed, deciduous, coniferous forest)	3	2 - Ecosystems
			Learn about the adaptations of typical representatives of animals and plants in the forest on living and non-living environmental factors (for example: prey - predator, defense of plants against herbivores, seasonal variations of light - spring undergrowth in deciduous forest, adaptations to life in the soil) and some interspecies relationships		2 - Ecosystems
			Know that the producers (plants and photosynthesis microorganisms as the base of the food web) produce energy that enters the ecosystem as solar energy, transform it during photosynthesis into chemically bound energy, and this energy is then transferred from organism to organism through the food web (consumers - eating other organisms)		2 - Ecosystems

			Know that the food web can be represented by an energy pyramid and that on each hierarchical level of the pyramid part of energy is lost through transfer on the non-living environment		2 - Ecosystems
			Know that the substances are transferred from organism to organism in the food web and from organisms to non-living environment; substances constantly circulate		2 - Ecosystems
			Recognize that part of the carbon returns into the inanimate environment as carbon dioxide, which is produced during cellular respiration of organisms		2 - Ecosystems
			Recognize that biomass produced in a forest, which a man does not interfere with (a stable ecosystem), is also decomposed in this forest and that this forest consumes about as much oxygen as it produces		2 - Ecosystems
	12 and 14	Comparison of the structure and functions of different ecosystems	Compare the structure and function of natural ecosystems (e.g. forests, natural meadows, sea, inland waters, marshlands, cave ecosystem)	6	2 - Ecosystems
			Recognize that plant biodiversity in the ecosystem also depends on non-living environmental factors, such as the amount of light and water, temperature area and composition of the soil		2 - Ecosystems
			Understand that biodiversity of plants as producers has the impact on biodiversity and the number of organisms that can live in the ecosystem; the number of herbivores in the ecosystem is directly dependent on the amount of edible plants, the number of predators depends on the number of organisms that represent their food		2 - Ecosystems
	12	Man changes ecosystems	Learn about the importance of biodiversity for ecosystem stability	3	2 - Ecosystems

			Learn about examples of anthropogenic ecosystems (e.g. fields, orchards, meadows, vineyards, etc.) and study biodiversity in surrounding natural and anthropogenic ecosystems		2 - Ecosystems
			Learn from the comparison of functioning of natural and anthropogenic ecosystems, why Man must constantly maintain anthropogenic ecosystems (e.g. fertilising, weeding and pest control)		2 - Ecosystems
			Understand that there aren't any beneficial or harmful species in nature, but in anthropogenic ecosystems only in terms of humans individual animal and plant species are considered harmful (e.g. pests of crops and fruit trees, weeds) or useful (bees, predators of pests)		2 - Ecosystems
			Learn about the effects and consequences of fertilization in agriculture and the use of pesticides (e.g. herbicides, insecticides) in groundwater pollution		1 – Man's impact on Earth
			Learn about the possible consequences of removing trees from the forest (e.g. a comparison of selective cutting and clear cutting)		1 – Man's impact on Earth
			Understand that biodiversity is maintained by the direct protection of all nature and the biosphere in general, with sustainable use of landscape and sustainable development, especially in protected areas		1 – Man's impact on Earth 2 - Ecosystems
BIOLOGY	14	Evolution	Realise that even very slow geological processes have large effects through long periods of time (e.g. change of the position of continents, fossil evidence for the existence of the Pangaea) and can lead to the development of broad groups of organisms (e.g. marsupials in Australia)	6	3 - Geology
			Know that the species in their evolutionary history changed (evidenced by fossils, also embryology, organs atrophy, etc.) and that with evolution new species are created and some become extinct		3 - Geology

			Recognise that the evolution of life on Earth was strongly influenced by global catastrophes (large volcanic eruptions, collisions of asteroids, global climate changes) Recognize that biodiversity is the result of millions of years of evolution of the living world and the basis for the functioning of ecosystems and the biosphere, and thus also the basis for human survival (e.g. food, natural resources) Understand that the organisms (including humans) have had and still have an important role in the changing of our planet (the impact on the structure of the atmosphere, participation in the formation of certain types of rocks and the weathering of rocks and the formation of soil)		3 - Geology 2 - Ecosystems 1 – Man's impact on Earth
CHEMISTRY	13 14		Learn the basic features and the use of alkali metals, alkaline earth metals, the selected transition metals, halogens and noble gases Use the experimental reasearch approach or laboratory skills	10	
PHYSICS	13	About Forces	List some forces that alter the body's shape Numerate some of the contact forces originating from the visible body Distinguish between the contact and non-contact forces Select contact and non-contact forces Distinguish between flexible and rigid bodies Recognise the bigger force between two forces when given a concrete example Ability to find equal force in the opposite direction to the given force Determine whether the body is balanced or not Distinguish between forces distributed point-wise, surface-wise and spatially	7	

	13	Density and Specific Weight	Learn about and list the volume units Know about prefixes and according to prefixes determine converters and derive decimal units of measurement Define mass of substance, its units of measurement and measurement devices Define density and its units of measurement Classify homogeneous bodies of the same volumes by density Classify homogeneous bodies of the same masses by density Know about units of measurement for density Distinguish between homogeneous and non-homogenous bodies Calculate density of substance from mass and volume Name unit of measurement for specific weight Calculate specific weight from given weight and volume Derive specific weight from given density	5	
	13	Air pressure	Explain that air causes pressure Learn the physical properties of air (air temperature, air humidity, air movement, clouds and precipitation) Explain what normal air pressure is like	3	
	13	Buoyancy	Explain the buoyant force as a resultant of forces of a fluid, acting on the sunken object Know that buoyancy is a force of a liquid acting on the sunken object Learn that buoyant force is equal to the weight of the displaced fluid and know about its direction Distinguish between the circumstances in which the body swims, floats or sinks and explain how an object's density influences its buoyancy Calculate simple examples of the buoyant force	5	

GEOGRAPHY	12	Earthquake and volcano zone	Explain tectonic causes of earthquakes and explain volcanic actions		3 - Geology
			Describe the consequences of volcanic eruptions and seismic activity on people's lives	2	3 - Geology
			Using the map to determine the direction of the stretching of the Alps		3 - Geology
			Describe the transformation of the Alps, with emphasis on the action of glaciers and their effects on the transformation of river valleys	2	3 - Geology
			Draw up conclusions about the possibilities for life and management with an emphasis on tourism and grazing		1 – Man's impact on Earth
	13		Describe the characteristics of the climate and landforms in Northern Europe and compare them with each other in terms of the possibility of settlement	1	3 - Geology
			Explain the glacial transformation in Northern Europe and the people's dependency from it		3 - Geology
			Using the map and imagery to describe the surface morphology of Australia and make conclusions about the impact of the Great Dividing Range on the climate and waters	2	3 - Geology
			Understand the formation of the Great Barrier Reef and evaluate its importance		3 - Geology
	14	Natural geographical units of Slovenia	Define five natural geographical units of Slovenia and compare them with each other based on geographical location, climate and relief features	1	
			Explain the main stages of the current relief formation of Slovenia and factors that formed it	1	3 - Geology
			Based on fieldwork results pupils evaluate the significance of soil and rock structure for human	1	3 - Geology

	14	Dinaric Karst area: Dinaric Karst plateaus and hills: Dinaric karst lowlands and levelled surfaces	Pupils present the efforts and measures for conservation of natural and cultural heritage using the example of the Postojna Cave	2	3- Geology

4.2.2. RESULTS OF DESK RESEARCH IN PORTUGAL

Natural Sciences teaching in Portugal occurs from Primary education to Secondary education. In the first cycle it is integrated in the subject of Environmental Studies, in the second and third cycle in the subject of Natural Sciences, Physics and Chemistry and Geography; In Secondary education it is split into subjects such as Biology, Physics, Chemistry, Geology and Geography.

The content is diversified and its achievement is defined by curricular goals. Pupils must meet these goals by the end of each of the four teaching cycles that culminate when they are ten, twelve, fifteen and eighteen years old, successively.

From the different scientific areas treated by the various subjects, we can highlight the Man's Impact on the Planet, the Dynamics of Ecosystems and Principles of Geology. The first set of themes addresses the way Man and his actions influence terrestrial subsystems. The second batch of subjects discusses the functioning of the planet's ecosystems and the third group presents phenomena and processes occurring in the geosphere. These fields of scientific knowledge are dealt in depth and balanced throughout the various levels of teaching in the different subjects.

SUBJECT	AGE	THEME (subthemes)	OPERATIONAL OBJECTIVES (goals)	No. of pedagogical hours (minutes per week)	APP THEME
NATURAL SCIENCES Biology and Geology	12	EARTH TELLS ITS STORY Fossils and their importance for the reconstruction of Earth's History Major stages of Earth's History EARTH´S INTERNAL DYNAMICS Drift of continents and tectonics plate Occurrence of faults and folds CONSEQUENCES OF EARTH`S INTERNAL DYNAMICS Volcanic activity: risks and benefits of volcanic activity Seismic activity: risks and protection of populations	Understand the importance of fossils for the reconstruction of Earth's history. Understand the great stages of Earth's history. Understand the foundation of the structure and dynamics of Earth. Apply concepts related to the deformation of rocks. Understand volcanic activity as a manifestation of Earth's internal dynamics. Interpret the formation of magmatic rocks. Understand metamorphism as a consequence of Earth's internal dynamics. Recognise the cycle of rocks. Understand that lithological formations (in Portugal) should be explored in a sustainable way. Understand seismic activity as a consequence of Earth's internal dynamics.	90+45 = 135 minutes	3. Geology
		INTERNAL EARTH´S STRUCTURE Contribution of Science and Technology to the study of the internal structure of the Earth Models of the internal structure of the Earth EARTH´S EXTERNAL DYNAMICS Magmatic, sedimentary and metamorphic rocks: testimonies of the Earth's activity Geological landscape and rock applications	Understand Earth's internal structure. Understand the diversity of geological landscapes. Understand minerals as basic units of rocks. Analyse the concepts and processes related to the formation of sedimentary rocks.		
	13	ECOSYSTEMS		90+45 = 135	2. Ecosystems

		Interactions between living beings and the environment Environmental factors: Abiotic factors and Biotic factors Energy flow and Cycle of matter Food chains and Food webs Ecological succession Ecosystem dynamics Balance disturbances in ecosystems Natural disasters: Storms and floods Natural disasters: Droughts Natural disasters: Earthquakes and volcanoes Natural disasters: Fires	Understanding the levels of biological organization of ecosystems Analyse the interaction dynamics between living beings and the environment Explore the dynamics of interaction between living beings Understanding the importance of energy flows in the dynamics of ecosystems Synthesising the role of major cycles of matter in ecosystems Linking the dynamic balance of ecosystems with the sustainability of planet Earth Analyse how ecosystem management contributes to achieving the goals of sustainable development Understanding the influence of disasters on the balance of ecosystems Synthesising measures to protect ecosystems	minutes	
		DISTURBANCES IN THE BALANCE OF ECOSYSTEMS Catastrophes directly caused by Man: Wars, Terrorism, Pollution, Deforestation SUSTAINABLE RESOURCE MANAGEMENT Natural resources: use and consequences Natural resources: Mineral resources, Biological resources, Water resources, Energy resources Protection and conservation of nature: Waste and Storage of waste Preservation and Conservation of Nature and Biodiversity Risks of scientific and technological innovations for the individual, society and the environment	Understanding the influence of natural disasters on the balance of ecosystems Summarise protective measures of the ecosystems Understanding the classification of natural resources Understand how natural resources are exploited and transformed Relate the role of territorial management tools and plan the protection and conservation of nature Integrate knowledge of territorial management Understand the link between waste and water management with sustainable development	90+45 = 135 minutes	1. Man's impact on earth

			Relate the scientific and technological development with the improvement of life quality of the human population		
NATURAL SCIENCES Physics and Chemistry	12	MATERIALS Constitution of the material world	Recognise the enormous variety of materials with different properties and uses, as well as the role of chemistry in the identification and transformation of these materials. Identify several materials and some criteria for their classification. Conclude that materials are limited resources and that you need to use them well by reusing and recycling them. Identify, in everyday examples, manufactured materials that do not exist in Nature.	90+45 = 135 minutes	1. Man's impact on Earth
		MATERIALS Physical and chemical transformations	Recognise physical and chemical transformations and conclude that the transformations of substances may involve absorption or release of energy. Associate physical transformations with changes in substances without others being originated. Explain the water cycle referring to the changes of physical state that occur in it. Associate chemical transformations to the formation of new substances, identifying evidence of this formation. To justify, from selected information, the importance of chemical synthesis in the production of new and better materials, in a more economical and ecological way.	90+45 = 135 minutes	2. Ecosystems
		ENERGY Energy sources and energy transfers	Recognise that energy is associated with systems, that it transfers globally, that energy sources are relevant in society and that there are different processes of energy transfer. Identify renewable and non-renewable energy sources, assessing the advantages and disadvantages of their use in today's society and their consequences for the sustainability of Earth by interpreting data on their use in graphs or tables.	90+45 = 135 minutes	1. Man's impact on Earth
	13	CLASSIFICATION OF MATERIALS Chemical bonding	Understand that diversity of substances results from the combination of atoms of chemical elements through different bonding models: covalent, ionic and metallic.	90+45 = 135 minutes	1. Man's impact on Earth

			Give examples of covalent substances and covalent networks of elementary substances with different structures and properties (diamond, graphite and graphene). Associate metal bonding to the bond that is established in the networks of metal atoms in which there is shared off-center valence electrons. Identify carbon as a chemical element that enters the composition of living beings which have a large variety of substances where there are covalent bonds between carbon and elements such as hydrogen, oxygen and nitrogen. Define what hydrocarbons are and distinguish saturated hydrocarbons from unsaturated ones. Identify, from selected information, the main sources of hydrocarbons, evidencing their use in the production of fuels and plastics.		
NATURAL SCIENCES **Geography**	12	THE NATURAL ENVIRONMENT The climate	Understand the relationships between climate types and different plant formations in hot, temperate and cold regions Understand the climate of Portugal and the main vegetable formations	90+45 = 135 minutes	2. Ecosystems
		THE NATURAL ENVIRONMENT The relief The dynamics of the coast	Understand the external agents responsible for forming different forms of relief. Characterise the main erosive agents (water and wind). Distinguish the three stages of the erosive process: wear, transport and accumulation. Characterise forms resulting from erosion and sediment accumulation by water and wind. Understand the coastline evolution. Explain the action of the sea on a cliff. Define abrasion platform. Distinguish types of cliffs: living and fossil. Relate the layout of the coastline with the lithological structure	90+45 = 135 minutes	3. Geology

			and the erosive and depositional action of the sea.		
	13	ECONOMIC ACTIVITIES Natural Resources ECONOMIC ACTIVITIES Agriculture ECONOMIC ACTIVITIES Fishing ECONOMIC ACTIVITIES Industry	Understand the unequal distribution of resources. Distinguish renewable resources from non-renewable resources, using examples. Understand the relationships between distribution and consumption of different types of resources Interpret the relationship between the evolution of population and the consumption of resources (sustainable development). Explain the causes of increased consumption of resources. Explain the impacts of natural resources exploration. Understand the differences between traditional agriculture and modern agriculture. Distinguish: monoculture, polyculture, production yield, extensive agriculture and intensive agriculture. Distinguish traditional agriculture / subsistence from modern agriculture / market, exemplifying with different types. Explain the main consequences of traditional agriculture and modern agriculture. Understand the existence of sustainable forms of agricultural production. Characterise organic farming and identifyadvantages and disadvantages of its use. Identify other forms of agricultural production environmentally sustainable (biodynamic, natural, permaculture, etc.). Understand the importance of the ocean as a source of resources and natural heritage. Explain the importance of the ocean as a source of resources. Problematise the importance of environmental preservation of the oceans. Characterise the marine relief: continental shelf, slope, abyssal zone. Discuss the impacts of industrial fishing activity. Distinguish each stage of industrial development: the energy sources used, the main industrial powers, the main innovations in production. Explain the economic, social and environmental consequences of	90+45 = 135 minutes	1. Man's impact on Earth

		ECONOMIC ACTIVITIES Means of Transport and Telecommunication	industrial activity worldwide. Mention solutions to the economic, social and environmental problems of industrial activity. Relate the economic, social and environmental impacts of land, air and water transport. Explain the importance of pipelines in energy transportation, highlighting the main areas of provenance.		
	14	RISK, ENVIRONMENT AND SOCIETY Natural hazards (Geohazards)	Distinguish risk from catastrophe. Identify different risks and their causes: natural and mixed. Understand droughts as a climatic risk with influence in the environment and in society. Understand the heat and cold waves as climatic risks with influence in the environment and in society. Understand floods as hydrological risks with influence in the environment and society. Understand the slope movements and the avalanches as geomorphological risks with influence in the environment and society.	90+45 = 135 minutes	2. Ecosystems
		RISK, ENVIRONMENT AND SOCIETY Mixed risks	Understand the influence of atmospheric pollution on the formation of smog and acid rain. Analyse the main consequences of acid rain. Know about the influence of atmospheric pollution on the greenhouse effect and the ozone layer. Identify the gases that contribute to the increase of the greenhouse effect. Identify the consequences of increasing greenhouse gases on global and local climate change. Know about the influence of hydrosphere pollution on the environment and society. Understand the influence of soil degradation and desertification on the environment and society. Define lithosphere and biosphere. Understand the importance of the forest on a planetary scale and in Portugal. Explain the main causes of deforestation on a planetary scale and	90+45 = 135 minutes	1. Man's impact on earth

			in Portugal. Inferring the consequences of deforestation on a planetary scale and in Portugal. Identify forest preservation measures. Understand the influence of forest fires in the environment and in society. Identify the natural and human causes responsible for the occurrence of forest fires. Infer the impacts of forest fires on the territory.		
		RISK, ENVIRONMENT AND SOCIETY Environmental protection, control and management for sustainable development	Understand the need to preserve natural heritage and promote sustainable development. Explain the importance of adopting environmental protection, control and management policies. Explain the need to apply the principles of protection, control and environmental management in the construction of sustainable and resilient territories. Understand the role of international cooperation in preserving natural heritage and promoting sustainable development. Define ecological footprint. Justify the adoption of habits in order to reduce the collective and individual ecological footprint.	90+45 = 135 minutes	1. Man's impact on Earth

Notes

12 years old - 7th Form

13 years old - 8th Form

14 years old - 9th Form
7th, 8th & 9th Forms are elementary school (3rd cycle)
7th, 8th & 9th Forms are followed by secondary school (10th, 11th & 12th year of mandatory school)

4.2.3. RESULTS OF DESK RESEARCH IN NORWAY

Natural Sciences as a subject has had a major role in the educational system in Norway for years and still has. The Norwegian Board for Education and Training emphasises that Natural Sciences has grown out of mankind's curiosity and will continue to do so since it is an important knowledge to understand our own existence and the world around us.

Pupils start with natural sciences learning as soon as they start Primary School, and it remains a mandatory subject until Upper Secondary School. The teaching of natural sciences is split into different topics that shall cover both biological, chemical, physical and geological aspects of the subject, i.e., sustainable development, body and health, energy sources for the future, technology and design, phenomena and materials, and the budding researcher. In Lower Secondary School, geological aspects are also covered in Social Studies as part of the Geography topic. Furthermore, in the Upper Secondary school pupils can select chemistry, physics, biology, geography and geoscience to take specific courses.

Deeply rooted in Natural Sciences, as in all subjects in the Norwegian school system, the national curriculum provides five basic skills for pupils and teachers to work with: oral skills, reading, writing, numeracy and digital skills. These are basic skills for learning, and teachers are supposed to facilitate the development of these skills through the teaching of Natural Sciences.

As part of the national curriculum, it is pointed out the importance of learning Natural Sciences both through theory and practical work. The reason for this is that pupils should have the possibility to experience and develop knowledge about ways of thinking and the methods used. The aim is to help the pupils develop creativity, a critical way of thinking and openmindness and to become active participants in common debates related to Natural Sciences.

The arenas for practical work used in school are fieldwork in the local areas, experiments performed in school laboratories and excursions to local museums, science centres and companies. In the Upper Secondary School, some pupils have the chance to participate in fieldworks abroad. This practical work is expressed in the national curriculum, especially through “the budding researcher”, and the goal is to prepare pupils for vocational education and further studies.

SUBJECT	AGE	THEME	(OPERATIONAL) OBJECTIVES	NO. OF PEDAG. HOURS	APP THEME
NATURAL SCIENCES	from 12 to 15	**Diversity in nature**	Ex:	*	
			Formulate testable hypothesis, plan and undertake hypothesis testing and discuss observations and results from trials in a report		2 - Ecosystems
			Gather and process Natural Sciences data, perform calculations and present the results in a graph		
			Write explanatory and argumentative texts with references to relevant sources, evaluate the quality of one's own texts and those of others making appropriate revisions		
			Explain the importance of looking for relationships between cause and effect and explain why argumentation, disagreement and publication are important in natural sciences		
			Identify Natural Sciences arguments, facts and assertions in texts and visual information from newspapers, brochures and other media and evaluate their content in a critical manner		
			Comply with safety measures as described in environment, health and safety (EHS) routines and risk assessments		
			Explain the main features of the theory of evolution and give an account of observations that support this theory		3 - Geology
			Describe the structure of animal and plant cells and explain the main characteristics of photosynthesis and cellular respiration		
			Elaborate a Natural Sciences curriculum on cell division and genetic variation and heritage		
			Explain the main characteristics of theories on how Earth is changing and has changed over the years and the support of these theories		3 - Geology
			Investigate and register biotic and abiotic factors in a local ecosystem and explain the relationship between these factors		2 - Ecosystems

		Observe and provide examples of how human actions have affected a natural area, investigate the points of view of different interest groups on these effects and suggest measures that might preserve nature for future generations Give examples of how Sami people exploit natural resources		1 – Man's impact on Earth 1 – Man's impact on Earth
	Body and health	Describe the nervous system and the endocrine system and explain how these control body processes Provide a short description of fetal development and how birth occurs Formulate assertions and discuss and elaborate on problems related to sexuality, sexual orientation, gender identity, setting limits and respect, sexually transmitted diseases, prevention and abortion Explain how one's own lifestyle can influence health, including dieting and eating disorders, compare information from different sources and discuss how one can prevent health risks Provide examples of traditional medicine, including Sami traditional medicine, and discuss the difference between alternative medicine and conventional medicine		1 – Man's impact on Earth
	Phenomena and substances	Describe the universe and different theories of how it has developed Investigate a theme from exploring the outer space; compare and present information from different sources Assess characteristics of elements and compounds using the periodic table Examine the properties of some substances used in everyday life and make simple calculations related to diluting solutions		3-Geology

			Examine and classify pure substances and compounds based on solubility in water, combustion, acidity and basicity Plan and carry out experiments with detection reactions, separation of substances in a mixture and analysis of an unknown substance Examine hydrocarbons, alcohols, carboxylic acids and carbohydrates, describe the substances and give examples of their fabrication and areas of use Explain how crude oil and natural gas have come about Use terms such as current, voltage, resistance, output and induction to explain results from experiments with electrical circuits Explain how we can produce electrical energy from renewable and non-renewable energy sources and discuss the environmental effects that arise from different ways of producing energy Elaborate on the concepts of velocity and acceleration, measure magnitudes using simple aids and give examples of how power is connected to acceleration Carry out experiments and simple calculations with work, energy and output Elaborate on how traffic safety equipment prevents and reduces injuries in accidents Carry out experiments with light, vision and colour;describe and explain results		
		Technology and design	Develop products based on specifications that use electronics, evaluate the design process and assess product functionality, user friendliness and sustainable development Test and describe the characteristics of materials used in a production process and evaluate the use of materials from an environmental standpoint		

			Describe an electronic communication system, explain how information is transferred from sender to recipient and give an account of the positive and negative consequences related to this system		
		Numbers and algebra in practice	Compare and convert whole numbers, decimal numbers, fractions, percentages, per thousands and express such figures in various ways, and evaluate situations where the different representations are suitable Calculate with fractions, carry out division of fractions and simplify fractions Use factors, powers, square roots and prime numbers in calculations Develop, use and elaborate on methods for counting in one's head, make estimation calculations and written calculations with the four arithmetic operations Process, factor and simplify algebraic expressions, tie expressions to practical situations, calculate by using formulas, brackets and fraction expressions and use square expressions Solve equations and inequalities of the first order and simple equation systems with two unknowns and use this to solve practical and theoretical problems Do calculations on consumption, use of credit cards, income, loans and savings, set up budgets and accounts using a spreadsheet, explain the calculations and present the results		

			Analyse complex problems, identify fixed and variable quantities, connect complex problems to known solution methods, carry out calculations and present the results in a suitable manner Use numbers and variables in exploration, experimentation, practical and theoretical problem solving and technology and design projects		
		Geometry	Investigate and describe the characteristics of two- and three-dimensional figures and use them for constructions and calculations Perform, describe and provide rationale for geometric constructions using a compass and ruler and dynamic geometry programs Use congruence and the Pythagorean theorem to calculate unknown lengths and angles and provide rationale for one's choices Interpret and make working drawings and perspective drawings with several vanishing points, with and without digital tools Use coordinates to represent figures and find characteristics of geometric forms with and without the use of digital tools Explore, experiment with and formulate logical reasoning by means of geometric ideas, and elaborate on geometric relations that are particularly important in technology, art and architecture		
		Measurement	Make estimates of and calculate length, circumference, angle, area, surface, volume and time, and use and change scales Choose appropriate measurement units, explain relationships and convert between different measurement units, use and assess measuring instruments and measuring methods for practical measuring, and discuss and elaborate on precision and measuring uncertainty		

			Elaborate on the number π and use it for calculating circumference, area and volume		
		Statistics, probability and combinatorics	Carry out investigations and use databases to search for and analyse statistical data and critically assess sources Order and group data, find and discuss and elaborate on the median, mode,average and spread, and present data with and without digital tools, and discuss and elaborate on different ways of presenting data and what impressions these can give Find and discuss probability by experimenting, simulating and calculating in day-today contexts and games Describe sample space and represent probability as fraction, percentage and decimal number Discuss and elaborate on and solve simple combinatorics problems		
		Functions	Prepare functions that describe numerical relationships and practical situations, on paper and digitally, describe and interpret them and convert between various representations of functions, such as graphs, tables, formulas and text Identify and explore characteristics of proportional, inversely proportional, linear and simple square functions, and provide examples of situations that may be described using these functions		

Note: * In Norway there is no specific number of pedagogical hours for each subject.

4.3. ON-LINE RESEARCH

4.3.1. ON-LINE RESEARCH FOR PUPILS

ANALISIS OF THE ESTEAM QUESTIONNAIRE FOR PUPILS

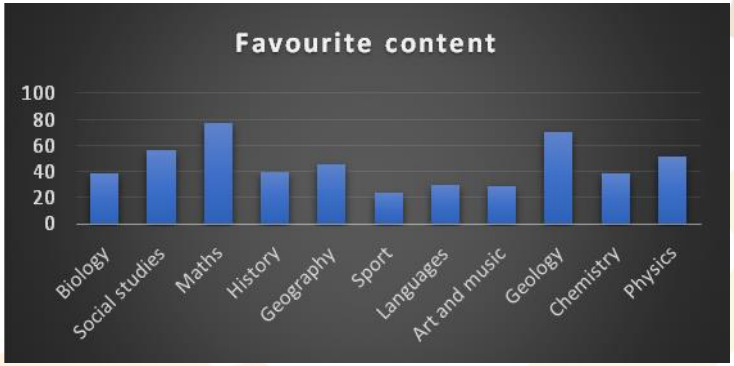
443 pupils have answered the questionnaire. The exact number of pupils per country is listed in the table below.

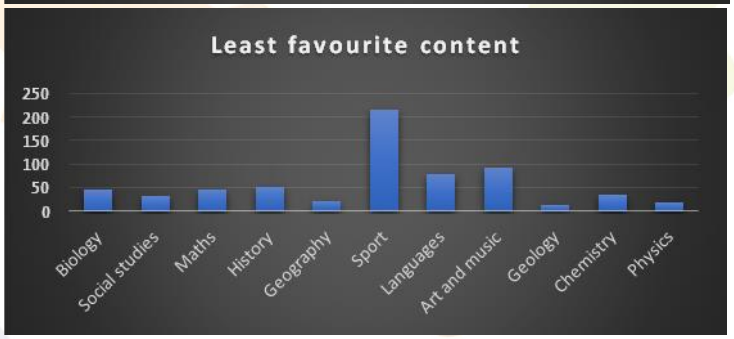
Albania	1
Andorra	1
Brazil	1
Hong Kong	1
Hungary	27
Norway	36
Portugal	161
Slovenia	215

NATIONAL CURRICULUM GOALS

What do you prefer learning at school?

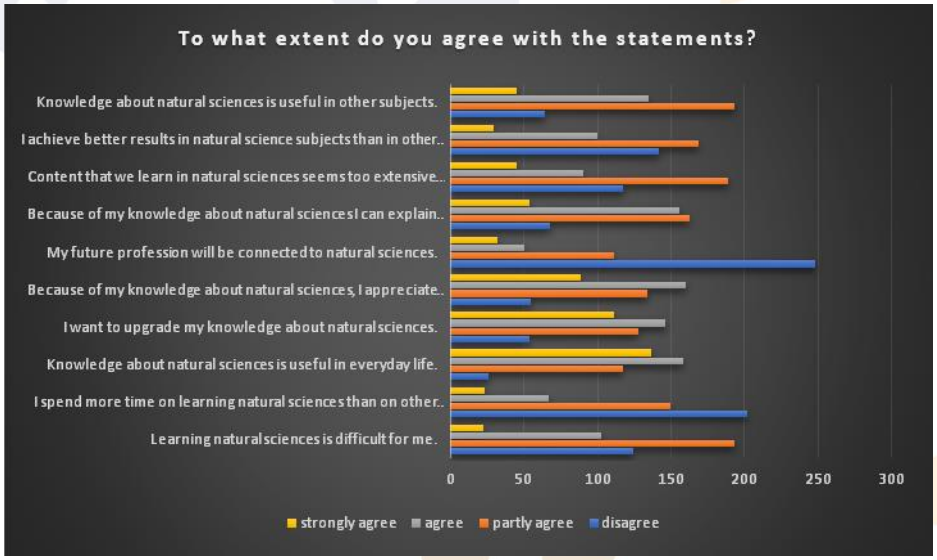
The surprising revealing answer to this question is that the majority of pupils favours Maths, Geology, followed by Social studies and Physics. On the negative side is that the by far least favourite subject is Sports, followed in long distance by Arts, Music and Languages.





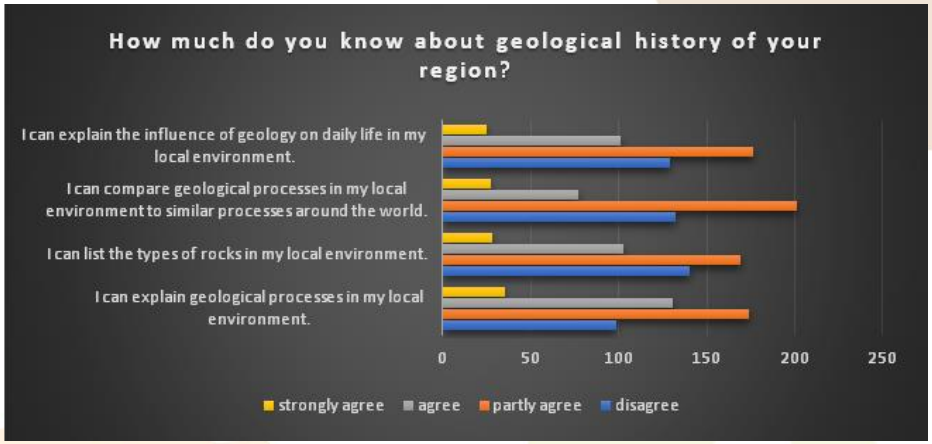
To what extent do you agree with the statements?

Although pupils appreciate the knowledge of Natural Sciences in ordinary life and in connection with other sciences, they do not want their future job to be connected to Natural Sciences.



How much do you know about geological history of your region?

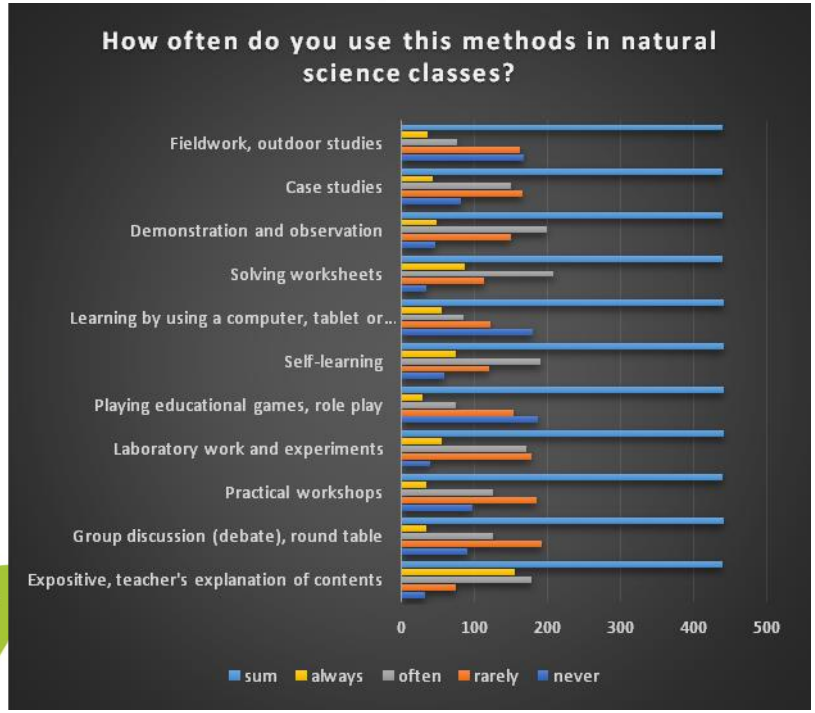
All answers to the question related to geology are quite similar. Pupils do not feel confident in their geological knowledge as the majority answers (usually more than 300 students) to all of the questions in this part are ''partly agree and disagree''.

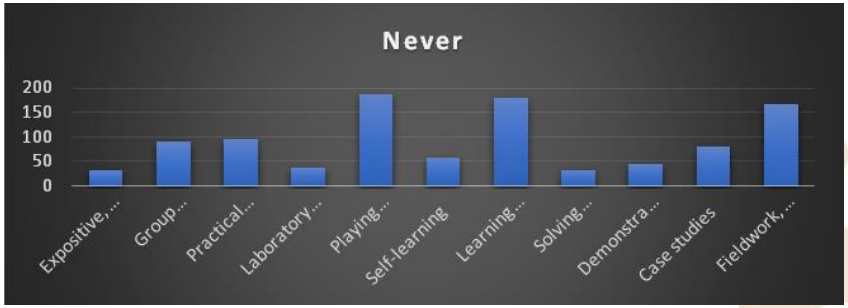


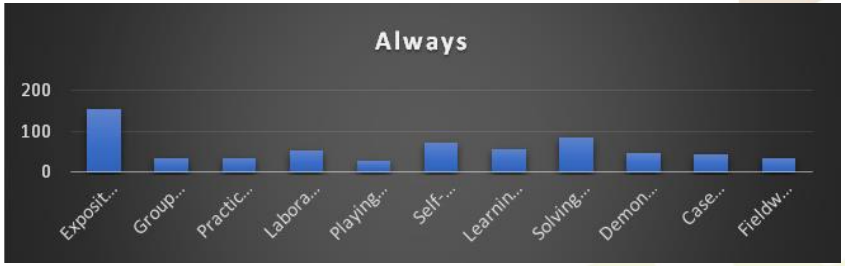
CURRENT METHODOLOGY IN NATURAL SCIENCES TEACHING

How often do you use these methods in Natural Sciences classes?

More than 180 of 442 pupils never play educational games, role play or learn by using a computer, tablet or mobile phone in Natural Sciences classes. More than 160 pupils never do fieldwork or other outdoor activities. They often have expositive lessons with the teacher's explanation of contents. More than 160 out of 442 pupils always use this method in Natural Sciences classes.

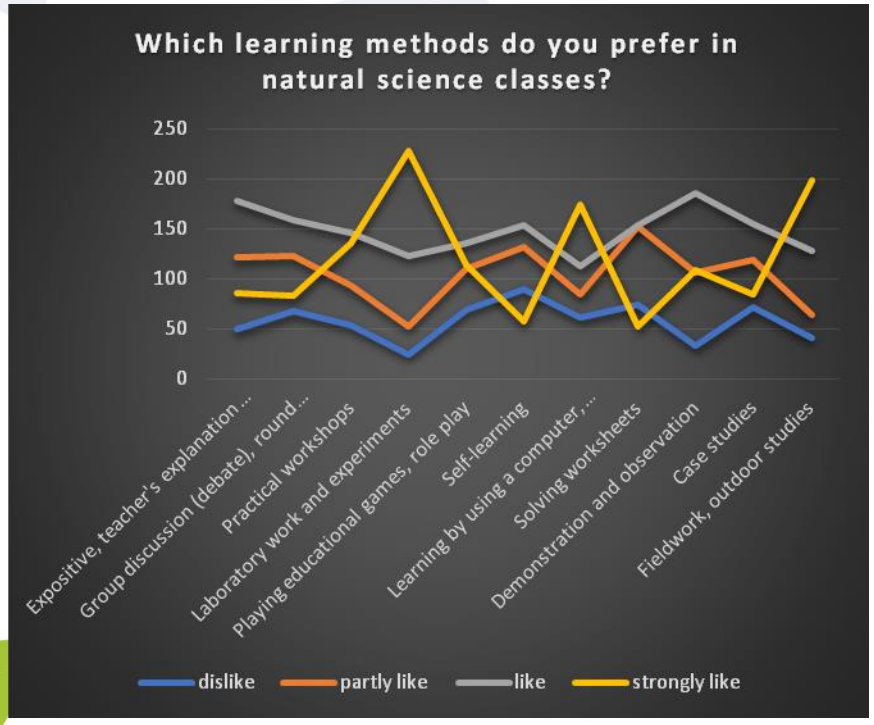


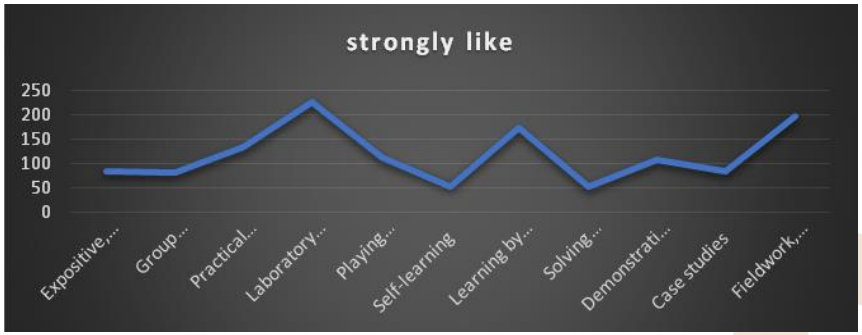


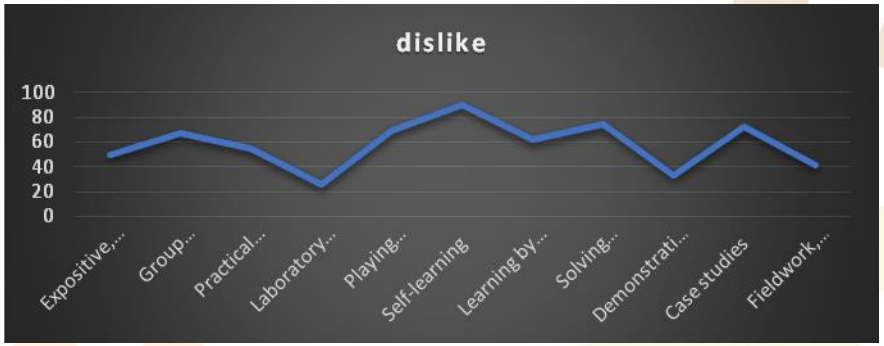


Which working methods in Natural Sciences classes do you prefer the most and which ones the least?

Pupils strongly like laboratory work and experiments and learning by using a computer, tablet or mobile phone. They also like fieldwork, outdoor activities, demonstration and observation. They dislike (91 out of 442) self-learning, solving worksheets (75 out of 442) and case studies (73 out of 442).

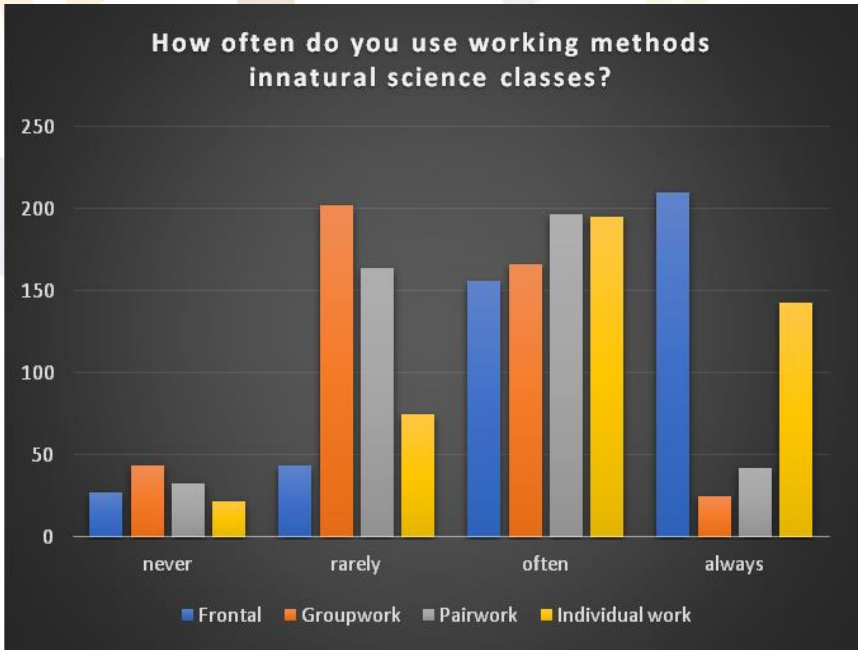


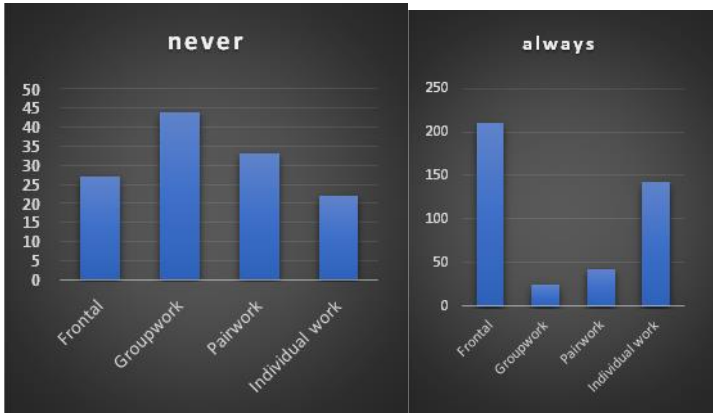




How often do you use working methods in Natural Sciences classes?

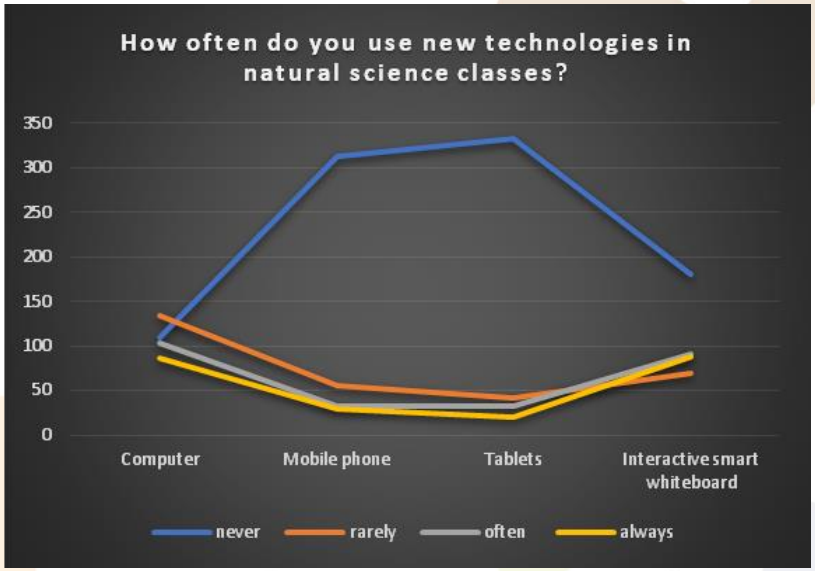
Pupils always (210 out of 420) or often (156 out of 420) use the frontal method in Natural Science classes. They also do always (143 out of 420) or often (195 out of 420) individual work in Natural Sciences classes. They prefer pair work (165 out of 420) and group work (156 out of 420) and dislike individual work in Natural Sciences classes.



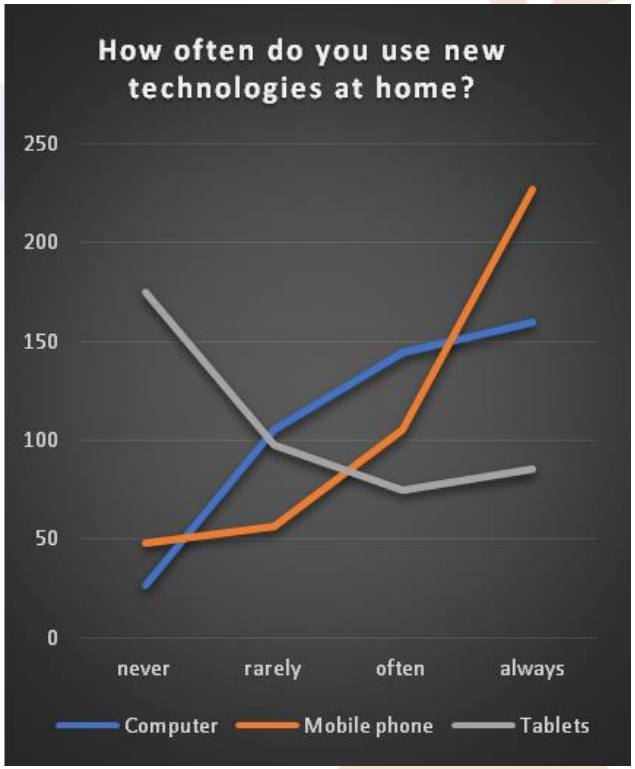


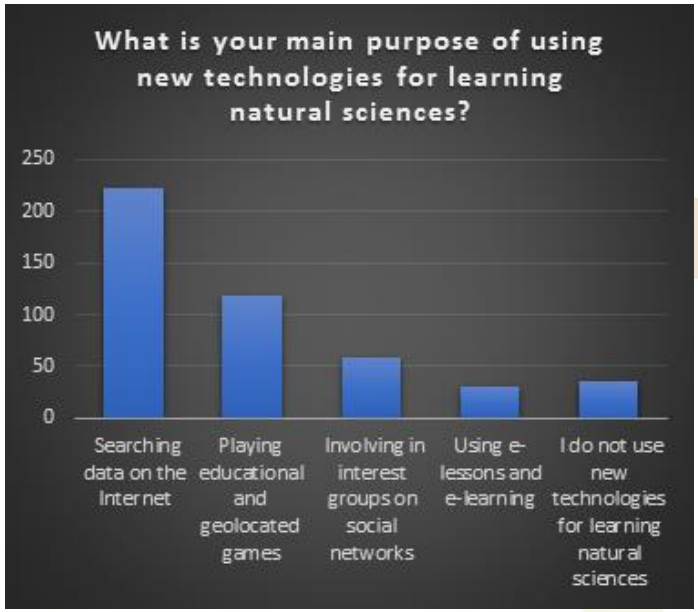
How often do you use new technologies in Natural Sciences classes?

333 out of 427 pupils never use tablets in Natural Sciences classes. 313 out of 431 pupils also never use mobile phone in Natural Sciences classes. But 323 pupils out of 436 often (105 out of 436) and always (227 out of 436) use mobile phones at home.



How often do you use new technologies at home?





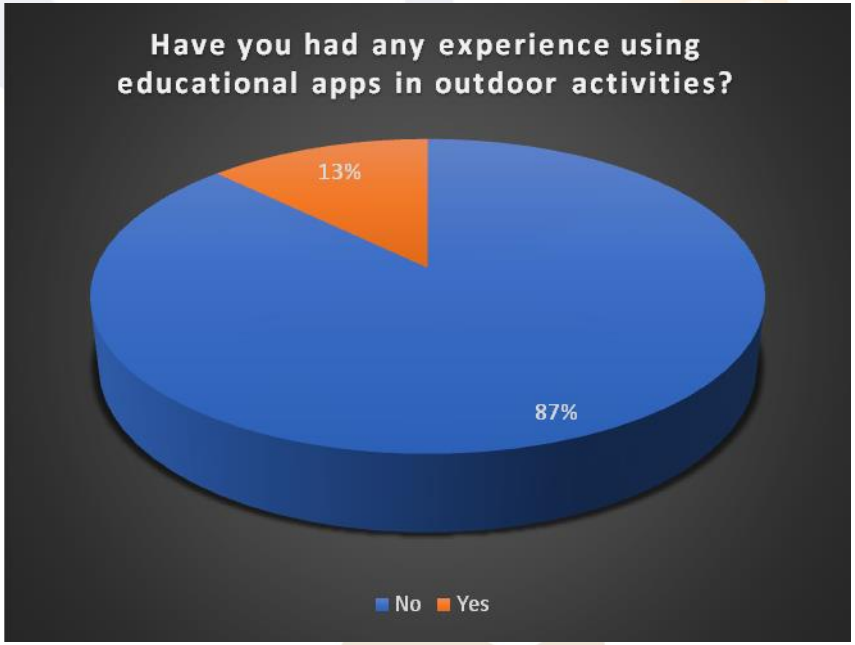
What is your main purpose of using new technologies when learning Natural Sciences?

The main purpose for using new technologies when learning Natural Sciences for pupils is searching for data on the internet (223 out of 467) instead of playing educational and geo-located games (119 out of 467). 36 pupils don't use new technologies when learning Natural Sciences.

SKILLS AND COMPETENCES IN OUTDOOR ACTIVITIES

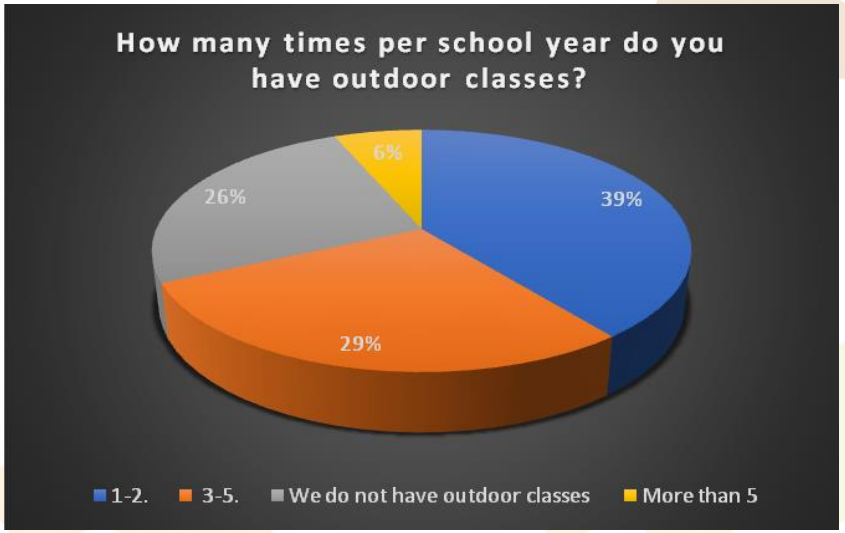
Have you had any experience in using educational apps in outdoor activities?

87 % of pupils have had no experience in using educational apps in outdoor activities and only 13% did.



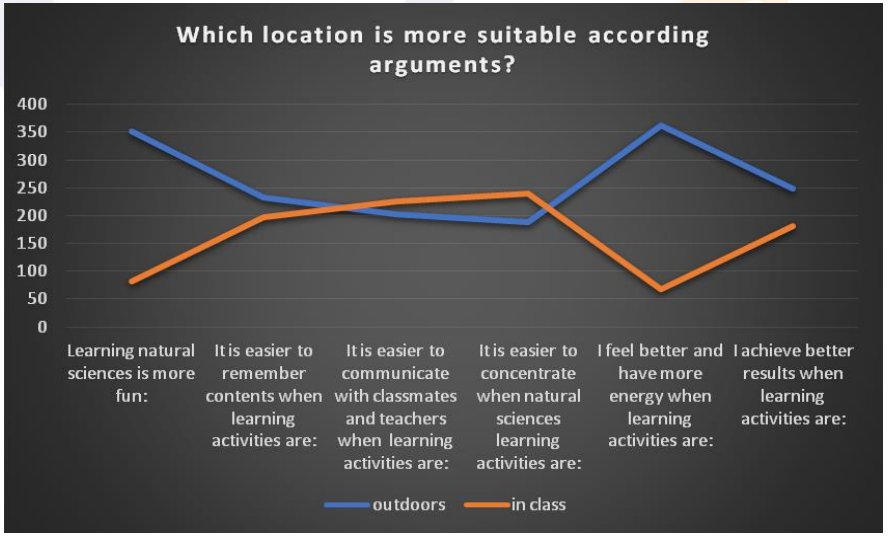
How many times per school year do you have outdoor classes?

26 % of pupils do not have outdoor classes and 39 % of them have one or two days of outdoor classes per school year. 29 % of pupils have three or five outdoor classes per school year and only 6 % of students have more than 5 outdoor classes per school year.



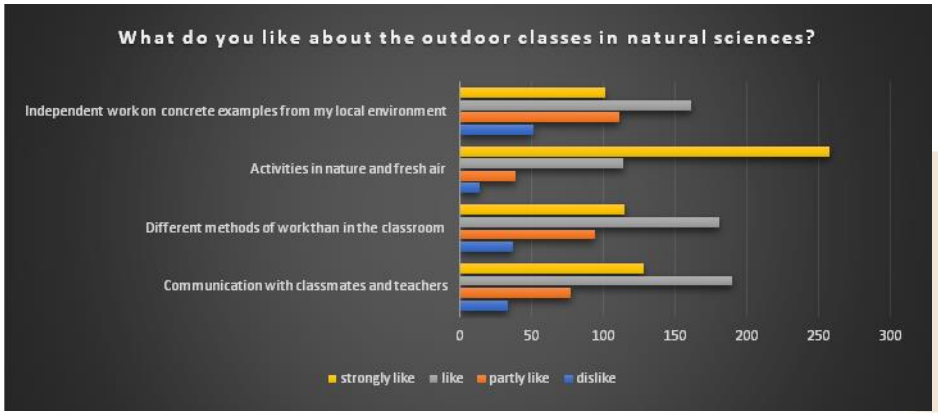
Which location is more suitable according to the arguments?

Learning Natural Sciences is more fun outdoors (352 out of 433) and they feel better and have more stamina when learning activities are outdoors (362 out of 429).



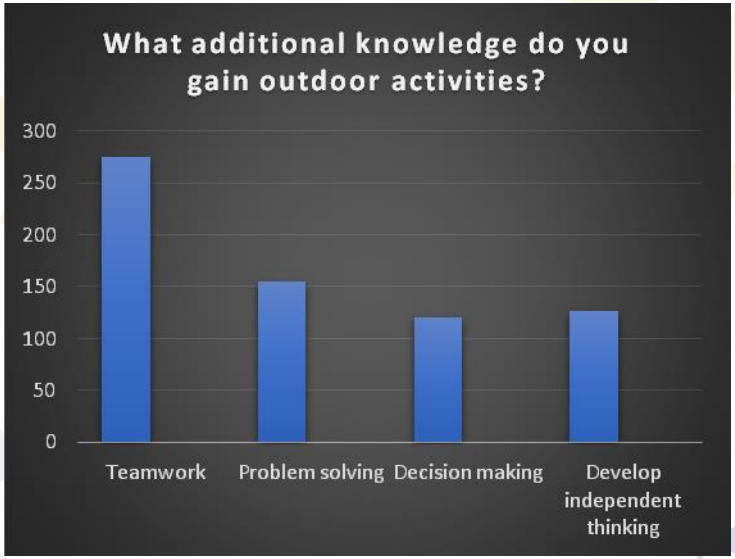
What do you like about the outdoor classes in Natural Sciences?

257 pupils out of 424 strongly like activities in nature and fresh air in Natural Sciences outdoor classes. They also like communication with classmates and teachers, different methods of working instead of the classroom and independent work on concrete examples from their local environment.



What additional knowledge do you gain with outdoor activities?

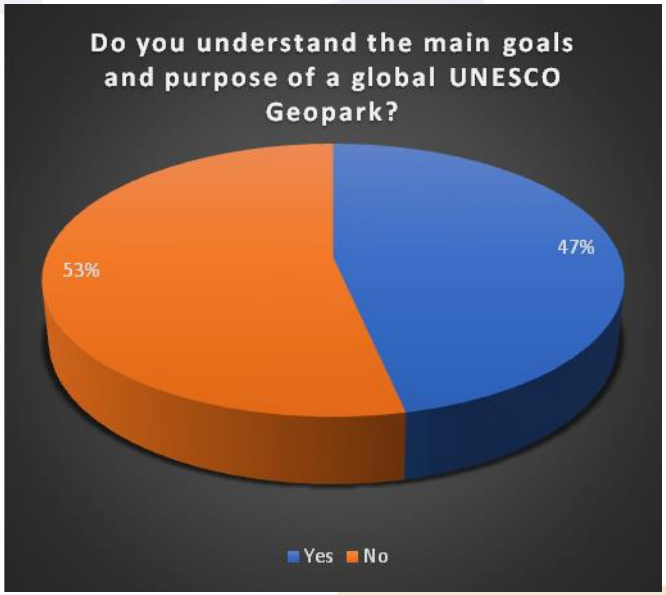
275 pupils refer teamwork as an additional knowledge of outdoor activities.



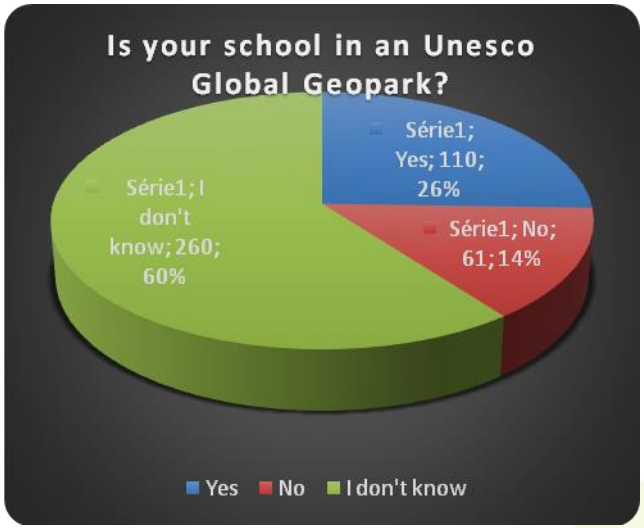
OUTDOOR LEARNING METHODOLOGIES

Do you understand the main goals and purpose of a global UNESCO Geopark?

53 % of pupils don't understand the main goals and purpose of a global UNESCO Geopark and 26 % of schools are in the area of a Unesco Global Geopark. 60 % of pupils don't know their school is in the area of a Unesco Global Geopark.

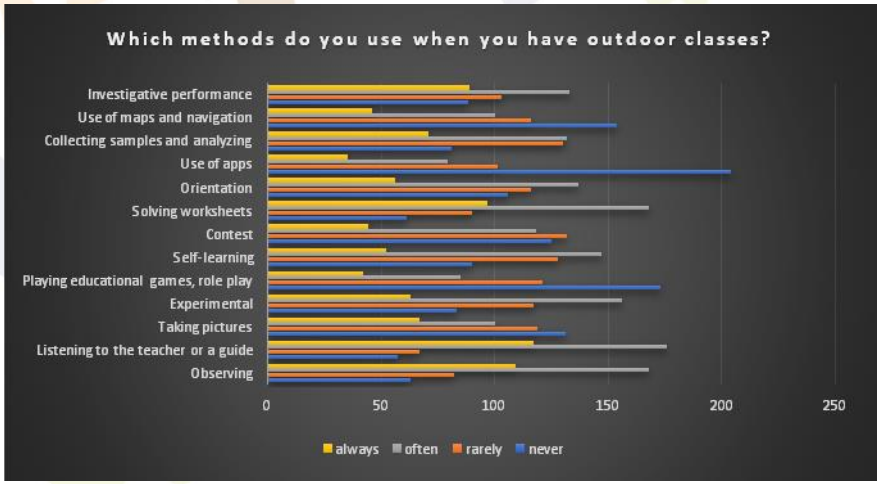


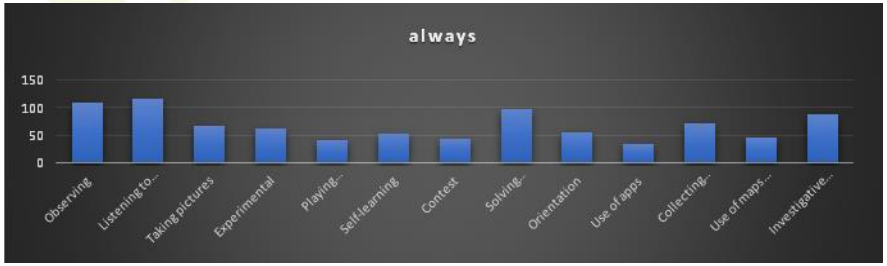
Is your school in the area of a UNESCO Global Geopark?

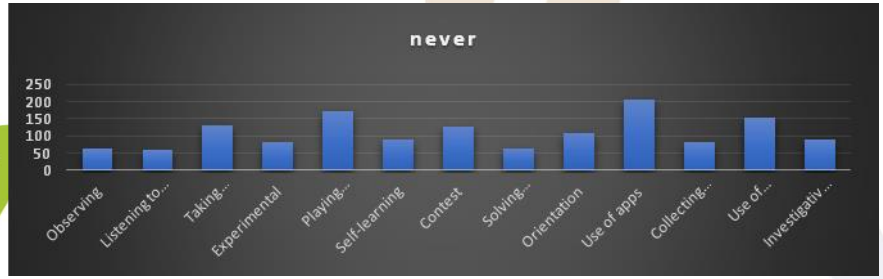


Which methods do you use when you have outdoor classes?

293 pupils out of 417 always or often listen to the teacher or a guide. They also always or often solve worksheets and observe. They never or rarely use apps (305 out of 419 pupils), play educational games or role play (294 out of 421) when they have outdoor classes.

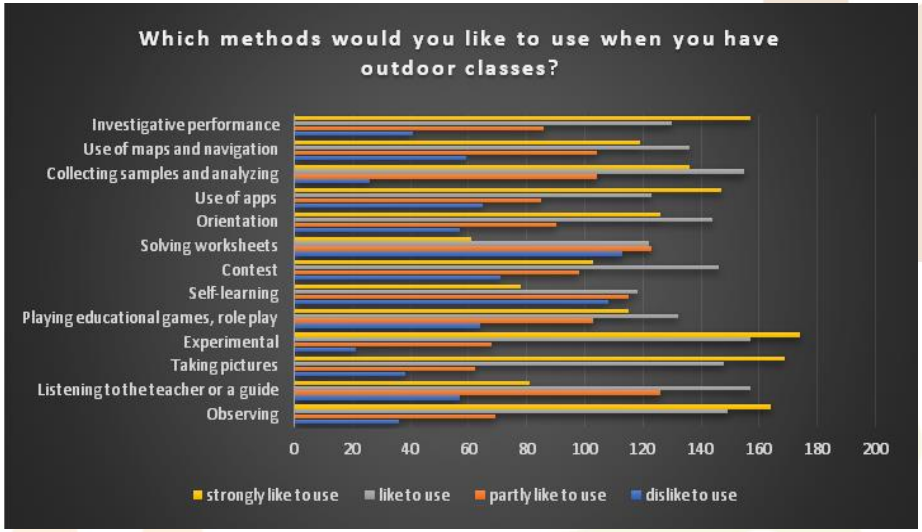


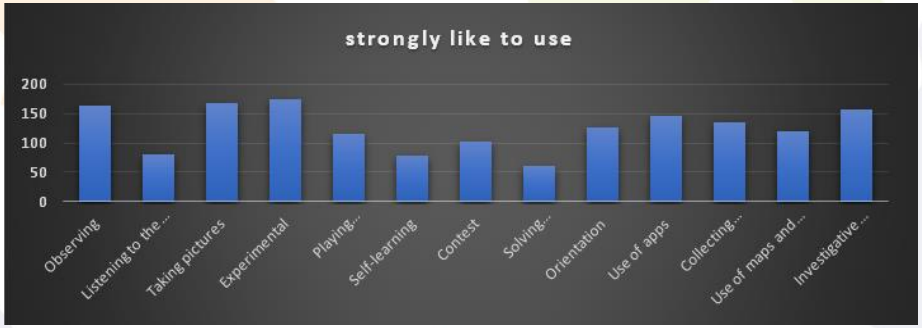


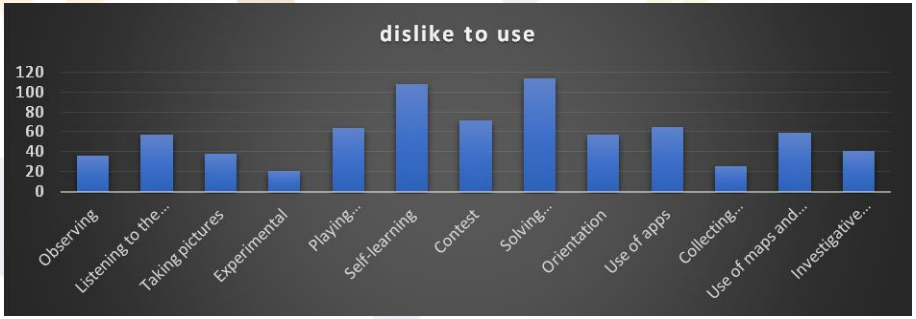


Which methods would you like to use when you have outdoor classes?

Pupils partly like and dislike solving worksheets, self-learning and listening to the teacher or a guide, but they do like or strongly like to experiment, take pictures, observe, investigate and use apps.

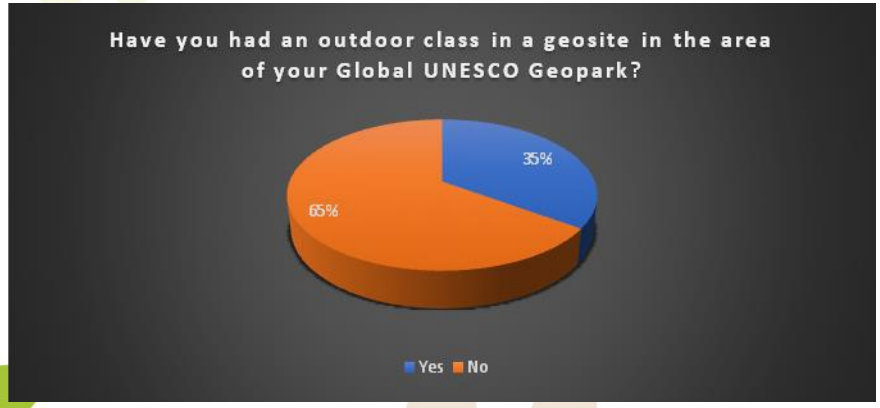






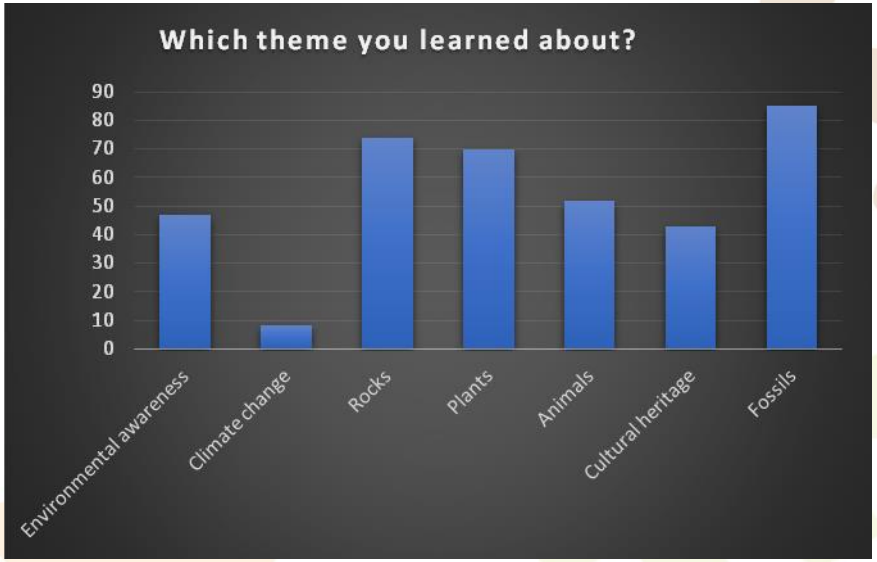
Have you had an outdoor class in a geosite in the area of your Global UNESCO Geopark?

65 % of pupils have not had an outdoor class in a geosite in the area of their Global UNESCO Geopark, only 35 % did.



Which theme did you learn about?

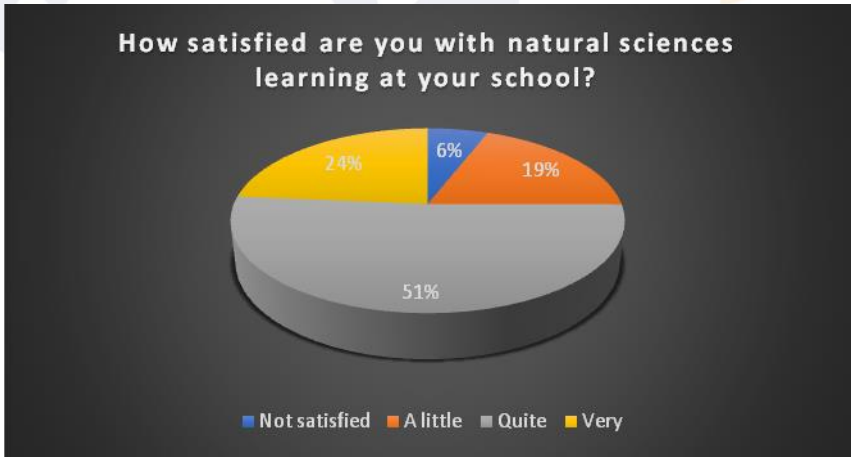
They learned especially about fossils (85 out of 379), rocks (74 out of 379) and plants (70 out of 379). Pupils also learned about animals (52 out of 379) and cultural heritage (43 out of 379).



SATISFACTION LEVEL AND PROPOSALS FOR IMPROVEMENTS

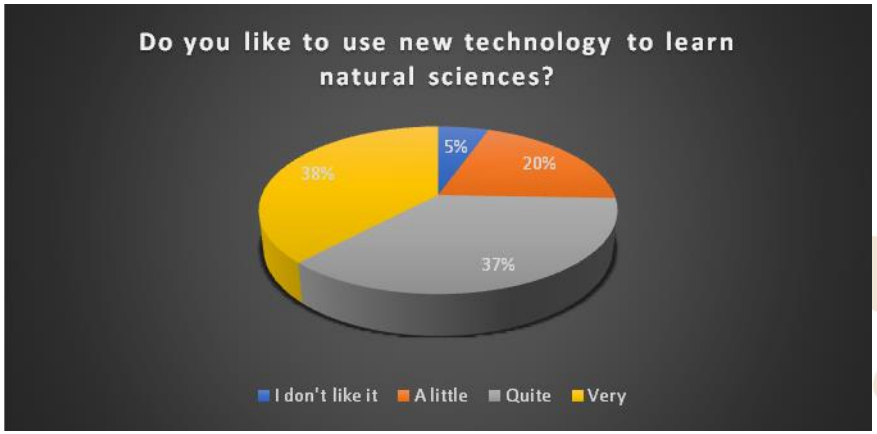
How satisfied are you with Natural Sciences learning at your school?

24 % of pupils are very satisfied with Natural Sciences learning at school. 51 % are quite satisfied, 19 % a little and 6 % are not satisfied at all with Natural Sciences learning at school.



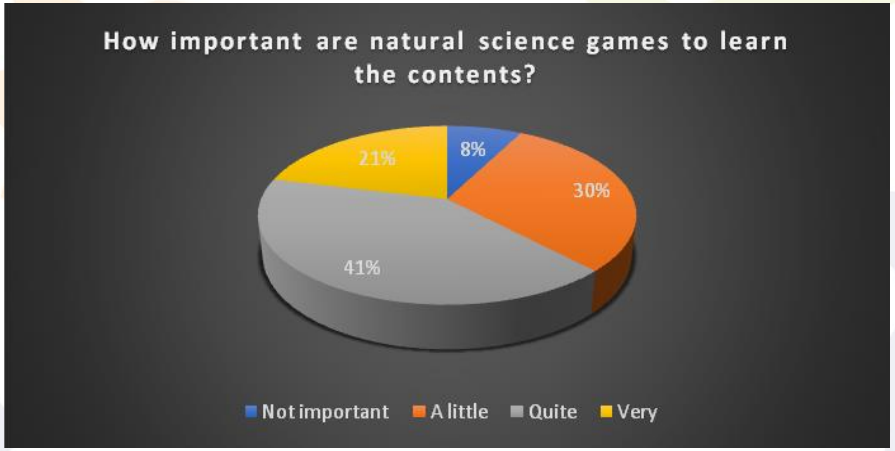
Do you like to use new technologies to learn about Natural Sciences?

38 % of pupils like it very much and 37 % quite like to use new technologies to learn about Natural Sciences. 20 % of pupils like it a little and only 5 % don't like to use new technologies in Natural Sciences.



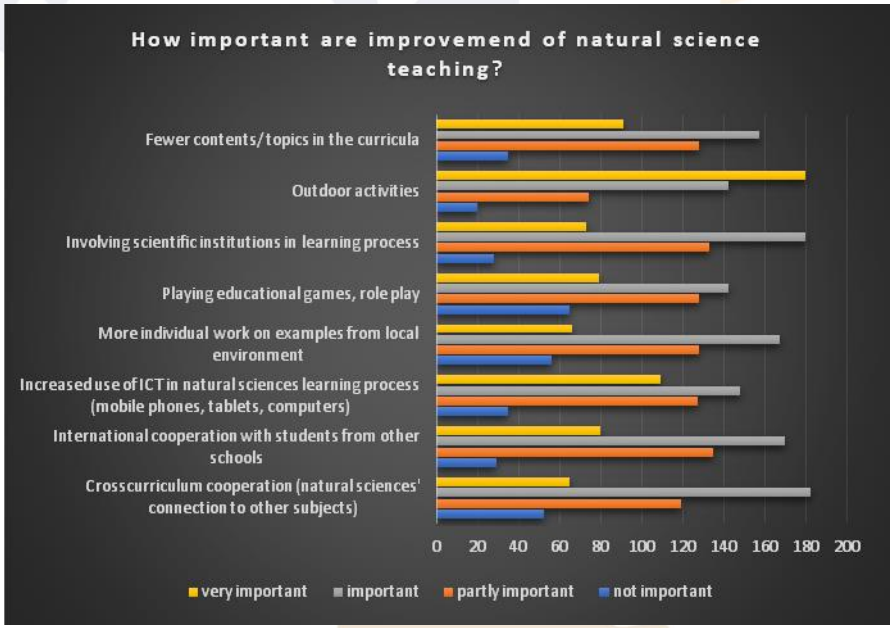
How important are natural science games to learn the contents?

62 % of pupils think that Natural Sciences games to learn the contents are very or quite important and only 8 % think that they are not important.



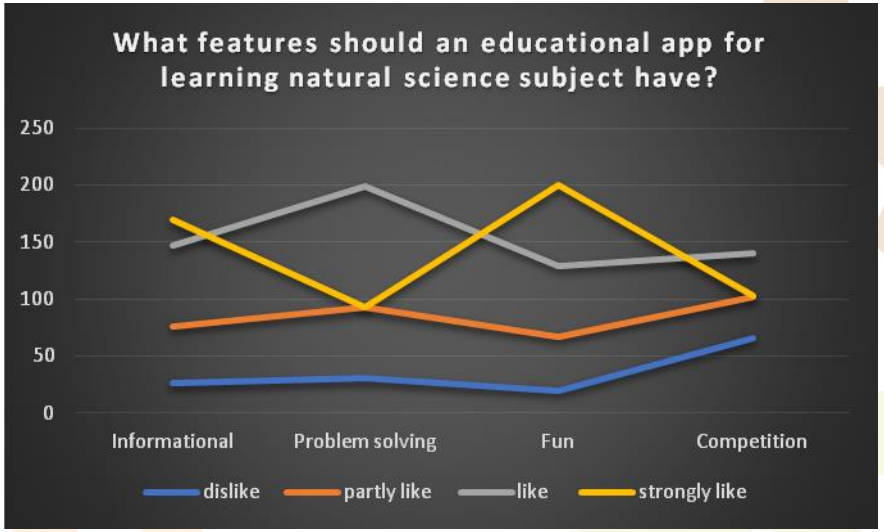
How important are the improvements in Natural Sciences teaching?

Pupils think that outdoor activities, the increased use of ICT in the Natural Sciences learning process (mobile phones, tablets, computers), playing educational games, role play and the international cooperation with students from other schools are very important.



What features should an educational app for learning Natural Sciences have?

Pupils strongly like having fun with an educational app when learning Natural Sciences. They also like problem solving.



MAIN CONCLUSIONS: PUPILS

1. The surprising revelation of this question is that the majority of pupils favours Maths, Geology, followed by Social studies and Physics. The least favourite subject in school is Sports by far, followed by Arts, Music and Languages.

2. Although pupils appreciate the knowledge of Natural Sciences in ordinary life and in connection with other sciences, and they want to upgrade it, they do not want their future job to be connected to natural sciences. Perhaps this dichotomy is a consequence of Natural Sciences reputation being traditional and not up to date. We believe that the application of modern (and popular) technologies is necessary to correct this problem.

3. All answers to the question related to Geology are quite similar. Pupils do not feel confident in their geological knowledge and they cannot relate their geological knowledge to their local environment. This clearly shows that in comparison to other Natural Sciences areas Geology is seriously underdone in national curriculums.

4. The most common methodology of studying Natural Sciences is expositive and the teacher's explanation of contents. Only rarely other methods are used, with the use of modern technology being really poorly represented. This strongly contradicts what pupils actually like doing in Natural Sciences classes, as they clearly prefer laboratory work, experiments and learning by using a computer, a tablet or a mobile phone and fieldwork. The same goes for teaching methods. The most common ones are the frontal method and individual work. However, pupils prefer working in pairs and groups.

5. The use of new technologies in Natural Science classes is only minor or non- existing, while students at home use them almost exclusively. They mainly use it for searching data on the internet and playing educational and geo-located games. Only 8% of pupils don't use new technologies for learning Natural Sciences at home.

6. Outdoor activities are also almost non-existing in the current curricula. The great majority of pupils (94%) have less than five days a year of outdoor activities. And this isn't again in conformity with what pupils want and like. Namely, they feel that learning Natural Sciences is more fun outdoors and they feel better and have more stamina when learning activities are outdoors.

7. When outdoor activities are actually going on, the methods of teaching are mainly aimed at listening to the teacher or a guide and solving the worksheets. They never or rarely use apps or play educational games during outdoor classes. Which is again opposite to pupils' preferences: they do not like to solve worksheets, self-learning and listening to the teacher or a guide, but they would rather do experiments, take pictures, observe, investigate and use educational apps.

8. The vast majority of pupils do not really know what Unesco Global Geoparks aim at. They do not also usually know if their school is in the park. There is a strong need for improvement here.

9. Despite all this the majority of pupils are quite satisfied with Natural Sciences learning. However, they also point out some improvements, which are mainly aimed at the outdoor activities being more fun and the use of modern technologies.

4.3.2. ON-LINE RESEARCH FOR TEACHERS

ESTEAM QUESTIONNAIRE FOR NATURAL SCIENCES TEACHERS ANALYSIS

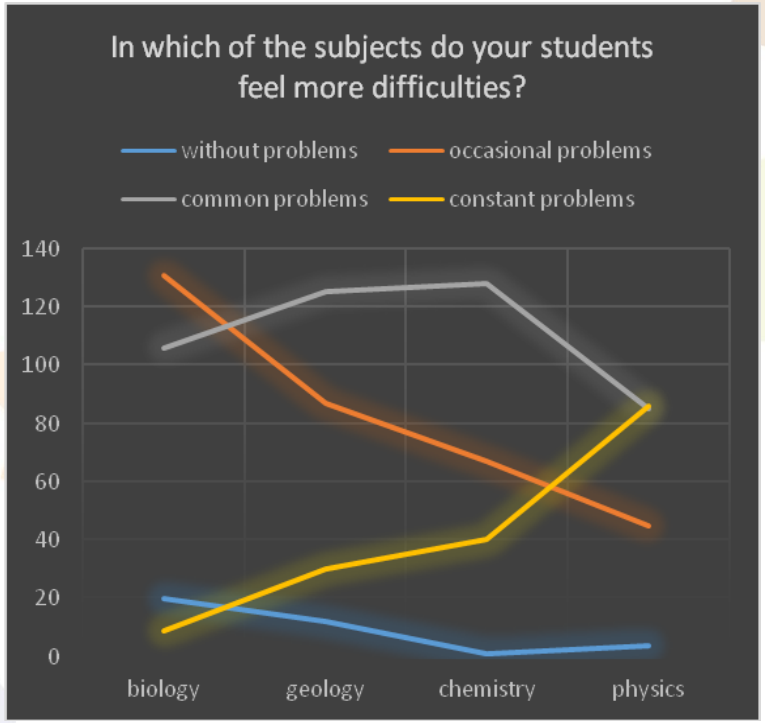
286 teachers have answered the questionnaires. The exact number of teachers per country is listed in the table below.

COUNTRY	NUMBER OF TEACHERS
France	2
Hungary	4
Norway	7
Portugal	172
Slovenia	101

NATIONAL CURRICULUM GOALS

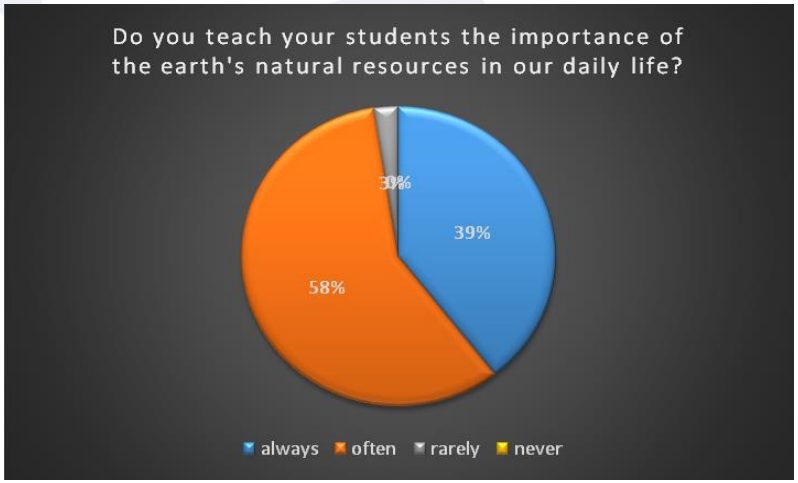
In which of the subjects do your pupils feel more difficulties?

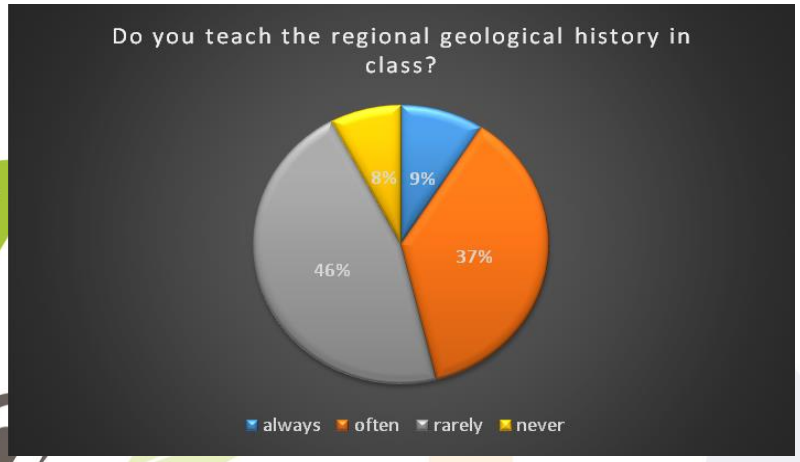
171 out of 220 teachers think that their pupils have common and constant problems with Physics. 195 pupils also have common and constant problems in Chemistry and 212 pupils have common and constant problems in Geology.



Do you teach your pupils the importance of Earth's natural resources in our daily life?

112 teachers always do and 165 out of 284 teachers teach students the importance of Earth's natural resources in daily life. 9 % of teachers never do and 46 % of teachers rarely teach the regional geological history in class. 37 % of teachers often do and 9 % of teachers always teach the regional geological history in class.

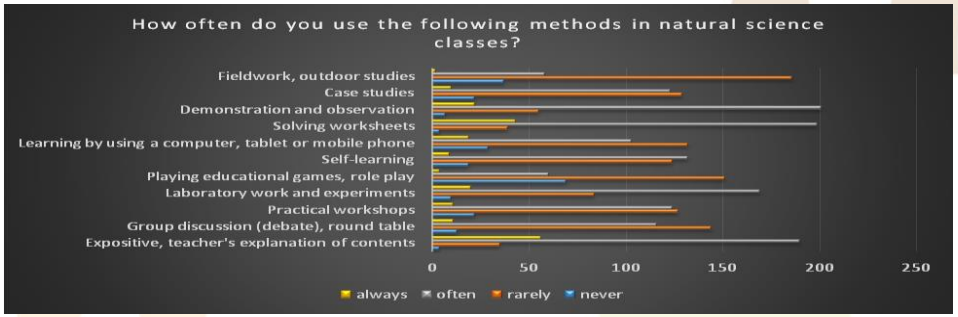


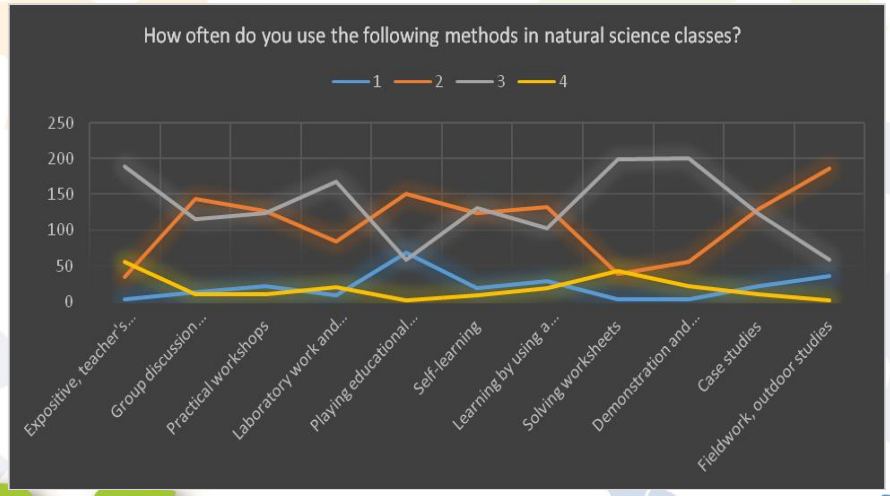


CURRENT METHODOLOGY IN NATURAL SCIENCES TEACHING

How often do you use the following methods in Natural Sciences classes?

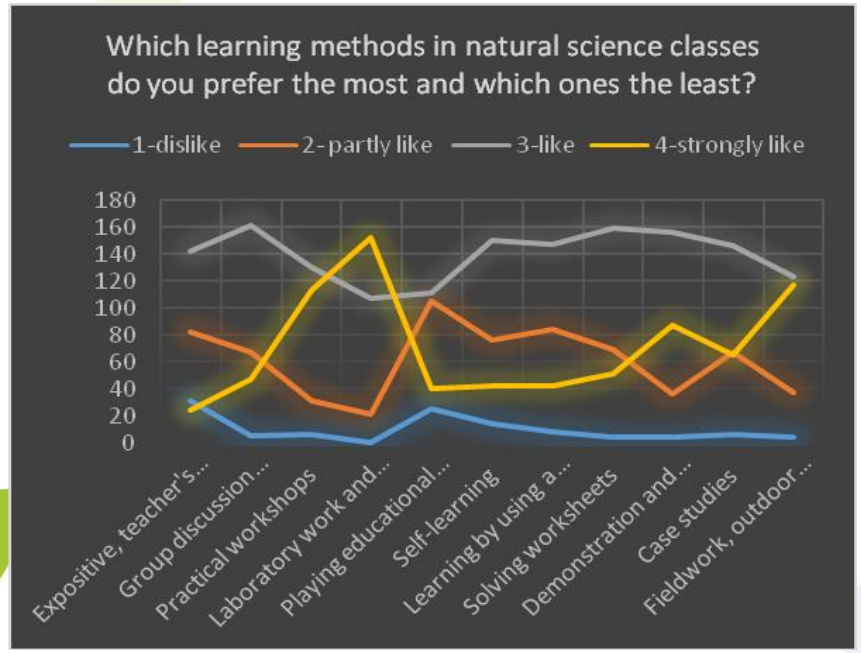
Teachers always or often use demonstration and observation, content exposition, explanation of contents by solving worksheets, laboratory work and experiments and self-learning in Natural Science classes. They never or rarely play educational games, role play, do fieldwork, outdoor activities, group discussion or round table debates in Natural Sciences classes.

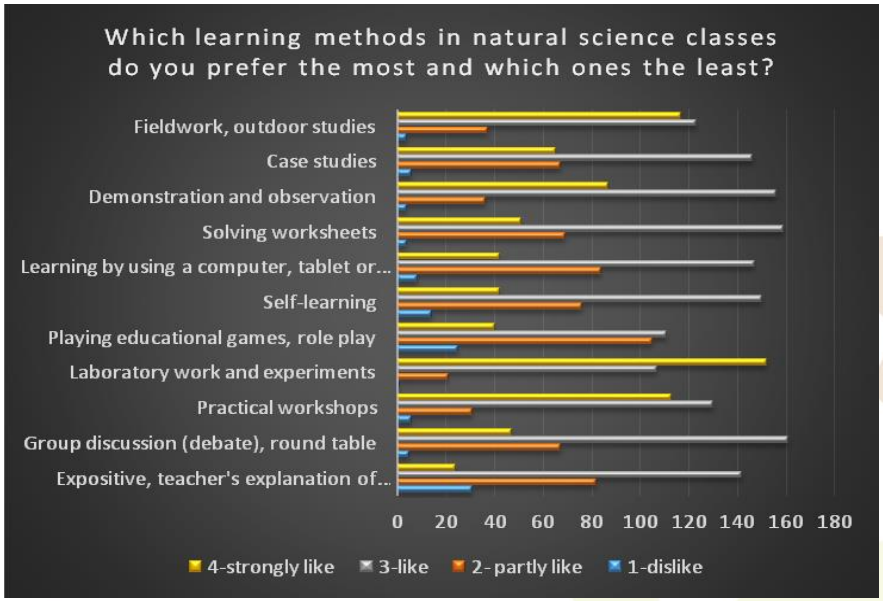




Which learning methods in Natural Sciences classes do you prefer the most and which ones the least?

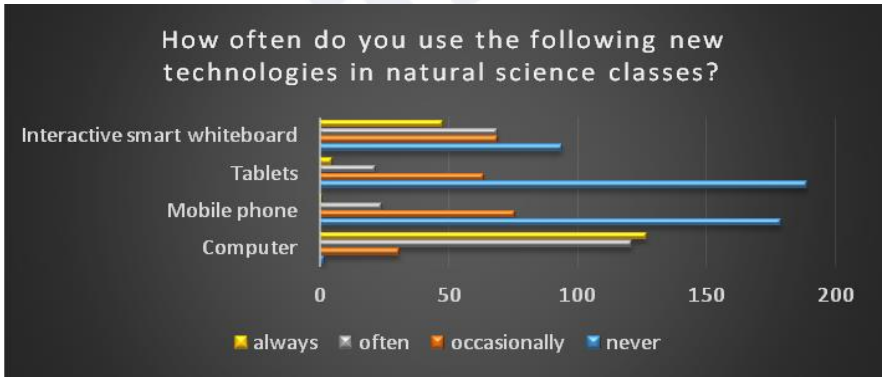
Teachers strongly prefer laboratory work and experiments, fieldwork, outdoor studies and also demonstration and observation. They like group discussion, round table debates, solving worksheets, self-learning, demonstration and observation, group discussion, round table debates and case studies. They dislike and partly like playing educational games and role playing. Only 40 out of 281 teachers strongly like these and 105 out of 281 teachers partly like playing educational games and role play methods in Natural Sciences classes.

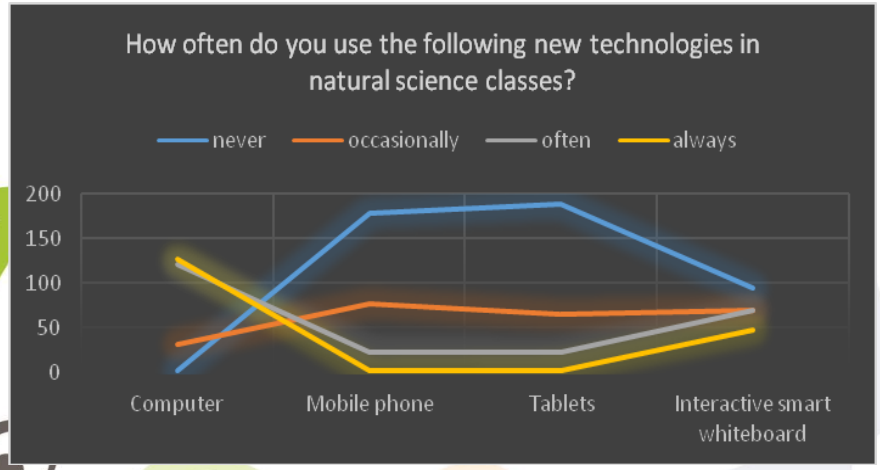




How often do you use the following new technologies in Natural Sciences classes?

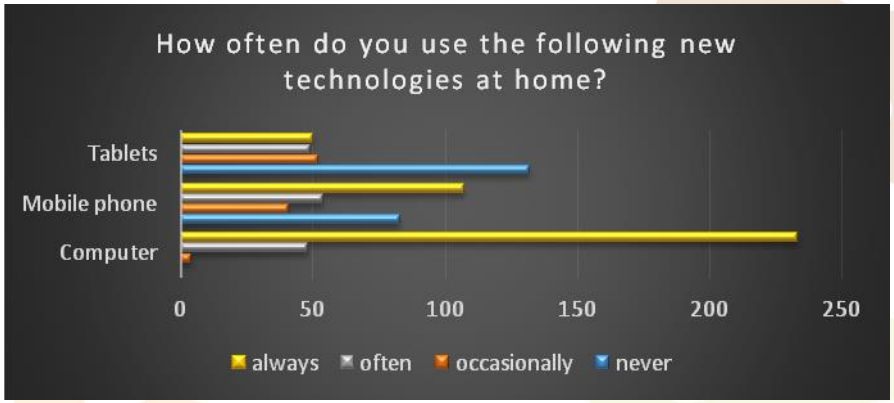
189 out of 280 teachers never use tablets in Natural Sciences classes and 64 out of 280 teachers occasionally do. 179 out of 280 teachers also never use mobile phone in Natural Sciences classes and 76 out of 280 teachers occasionally do. 127 teachers always use computer in Natural Sciences classes and 121 out of 280 teachers often do.





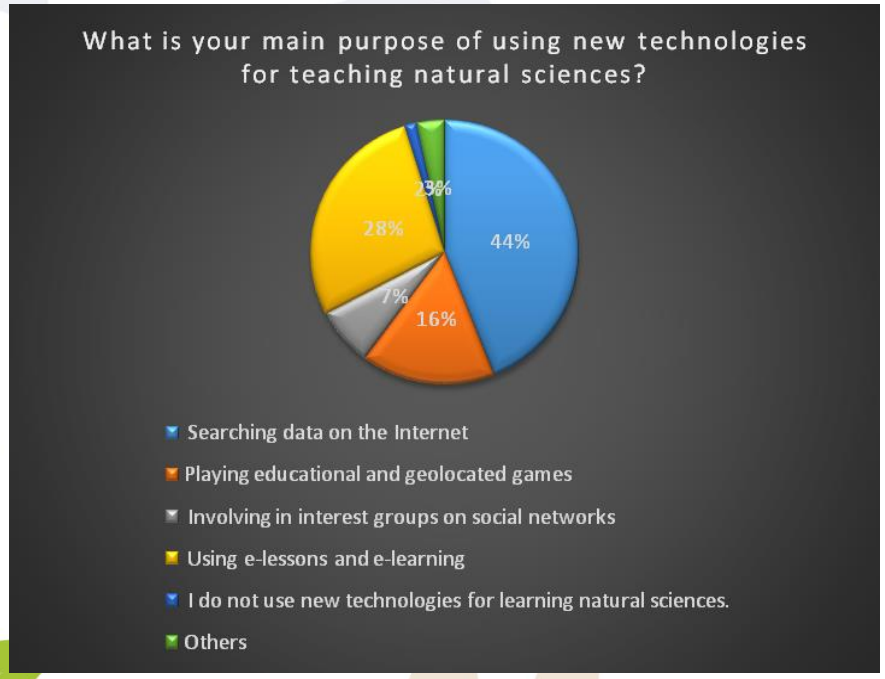
How often do you use the following new technologies at home?

Teachers always use computer at home (233 out of 285 teachers). 132 out of 280 teachers never use tablets and 83 teachers never use mobile phone at home.



What is your main purpose of using new technologies for teaching Natural Sciences?

44 % of the teacher's main purpose of using new technologies for teaching Natural Sciences is searching for data on the Internet. 28 % use e-lessons and e-learning, 16 % of teachers play educational and geolocated games.

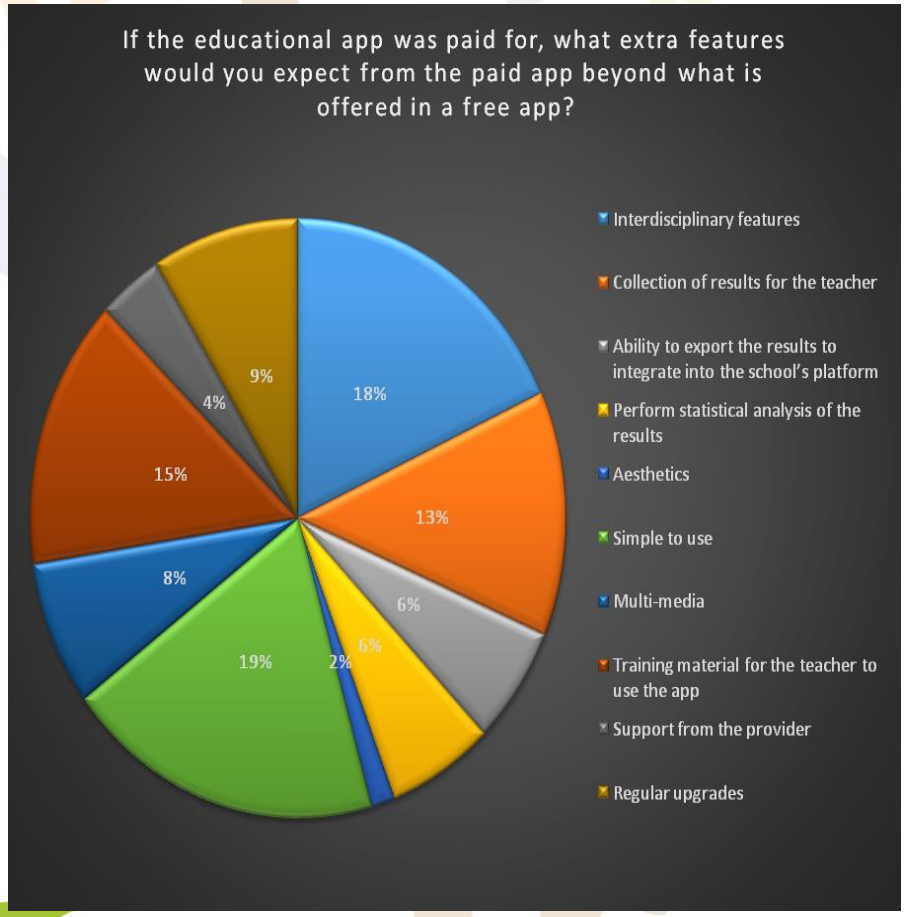


Would you use an educational app if it was not free?

72 % of teachers would not use an educational app if it was not free.

If the educational app was paid for, what extra features would you expect from the paid app beyond what is offered in a free app?

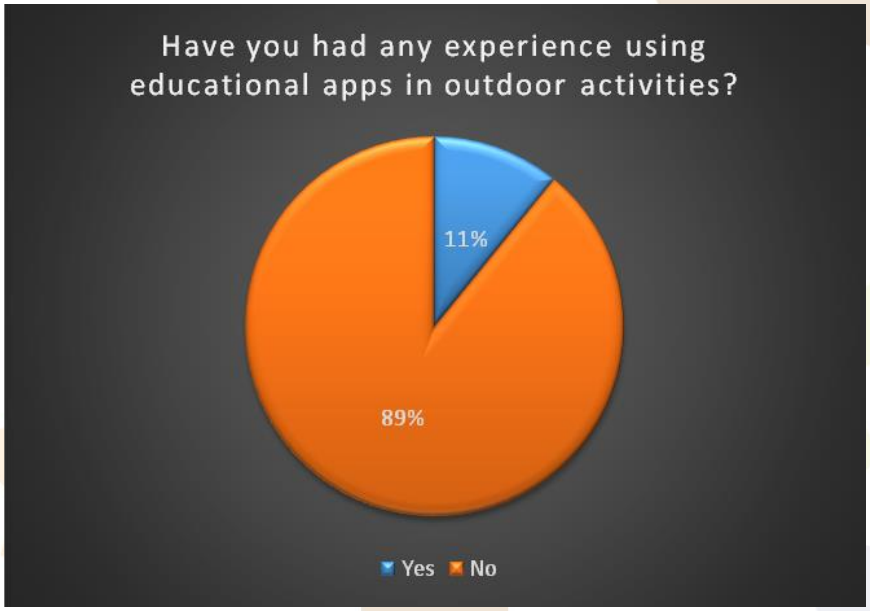
If the educational app was paid for, 19 % of teachers expect the paid app to be easy to use and 18 % of teachers expect interdisciplinary features. 15 % expect training material for the teacher to use and 13 % expect it to have a result collection. Only 6 % of teachers expect ability to export the results to integrate in the school's platform.



SKILLS AND COMPETENCES IN OUTDOOR ACTIVITIES

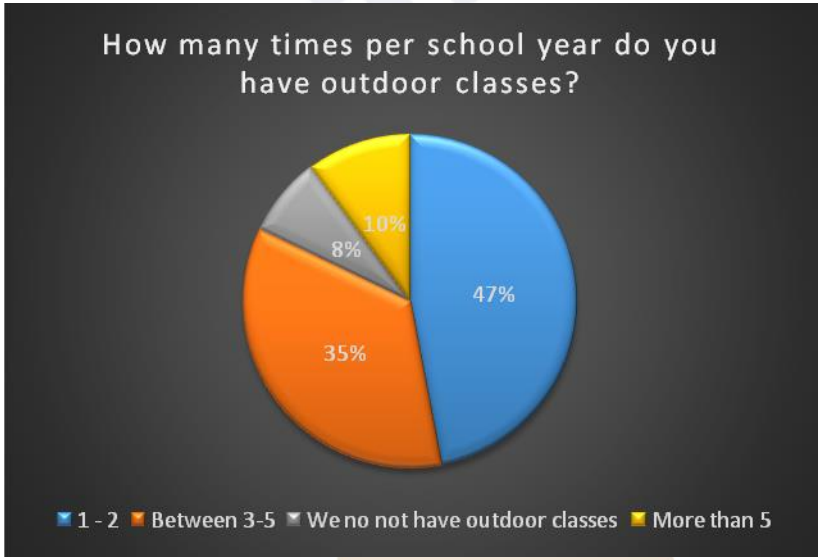
Have you had any experience using educational apps in outdoor activities?

89 % of teachers have no experience in using educational apps in outdoor activities.



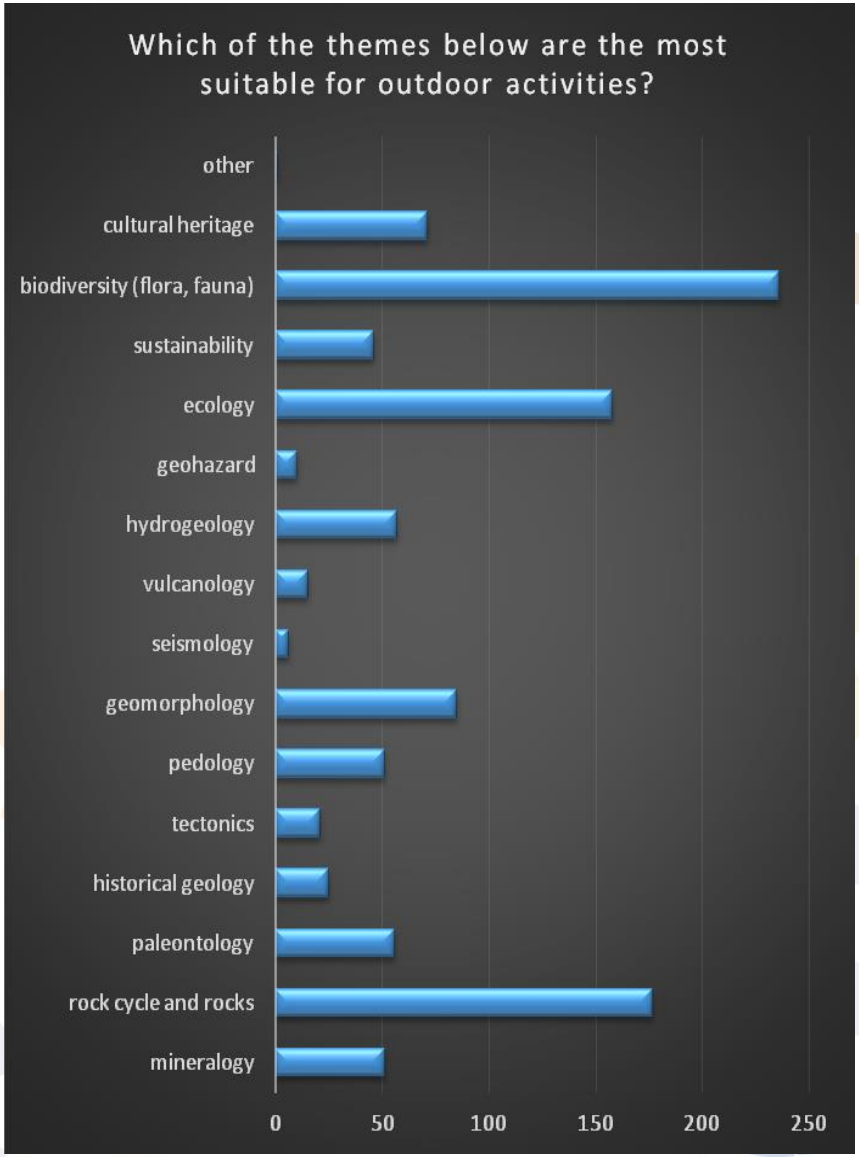
How many times a school year do you have outdoor classes?

8 % of teachers do not have outdoor classes and 47 % of teachers have only one or two days a school year. 35 % of teachers have these classes three or five times a school year and only 10 % of teachers have them more than five times a school year.



Which of the themes below are the most suitable for outdoor activities?

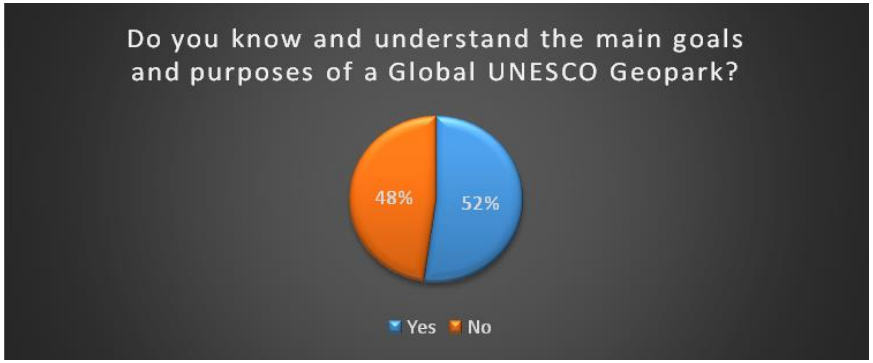
The most suitable themes for outdoor activities are biodiversity (flora, fauna) (22 % of teachers), rock cycle and rock (17 %), ecology (15 %) and geomorphology (8 % of teachers).



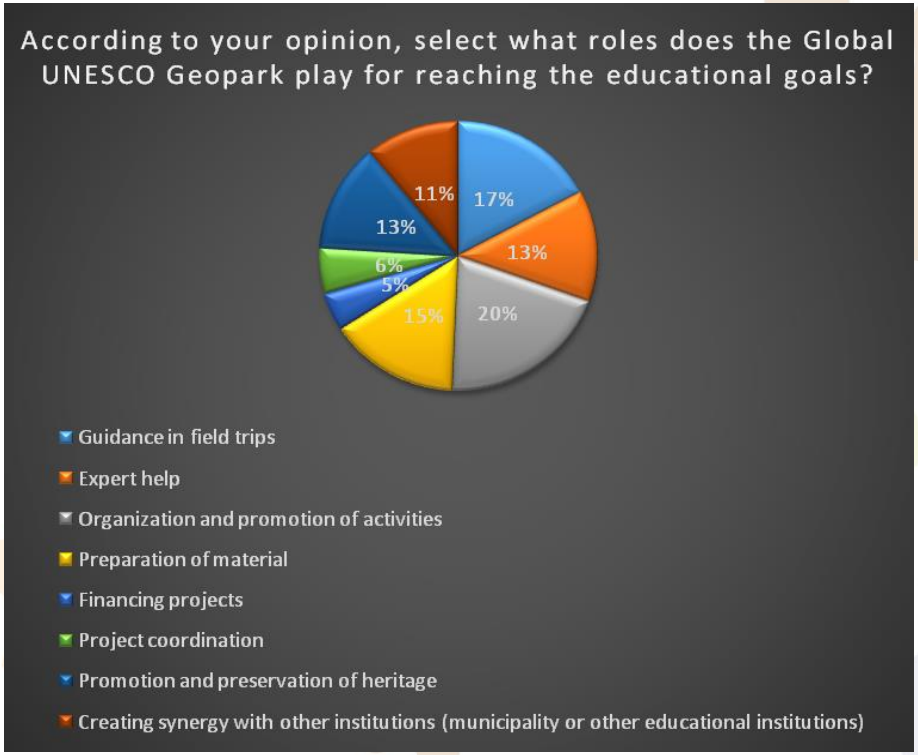
OUTDOOR LEARNING METHODOLOGIES

Do you know and understand the main goals and purposes of a Global UNESCO Geopark?

52 % of teachers know and understand the main goals and purposes of a Global UNESCO Geopark.



According to your opinion, what roles does a Global UNESCO Geopark play in order to reach educational goals?

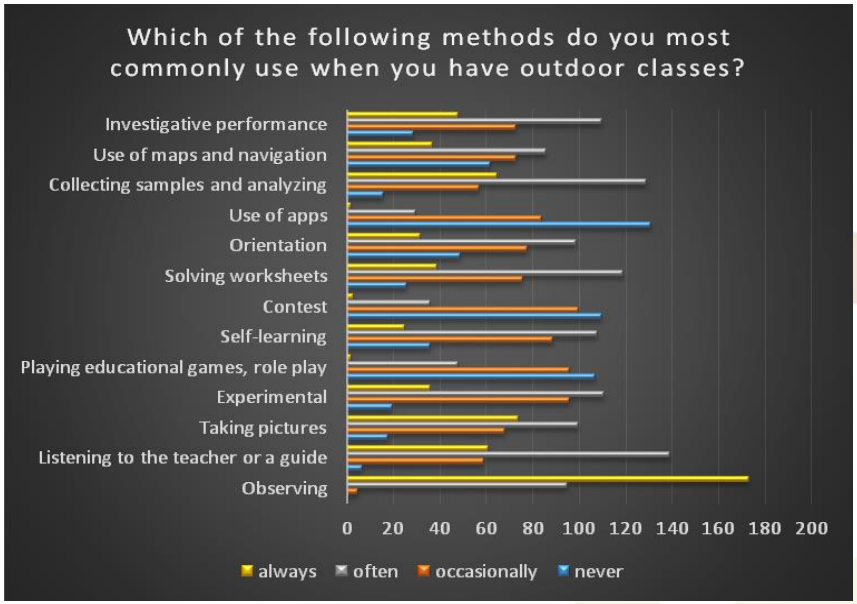


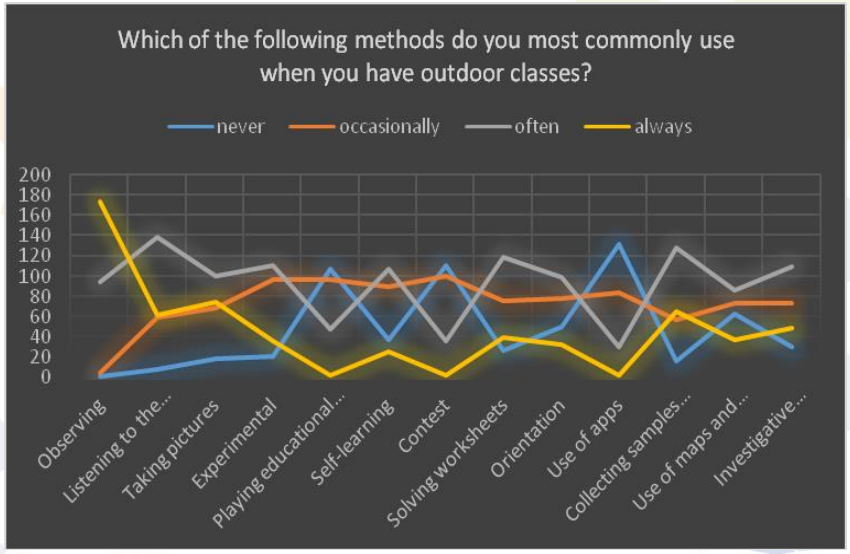
The achievement of goals could be improved with outdoor activities.

94 % of teachers think that the achievement of goals could be improved with outdoor activities.

Which of the following methods do you most commonly use when you have outdoor classes?

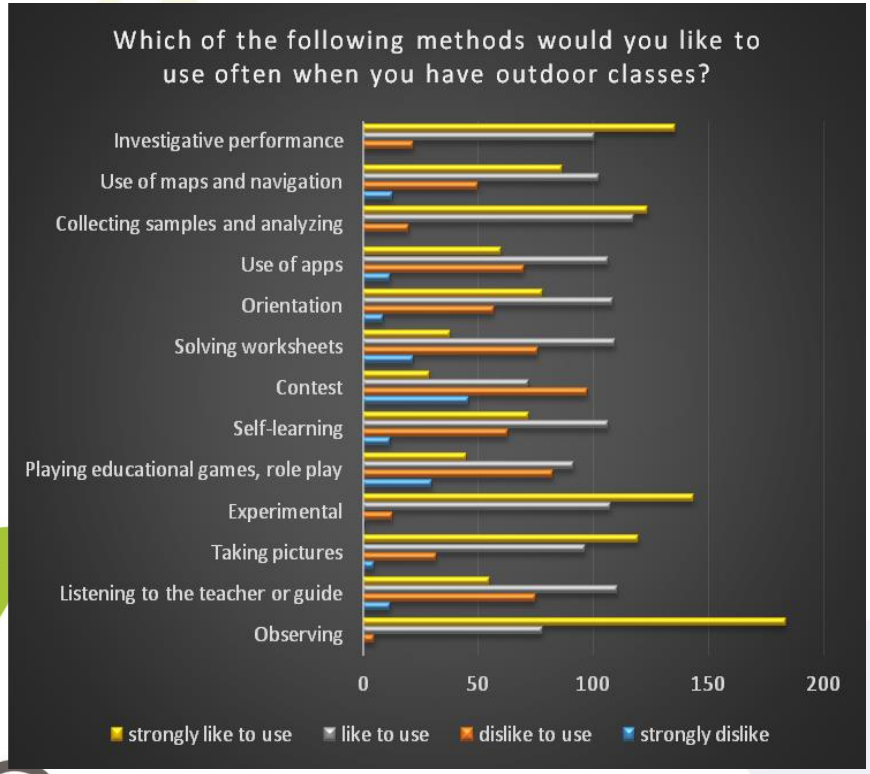
21 % of teachers never use apps and 18 % make contests. 18 % of teachers also never play educational games or role play. 10 % never use maps and navigation when they have outdoor classes. 29 % of teachers always do observation and 13 % of teachers take pictures when they have outdoor classes. 11 % of teachers collect samples and analyse them and 10 % of teachers use other methods such as listening to the teacher or a guide when they have outdoor classes.

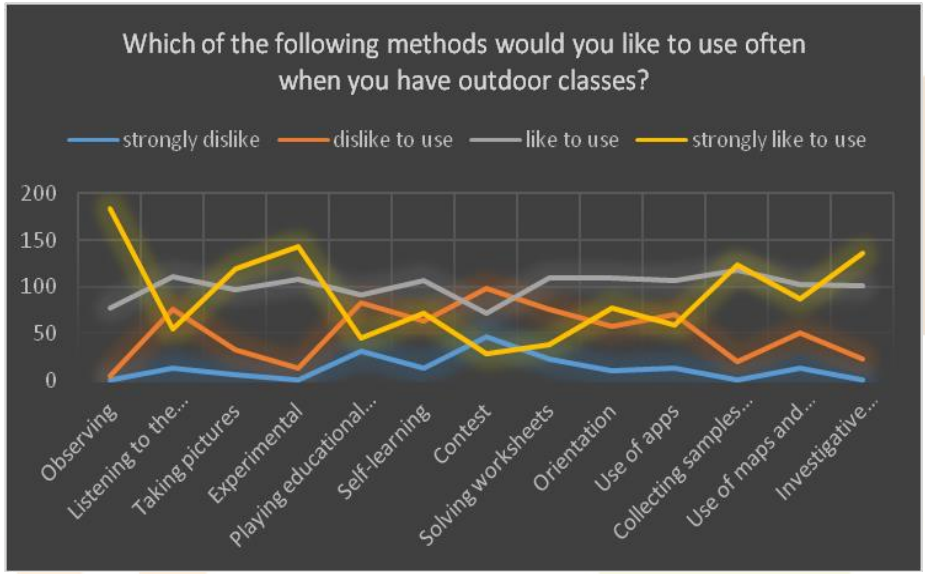




Which of the following methods would you like to use often when you have outdoor classes?

Teacher like and strongly like doing observation, experimentation, collecting samples and analysing, investigative performance and taking pictures when they have outdoor activities. They also strongly like and like the use of maps and navigation when they have outdoor activities. 46 out of 245 teachers strongly dislike and 98 teachers dislike making contests. 30 out of 250 teachers and 83 out of 250 teachers dislike playing educational games and role playing.





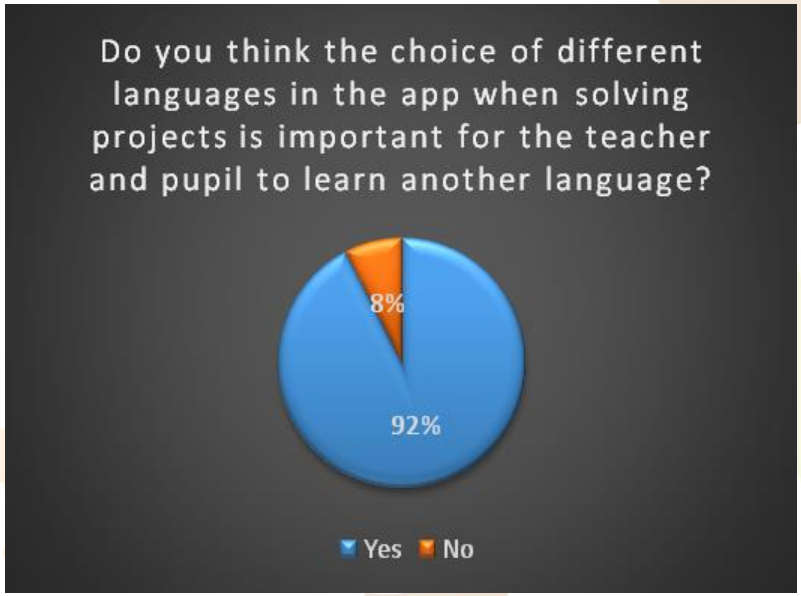
SATISFACTION AND PROPOSALS FOR IMPROVEMENTS

Do you think you have the necessary skills to organise outdoor activities and take students on field trips?

73 % of teachers have the necessary skills to organise outdoor activities and take students on field trips.

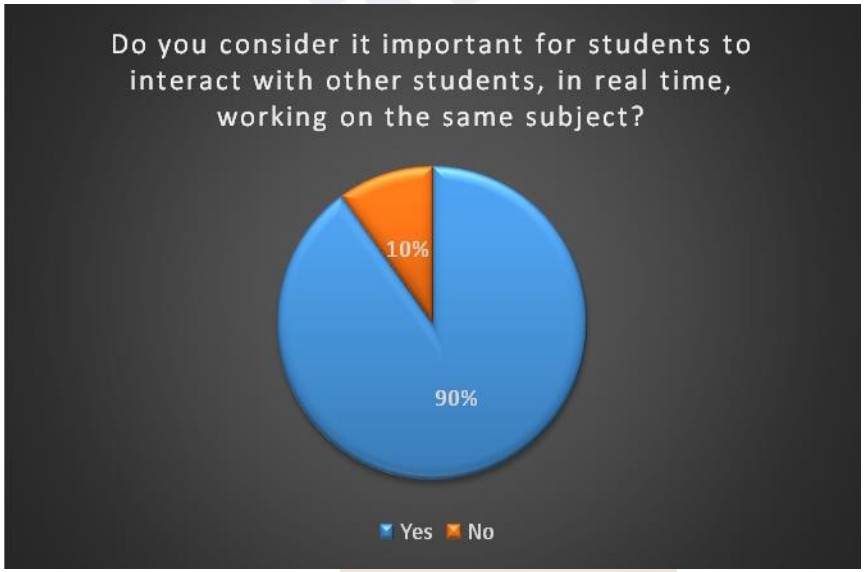
Do you think having the possibility to choose different languages in an app when solving projects is important for the teacher and pupil to learn another language?

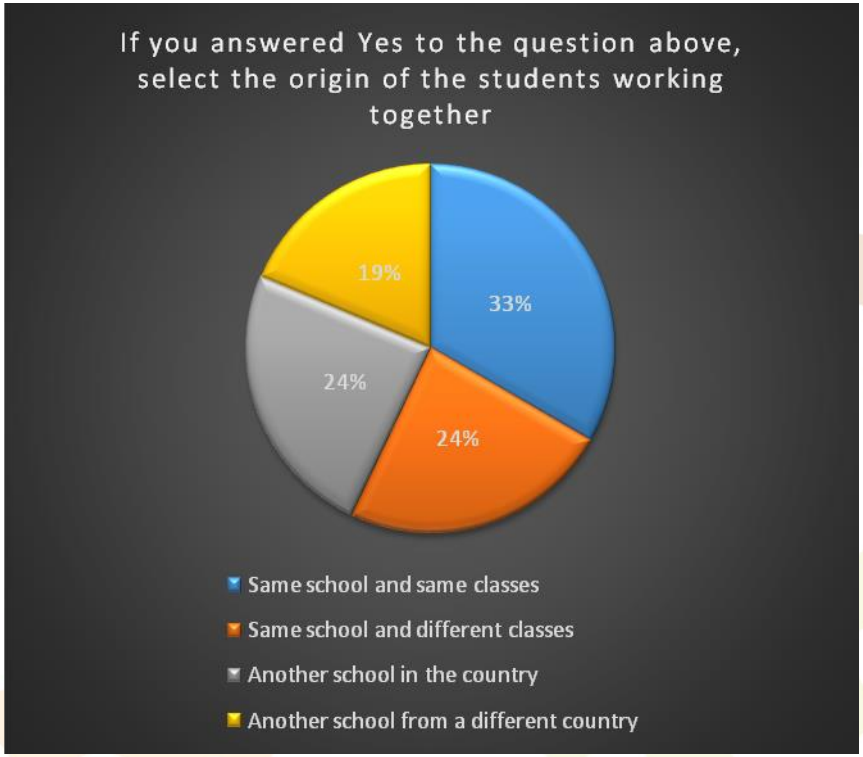
92 % of teachers think that the possibility of choosing different languages in an app is important for the teacher and pupil to learn another language.



Do you consider important for pupils to interact with other pupils in real time, working on the same subject?

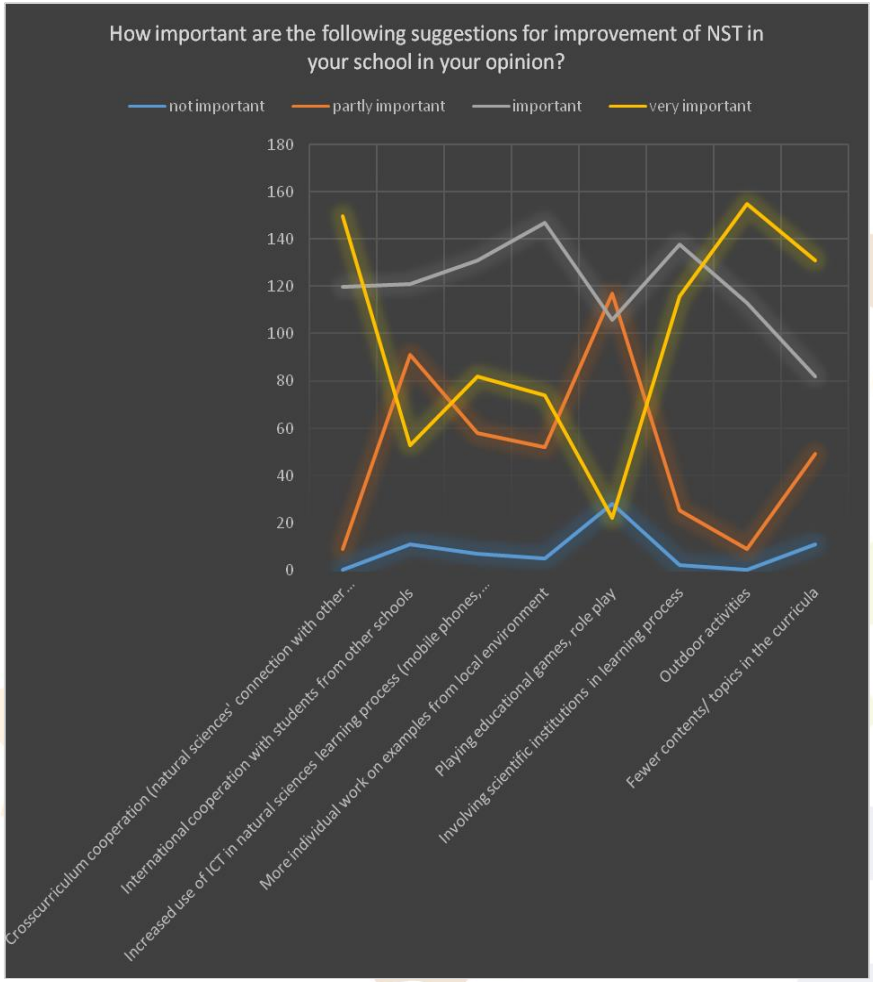
90% of teachers consider important for pupils to interact with their peers, in real time, working on the same subject (33 % = same school and same classes; 24 % = another school in the country; 24 % = same school and different classes and 19 % = another school from a different country (speaking a different language).





In your opinion, how important are the following suggestions for the improvement of Natural Sciences Teaching in your school?

43 % of teachers think that playing educational games and role playing is not important for the improvement of Natural Sciences Teaching in their school. They think that outdoor activities and cross curriculum cooperation (Natural Sciences' connection with other subjects) are very important and more individual work with examples from local environment and the involvement of scientific institutions in the learning process are important for the improvement of Natural Sciences Teaching in their school.



MAIN CONCLUSIONS – NATIONAL SCIENCES TEACHERS

1. Teachers believe that pupils usually have problems in understanding Physics, Chemistry and Geology, while Biology does not share this problem as pupils rarely have any problems with this subject. We relate this to the fact that life, Biology and similar subjects are naturally close to children, while Chemistry, Physics and also Geology need in depth and abstract thinking that is not so easy for pupils.

2. Despite almost all teachers teach about the importance of natural resources in our daily life, the connection of this to geology seems to be missing. In fact, the majority of teachers do not teach regional geological history and relate it to present day issues.

3. In teaching methodologies the majority of teachers use standard methods like demonstration and observation, exposition, teacher's explanation of contents solving worksheets, etc. while never or only rarely use new trends, for example, playing educational games, fieldwork, outdoor studies and group discussion (debate). On the other hand, teachers prefer laboratory work and experiments, fieldwork, outdoor studies and also group work, solving worksheets, and case studies, for example. The interesting thing is that they usually dislike playing educational games and role playing methods in Natural Sciences classes.

4. In Natural Sciences classes, teachers only rarely use tablets and mobile phones. This relates to the fact that teachers at home also prefer to use computer to tablets and mobile phones at home. The majority of them also uses internet to search for data.

5. The majority of teachers would not use payable apps. However, they are prepared to pay for the app if it is simple, interdisciplinary and features training material for the teacher and results collection.

6. The great majority of teachers (95%) has less than five days a year of outdoor activities, however they all think that more outdoor activities would really improve learning. They think that the most suitable themes for outdoor activities are biodiversity (flora, fauna), rock, ecology and geomorphology.

7. Approximately half of the teachers understand the goals of Unesco Geoparks. The help that they are seeking for in the parks is mainly in the preparation of materials, fieldtrips, expert help and organisation of activities.

8. Concerning the outdoor activities teachers are quite confident that they possess the necessary knowledge for organising and leading an outdoor activity. They are currently using maps, navigation and doing observation. However, they would like to use observing, experimental work, collecting samples and taking pictures. The use of maps and navigation is also quite enjoyable.

9. Most of the teachers consider important for pupils to interact with other pupils, in real time, working on the same subject, while quite a lot of teachers (43%) think that playing educational games and role playing is not important for the improvement of Natural Sciences Teaching. They also think that outdoor activities and cross curriculum cooperation (natural sciences' connection with other subjects) are very important and more individual work with examples from local environment and the involvement of scientific institutions in learning process are important.

4.3.3. ON-LINE RESEARCH FOR FUTURE TEACHERS OF NATURAL SCIENCES

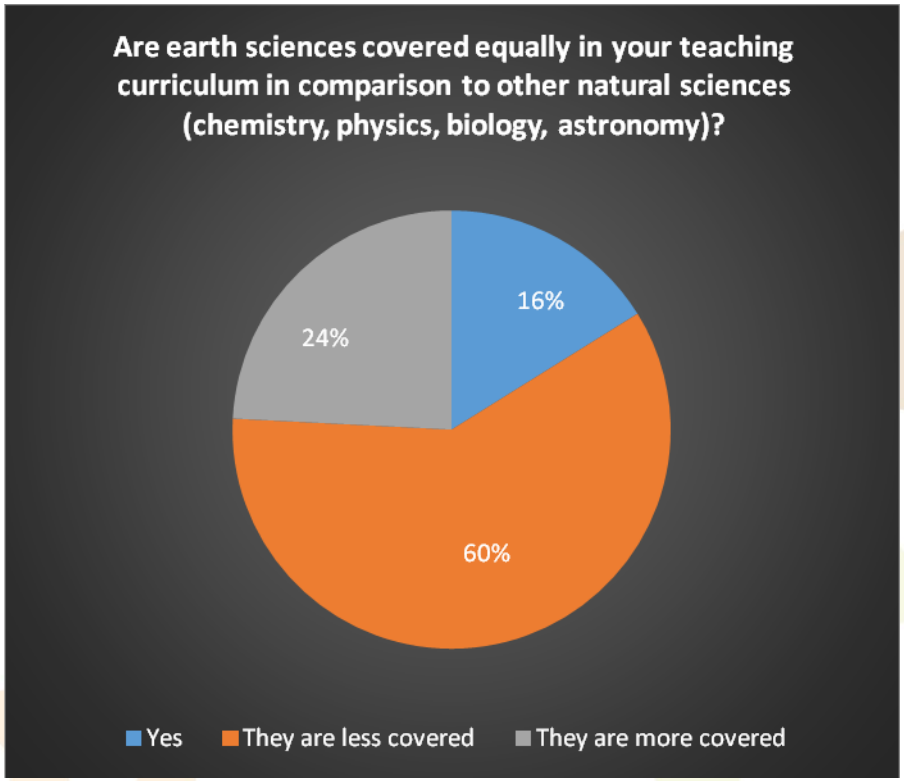
ESTEAM QUESTIONNAIRE FOR FUTURE NATURAL SCIENCES TEACHERS ANALYSIS

63 future teachers have answered the questionnaire and they are all from Slovenia.

NATIONAL CURRICULUM GOALS

Are Earth sciences covered equally in your teaching curriculum in comparison to other Natural Sciences (Chemistry, Physics, Biology, Astronomy)?

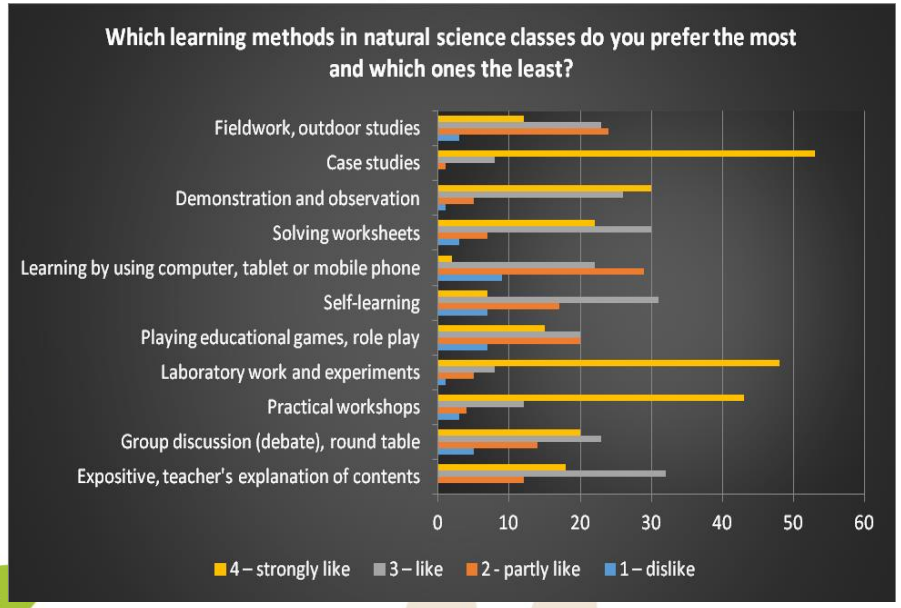
Only 16 % of future teachers think that Earth sciences are equally covered in their teaching curriculum in comparison to other Natural Sciences and 60 % of future teachers think they are less covered.

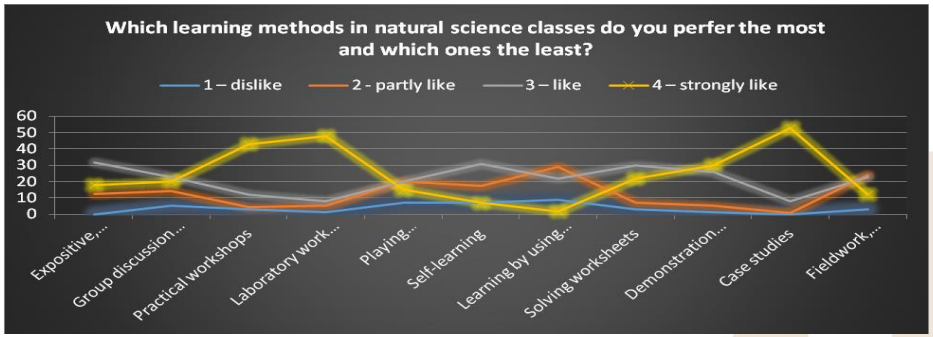


METHODOLOGY

Which learning methods in Natural Science classes do you prefer the most and which ones the least?

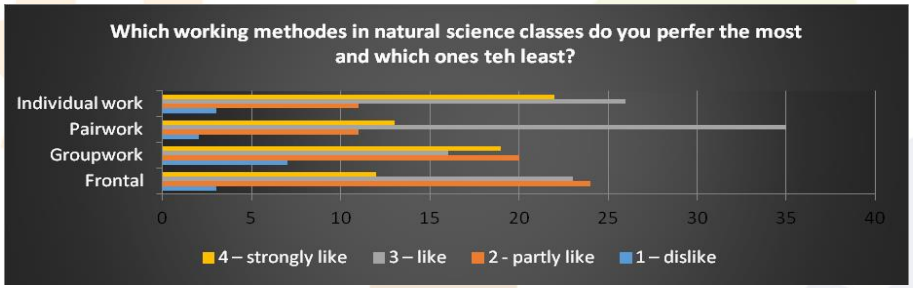
Future teachers strongly like case studies, laboratory work and experiments, practical workshops, demonstration and observation. They also like self-learning, expositive classes, teacher's explanation of contents and solving worksheets.





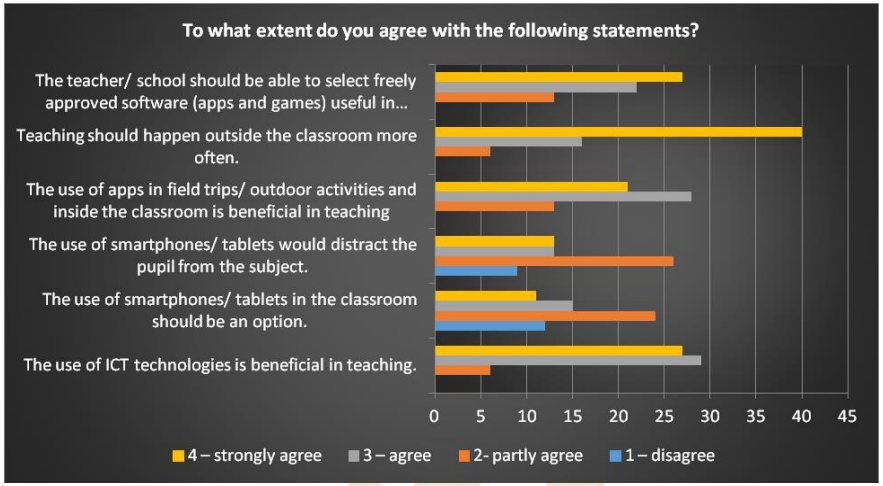
Which working methods in Natural Sciences classes do you prefer the most and which ones the least?

Future teachers like and strongly like individual work and pair work. They like and partly like frontal working methods in Natural Sciences classes. Some of them (12 out of 63) also strongly like frontal working methods.



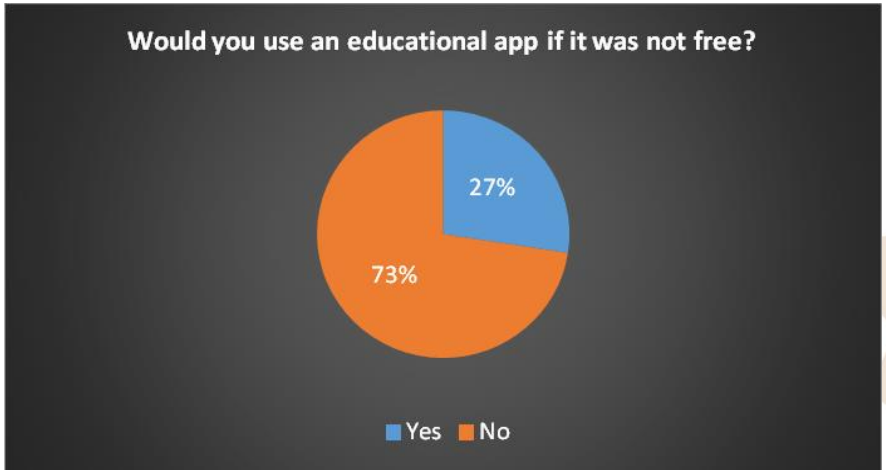
To what extent do you agree with the following statements?

Future teachers strongly agree that teaching should happen outside the classroom more often. They also agree and some of them strongly agree that the use of apps in field trips/ outdoor activities and inside the classroom is beneficial in teaching and also the teacher/ school should be able to select freely approved software (apps and games) useful in teaching, both for indoor and outdoor activities.



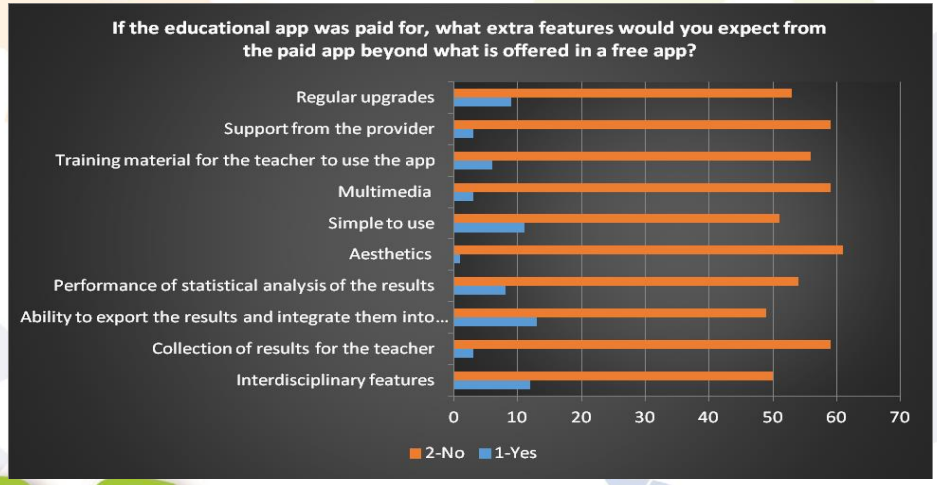
Would you use an educational app if it was not free?

73 % of future teachers wouldn't use an educational app if it was not free and only 27 % of future teachers would pay for an app.



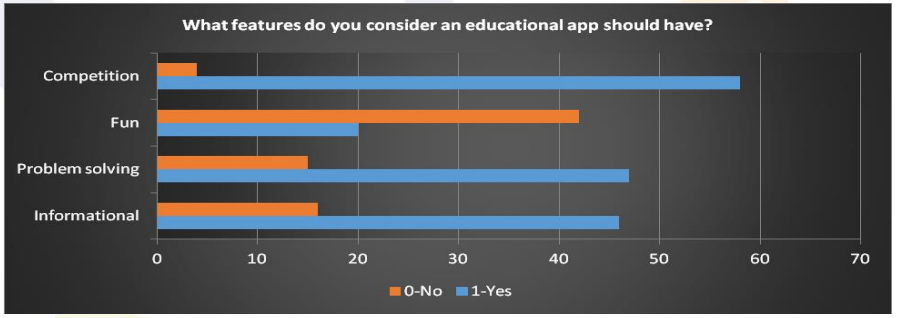
If the educational app was paid for, what extra features would you expect from the paid app beyond what is offered in a free app?

In general, future teachers wouldn't expect to have extra features from the paid app beyond what is offered in a free app.



What features do you consider an educational app should have?

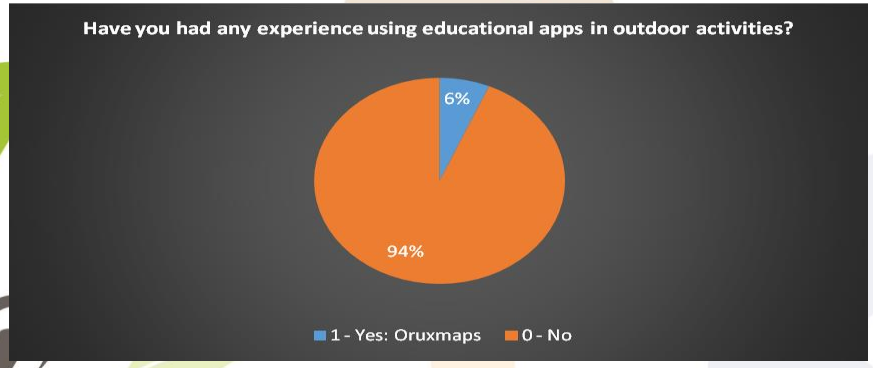
Future teachers think that an educational app should have competition in the first place, problem solving instead of information and it must be fun.



SKILLS AND COMPETENCES

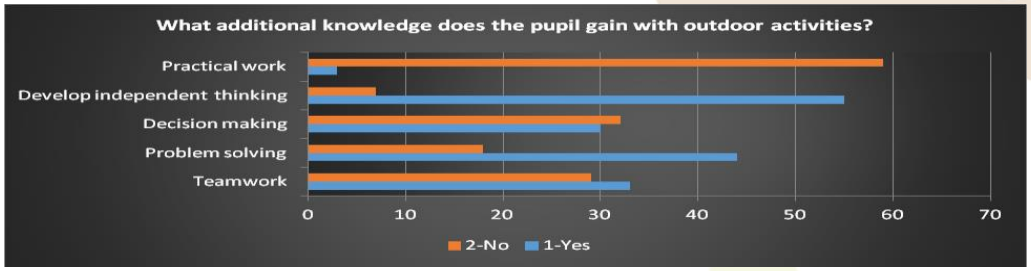
Have you had any experience using educational apps in outdoor activities?

94 % of future teachers have no experience in using educational apps in outdoor activities and only 6 % of them have already used an app named Oruxmaps.



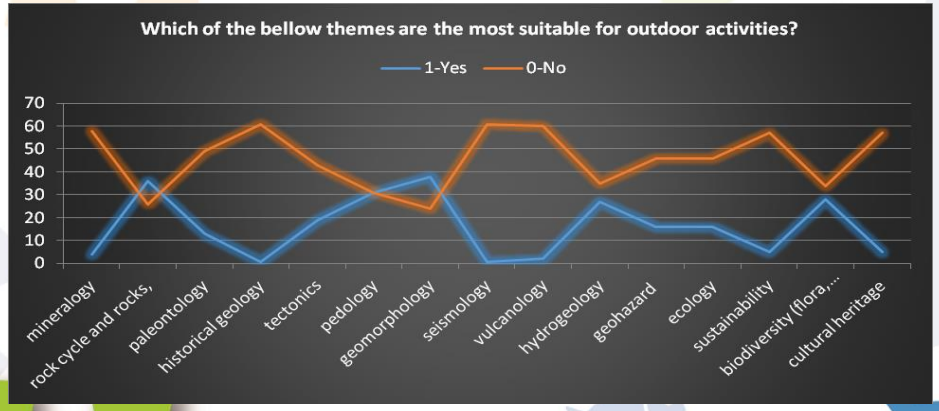
What additional knowledge does the pupil gain with outdoor activities?

Future teachers think that pupils develop independent thinking and also problem solving with outdoor activities. Half of them think that decision making and teamwork also are additional knowledge that the pupils gain with outdoor activities.



Which of the themes below are the most suitable for outdoor activities?

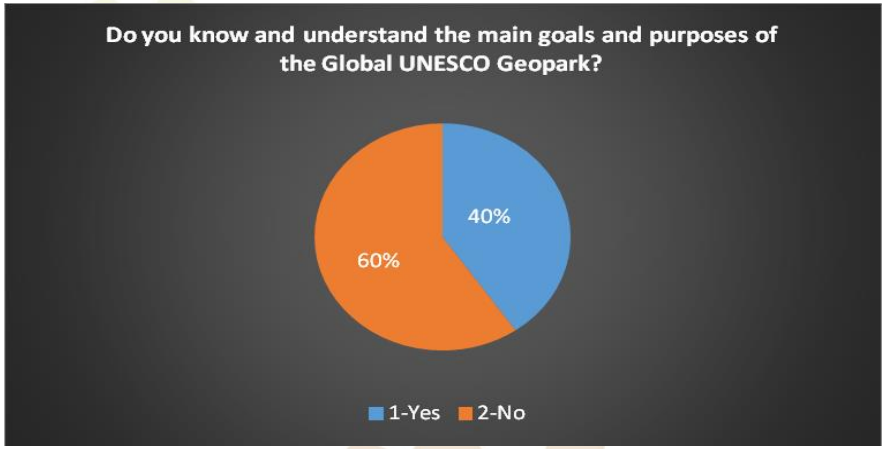
The most suitable themes for outdoor activities for future teachers are rock cycle and rocks, geomorphology, hydrogeology, biodiversity (flora, fauna).



LEARNING METHODOLOGIES

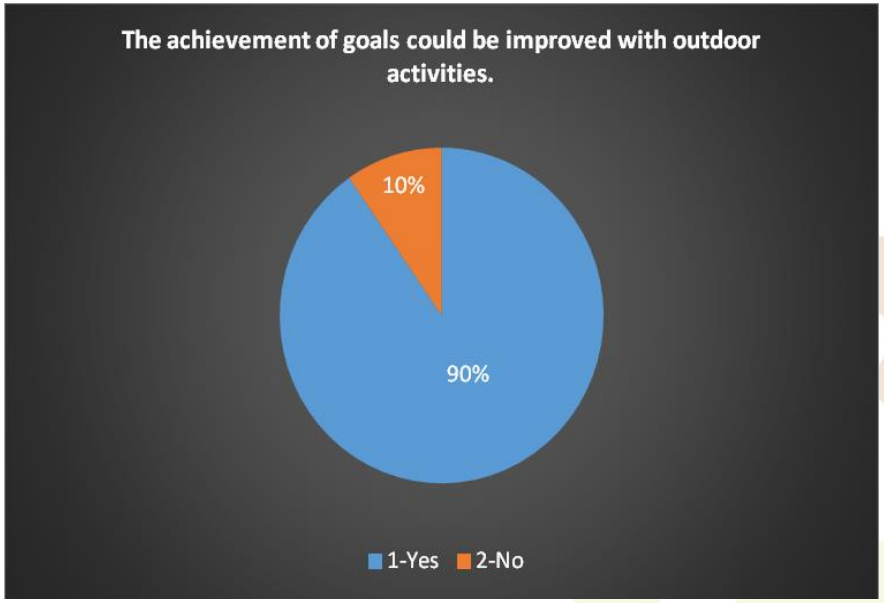
Do you know and understand the main goals and purposes of a Global UNESCO Geopark?

60 % of future teachers don't know and don't understand the main goals and purposes of a Global UNESCO Geopark.



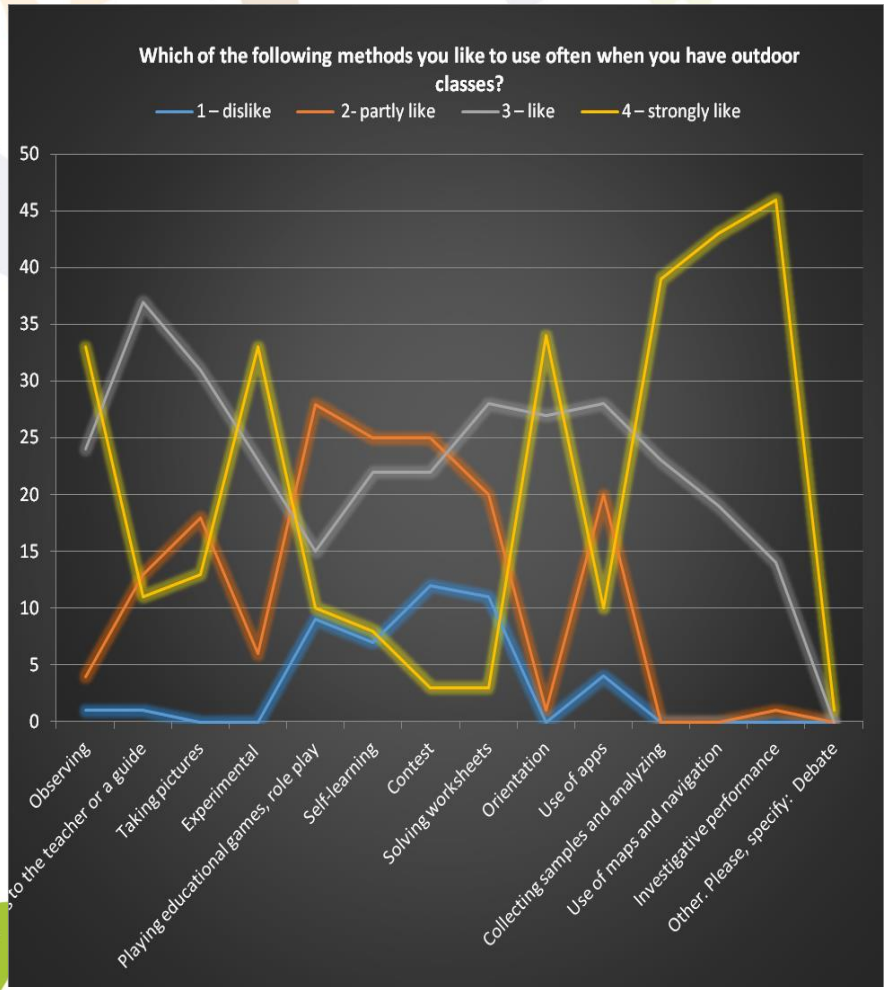
The achievement of goals could be improved with outdoor activities.

90 % of future teachers think that the achievement of goals could be improved with outdoor activities.



Which of the following methods would you like to use often when you have outdoor classes?

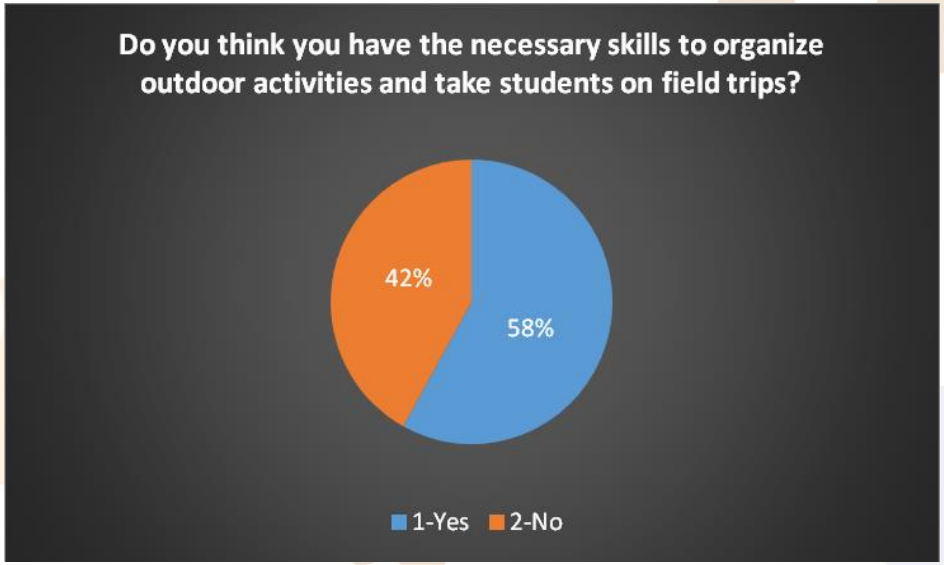
Future teachers strongly like to often use investigative performance, collecting samples and analysing, orientation, experimental and observation when having outdoor classes. They also often like listening to the teacher or a guide, solving worksheets and the use of apps. They partly like and dislike playing educational games, role playing, making contests and self-learning.



SATISFACTION LEVEL AND SUGGESTIONS FOR IMPROVEMENTS

Do you think you have the necessary skills to organise outdoor activities and take students on field trips?

58 % of future teachers think they have the necessary skills to organise outdoor activities and take students on field trips.



MAIN CONCLUSIONS - FUTURE NATURAL SCIENCES TEACHERS

1. The majority of future Natural Sciences teachers think that Earth sciences are less covered in comparison to other Natural Sciences and that is quite a worrying fact.

2. Future teachers would mainly use case studies, laboratory work and experiments, practical workshops, demonstration and observation. And they will do it as individual work or pair work, but group work is not the most desirable choice. They also only partly like learning by using computer, tablets or mobile phones, fieldwork, and outdoor studies.

3. Future teachers all agree to a point that teaching should happen outside the class and that ICT technologies are beneficial in teaching.

4. The great majority of them did not use any educational apps. But if they would use it, it has to be free. The most desirable feature in educational app is competition followed by problem solving and informational.

5. By their opinion outdoor activities would definitely improve achievement goals and develop individual thinking and problem solving but NOT practical work or skills.

6. Most suitable for outdoor activities for future teachers are rock cycle and rocks, geomorphology, hydrogeology, biodiversity (flora, fauna).

7. Majority of future teacher don't know about Unesco Global Geoparks.

8. During the outdoor work they would mainly choose investigative performance, collecting samples and analysing, orientation, experimental and observing. They do not like playing educational games. And the small majority of them believe that they possess necessary skills to organise outdoor activities.

4.3.4. SUMMARY OF PERSONAL INTERVIEWS FOR NST

A. SLOVENIA

Analysis of personal interviews with science teachers - Summary

1. Methodology

For the research of curricula, experiences, needs and expectations of teachers in science lessons we have prepared questions for personal interviews with science teachers. The questions were divided into the following parts:

Part 1: Curricula adequacy for science teaching
Part 2: Teaching methods in science lessons
Part 3: The use of modern technologies in science lessons
Part 4: Science teaching in nature
Part 5: Collaboration with UNESCO Global Geoparks

2. Description of the sample

Personal interviews involved four science teachers with different work experience in science teaching. All participating teachers work in primary schools within the area of Idrija UNESCO Global Geopark.

3. Analysis of personal interviews with science teachers – Summary

Part 1: Curricula adequacy for science teaching

The first set of questions relates to the curricula adequacy for science teaching. Among the main advantages of the existing curricula the science teachers pointed out the great degree of freedom in designing lessons. The content strands are available and can be adapted to students' interest and the subject

matter can be connected with current examples from everyday life. The curriculum includes teaching contents which enable a lot of practical work and optional contents which help teachers to reach the learning objectives. Teachers pointed out that the curriculum is fragmented and so the subject matter is repeating itself in different grades. In addition, they pointed out that the current curriculum is focusing too much on content objectives, while objectives focused on the strengthening of skills, learning how to implement procedures and other practical skills are missing. Such distribution of the subject's content enables traditional learning, but does not strengthen the pupil's sensorial perception of nature and the integration of knowledge in everyday life. Among the main suggestions for improving curricula is its updating in terms of simplification which would enable teachers to integrate more outdoor lessons and practical work in science.

Part 2: Teaching methods in science lessons

In the second part the participant teachers gave an opinion on the effectiveness of teaching methods used in science lessons. The answers given show that teachers use several methods. They underlined the implementation of experiments, the usage of different media (videos, photos, graphs, audio recordings) and written sources (current news, newspaper and online articles), individual work, debate, challenges and inquiry-based learning in higher classes ... In lessons, they most often combine different methods concerning the teacher's explanation, because it arouses curiosity in pupils and at the same time it encourages their active involvement in the learning process. One of the interviewed teachers pointed out that pupils who are successful in traditional working methods (teacher's explanation) achieve better results than with other methods (practical work, experiments,...). Pupils with low educational attainment don't achieve higher objectives when using different teaching methods. On the other hand, they are much more relaxed and unconcerned. According to the participant teachers, self-learning is the least effective method. They believe that pupils in primary school need a guided and structured acquisition of new subject contents, especially in lower classes. They are also convinced that pupils like to be involved in the learning process. Among the examples of good practice are experimental work (separation of substances in Chemistry), inquiry-based learning (research papers), work with media sources, the making of models, posters and flyers (production of molecular models and models of atoms in Chemistry) and practical work in nature.

Part 3: The use of modern technologies in science lessons

The third part of the interview includes questions that relate to past experiences and teachers' skills in the use of modern technologies in science lessons. Based on the answers, we can conclude that teachers most commonly use a computer and an overhead projector particularly for an explicit explanation and for the upgrade of an explanation they use media resources. The participant teachers stated that it is necessary to use modern technologies wisely especially when an explanation can be upgraded with concrete examples and practical work in the home environment. They have no experience with the use of mobile applications. The participant teachers have basic knowledge on how to use modern technologies and in the future they want to upgrade it (especially with knowledge on how to use tablets and smartphones in science lessons and how to use educational apps). One of the main advantages of using modern technologies in science lessons is a better demonstration and the ability of showing phenomena which cannot be shown in the classroom or in the home environment. Another advantage is also the fact that an educational mobile app can be a support for other educational activities (e.g. an aid for orientation, navigation, key for plant identification, thermographic camera, measuring device,…). Teachers believe that the use of modern technologies needs to be logical and that a very frequent use can dissuade students from active thinking and concrete perception of nature and the home environment.

Part 4: Science teaching in nature

The fourth part of the interview includes questions that relate to outdoor educational activities. Based on the answers we can conclude that the outdoor educational activities are usually carried out within the thematic science days and excursions. Otherwise, teachers rarely decide to have outdoor lessons. One of the main reasons is time limitation and the legal constraints, as in the case of a larger group of pupils the teacher needs additional escort. When teaching science in nature, the teachers most commonly use teaching methods that allow an active participation of pupils (independent research - determination of animals and plants with identification keys, solving worksheets, gathering, inventory, measuring, mapping ...). One of the main advantages of outdoor science lessons is the direct contact with nature and natural phenomena and the possibility for an active involvement of pupils in the educational process. With a direct experience the pupil remembers the subject's content better and on a long-term basis. Among the biggest disadvantages of outdoor lessons are difficulties in controlling and lower work effectiveness of large groups of pupils, more preliminary preparations and the pupils' attitude towards learning in nature.

Among the best examples of good practice in outdoor science lessons are: harvesting of plants, observation and identification of animals at bird-feeders in different conditions, ecosystem research, walks through the woods – as a repetition of the subject's content. One of the participant teachers designed a forest educational path in the school surroundings where pupils learn with the help of worksheets about several phenomena in nature and the characteristics of their home environment. The thematic educational path has proved to be an excellent example of good practice which also helps many other science teachers.

Part 5: Collaboration with UNESCO Global Geoparks

The fifth part of the interview includes questions that relate to the experience of science teachers and their previous collaboration with UNESCO Global Geoparks and their opinion on the role of Geoparks for subsequent inclusion in the educational process. Teachers pointed out the successful collaboration within the Idrija Geopark School Network. The idea behind the network is that each year one school organises a theme day for the seventh form pupils and prepares the programme. Some suggestions for an upgraded collaboration are: organisation and cooperation of Idrija UNESCO Global Geopark activity days, conducting science workshops on volcanism, earthquakes, rocks, participation in joint European educational projects, integration and cooperation with other institutions (Department for Geology at the Faculty of Natural Sciences and Engineering, Geological Institute of Slovenia ...).

B. PORTUGAL

Analysis of personal interviews with science teachers - Summary

Four interviews were conducted with Natural Sciences teachers with several years of professional experience in different schools of the Naturtejo UNESCO Global Geopark. The interviewees' answers were similar, which might mean a similar analysis and interpretation on the issues addressed.

Regarding the analysis of national curricular goals, the variety of contents included and the richness of the topics to be covered are mentioned as a strong point. The detail to which these topics should be addressed is referred to as a less positive aspect since the obligation to deepen the themes raises the degree of difficulty and limits a more favorable acquisition of the issues. The fact that

the subjects allow practical classes to be carried out and can be investigated in laboratory is also considered as an added value of the curriculum. Greater flexibility in curriculum management and the definition of mandatory practical activities are seen as necessary changes to enable educational success.

The most used methodology in science classes continues to be an exposition of themes supported in distinct visual supports followed by oriented debate. This presentation is usually preceded or succeeded by stages of guided research or discussion in smaller groups in order to build an autonomous knowledge. Practical and laboratory activities tend to be included in the teaching-learning process. The field trips and the activities in the laboratory allow a closer contact with nature as well as the management of variants and the study of phenomena in a more effective way are pointed as more appropriate methodologies. The use of technology is advised, with due supervision, and its contributions and possibilities are both vast and rich. The dynamics and interest in the proposed activities are always higher if it includes the use of these technologies in the process of acquiring knowledge. However, if there is no permanent control over how these technologies are brought into play and, for example, access to online content is not oriented and supervised, the risk of confusing notions and dispersing knowledge may occur. Also, there is the idea that the use of e-books may be desirable and aim at massification in the medium / long term.

Concerning outside activities, teachers choose to give pupils some freedom in searching for and collecting information, allowing the necessary autonomy for the development of knowledge. These actions usually follow a preamble that serves as an introduction to the themes, allowing pupils to develop an oriented and based work. Contact with nature and independence in the search for evidence and phenomena allow a better understanding of the notions and, consequently, acquisition of knowledge. The high number of pupils per class limits a better performance of these outdoor activities. Therefore, the support of the Geoparks' abled and knowledgeable staff in the promotion, definition and development of these activities assumes a central role. Visiting natural parks and geoparks or other protected areas are fundamental elements in an innovative, dynamic and fertile science teaching methodology.

C. NORWAY

In Norway Natural Sciences content is divided in the subjects of Social Studies curriculum and the Natural Sciences curriculum. These two curricula of secondary school enable understanding of the theory of evolution, how Earth has changed over the years, how human activities have affected nature, geographic characteristics of the world and they also enable the comparison of countries and regions. Other subjects relate to air mass, circulation of water, weather, climate and vegetation and the relation between nature and society.

Geological contents in our curriculum are mainly distributed into these two curricula of Social studies and Natural Sciences. Over all, they are the basis for understanding the world and the laws of the processes taking place in nature and in the human community. Pupils are working on testable hypothesis that they test and they are also discussing observations and results. It's widely used on students works as young scientist testing out hypotheses. They identify science arguments, facts and assertions in texts and written sources, digital sources, documentaries, movies etc. and evaluate the content of this in critical manner. Use of outdoor areas around the schools, geotops, for collecting information, counting, measuring, analyzing and working in smaller groups. Competition between groups also using Turfhunt app. The dividing between traditional desk teaching and testing of hypotheses indoor and outdoor is about 50/50.

Cross curricular links between school subjects are necessary for the understanding of life as a whole. To link between the different curricula and school subjects require that the teacher team work close together.

4.3.5 GENERAL CONCLUSIONS BASED ON COMPARISON OF ALL QUESTIONNAIRES: PUPILS, TEACHERS, FEATURE TEACHERS AND PERSONAL INTERVIEWS WITH TEACHERS

1. Students enjoy Earth sciences, however they can have some problems in understanding the basic concepts. We believe that this is a consequence of the fact that quite a part of natural sciences themes requires advanced abstract thinking (for example, in geology, thinking about a long time of millions or billions of years, temperatures over 1000^0C, and so on). An additional problem and in our opinion even more severe is that pupils do not know where to apply the knowledge provided and they don't know how to relate this knowledge to ordinary life problems.

2. Considering the teaching methods, pupils and teachers are on complete opposite grounds, because teachers in majority 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. So, we clearly have a generation gap in this matter.

3. The previous problem is also visible in the use of ICT. Only rarely or never do teachers use tablets or mobile phones during classes (and also at home) while pupils are already using them all the time.

4. The frequency of outdoor activities is just appalling. 95% of all pupils and teachers have less than 5 days of outdoor activities per YEAR. But everyone would love to do them more. From in-depth interviews we have understood that this problem is mainly related to the almost impossible required organisation (not enough time to go out) and also lack of motivation (for both pupils and teachers).

5. Pupils would really like to use modern technology in the outdoor activities… Especially games. Teachers are not so keen on this.

6. The majority of teachers does not consider paying for apps, except if it is a simple, interdisciplinary one which features training material and a collection of results.

7. The majority of pupils, teachers and future teachers do not know about Unesco Global Geoparks. The ones who do, are seeking for help in the preparation of materials, field trips, experts help and organisation of activities. Therefore, there is definitely some place for improvement here.

5. CHAPTER

NEW TRENDS AND GOOD PRACTICES IN NATURAL SCIENCES TEACHING IN ELEMENTARY SCHOOLS

University of Ljubliana

INTRODUCTION OF NEW METHODOLOGIES

Natural sciences teachers have an exciting opportunity to teach kids about how the world works. Unfortunately, reduced teaching budgets and apathy on the part of pupils sometimes makes it difficult to raise their interest in topics like Earth sciences, biology, physics, etc.

Traditionally, teachers used the lecture format to teach children about natural sciences. One of the drawbacks of the lecture format is that it does not engage pupils in their learning. This teaching technique encourages rote memorization and note-taking instead of excitement about the world of natural sciences.

Some teachers are now using techniques such as peer learning, role-playing, and incorporating current events in natural sciences lesson plans. These techniques help engage pupils and help them understand the importance of natural sciences. They also make it fun to teach natural scientific concepts and help pupils understand common topics in the natural sciences.

Modern trends in teaching aim at:

- a pupil centred learning
- supplying relevant sources
- engaging to active study
- promoting learning
- teamwork
- a formative work assessment

PUPIL CENTRED LEARNING

Basic change of teaching method: from teaching to promoting learning. This produces a further and useful knowledge of higher quality as proven by numerous research on how people learn best (psychology, neurology). This does not mean, that the role of the teacher is diminished. On the contrary, it is more demanding.

FROM LECTURES TO SUPPLYING RELEVANT SOURCES: the use of IC (information communication) technologies in learning.

Digital technology has changed the game in education. The devices that pupils carry in their pockets are far more powerful than massive computers that helped put man on the moon in 1969. Today‘s advanced technology offers many advantages, however it also presents a new set of challenges. It is not questionable if we should go digital, but how to go digital, starting now.

E-learning means that the teacher is no longer the sole keeper of knowledge. With e-learning time and place of study are irrelevant, it offers individual learning, interaction of users and menthor, cooperation of all, problem solving oriented learning, knowledge transfer. Contents, lectures and materials are also constantly available. WHAT TO USE? Possibilities are almost endless. You can choose between different multimedia computer softwares, e-learning, videoconferences, blogs, simulations, program tools for teachers (Moodle, Edynco, Nicenet, WebCT, Hot Potato.....), educational games, social networks, resources and so on.

ENGAGEMENT TO ACTIVE STUDY

The core of engagement to active study is to pay regard to different pupils’ interests, their knowledge level, past experience, their routine and ways to ‘’upgrade’’ all of the previously mentioned things. Active study is centred onto pupil instead of teacher, it focus on the things that the pupil is doing, it gives them more control over the teaching process and it also makes way to different learning needs and styles. There are numerous studies which indicate that this type of learning stimulates higher levels of learning and reasoning. It allows a connection between prior knowledge with new knowledge and, therefore, a deeper understanding. It motivates pupils better and provides them with more

pragmatic knowledge. Another important thing is that it takes into better account individual needs and differences.

Teamwork for active study

During the teamwork students are actively involved in the process of knowledge building. This type of learning promotes positive interdependence - each one contributes to the success of the group. It can be directed into more complex tasks with implementation of complex cognitive goals as well as motivation and skill objectives. The team work also offers knowledge transfer, that is the possibility of connecting a previous knowledge and experience with new knowledge.

The size of groups and communication depends on the task but in general a group of 3-6 works the best, since all participants are active, while in larger groups this is not the case.

The role of the teacher in the group work aims at organising work, he/she has to give precise instructions and interfere in the working process if necessary and summarise the results. In a less invasive manner the teacher can walk from group to group, advise, facilitate communication and promote the quitter ones. In any case it is absolutely necessary to be well prepared.

Peer-to-Peer Teaching

Peer-to-peer teaching is when the pupils actually get involved in teaching each other about science. This is an active learning method that encourages them to discuss about scientific topics, develop questions about the material, and work in teams to learn about new information. All of these techniques help pupils develop research and presentation skills that will help them in the science classroom as well as in other areas of life.

There are many possibilities to organize peer-to-peer teaching and here are just a few listed.

BUZZ GROUPS. When students work in buzz groups, they spend approximately 20 minutes studying a topic and gathering information. At the end of the session, one spokesperson from each group presents information to the entire class. It's suitable for clear problems and groups must be of 2-6 pupils. This method also works in large classrooms.

SNOWBALL GROUPS: Knowledge transfer from one to two, from two to four etc.. It combines the individual thinking with the group one.

SOLUTION AND CRITIC GROUPS For solution and critic groups, the teacher assigns one group of pupils to gather information and give a presentation. A second group of pupils acts as the critic group by evaluating the presentation.

COLLECTIVE INTERVIEW Here each pupil is involved and talk one after another.

Real-Life Scenarios and Case Studies

A **case study** is an account of an activity, event or problem that contains a real or hypothetical situation and includes the complexities you would encounter in the workplace. Case study teaching has gained a strong foothold in science education. Advances in the field include variations on methodology, from whole class discussion to the jigsaw approach. There are over a thousand studies that show improved learning when case studies are used and also illustrate that pupils enjoy and benefit from case studies.

These scenarios are ideal for classes of any size, but they work best when each pupil has access to needed specialised equipment. Case studies should be relevant to pupils, as this will make it easier to engage them in learning. Case studies should also address timely topics, as pupils are likely to become disinterested when presented with a case study that is not relevant to today's technology.

Current Events Tie-Ins

Some pupils do not enjoy science classes because they cannot imagine how they will ever use the information presented. Tying current events into science lectures and experiments is a great way to spark interest in the discussion at hand. Tornadoes, hurricanes, earthquakes, and other natural disasters are also ideal to include in this type of discussion. Once pupils get interested in a topic,

they are more likely to ask questions about it and take a real interest in learning more.

Hands-On Activities with Follow-Up Work

Hands-on activities are a great way to introduce pupils to the world of science. All hands-on activities should be followed by follow-up work, whether the teacher assigns an essay or asks pupils to complete a group project. Assignment questions should ask pupils to analyse the results of the activity and explain why a certain set of events may have occurred. These assignments reinforce learning and help pupils better understand scientific principles.

Elementary School Črni Vrh

NEW TRENDS IN TEACHING

For several years already the Science teachers of Primary school Črni Vrh have been making efforts to put these new trends into practice. Theoretical and practical aspects are being implemented in science classes in order to gain higher standards of knowledge and experience in this field of study. Teacher leads and directs the learning process of researching events in nature. The observations has shown that this way of teaching has increased pupils' creativity, abilities of critical reasoning and curiosity.

Recently, **Formative assessment** has become strongly recommended and promoted even by the National Education Board of Slovenia as an effective way of teaching and assessment in Primary schools. It includes a range of formal and informal assessment procedures during the learning process in order to engage pupils actively into learning activities. It usually involves a constant feedback rather than marks that focuses on the details of content and performance. Practice in classroom focuses on pupils' achievement, which is elicited, interpreted, and used to make decisions about the next steps. The principles of formative assessment have been gradually implemented into teaching of Natural Sciences.

European research **Project PROFILES** (Professional Reflection-Oriented Focus on Inquiry-based Learning and Education through Science) is a new trend in teaching science, that aims to promote the teachers' skills in providing creative, scientific problem-solving and crosscurricular learning environment. Within such environment pupils are challenged to develop positive attitude and intrinsic motivation to learn science and gain their individual abilities and skills, such as proper decision-making and scientific inquiry. This approach moves from a system that teaches science primarily as memorization and recall of information to one that emphasises global understanding, meaningful learning and logical process skills. Instead of the traditional teaching methodology frontally conveyed information, pupils should be engaged in hands-on activities to

conduct investigations, discover, practice and apply those principles in a variety of new, unknown situations. PROFILES Project unites several experienced teachers of science from all over Europe and offers many hands-on activities prepared by them.

AN EXAMPLE OF A PROFILES LEARNING ACTIVITY:

Learning content RESPIRATORY SYSTEM begins with an introductory question, "Do athletes really need an altitude training?" We try to get the answer through various activities. Some of the activities are prepared in advance, some are made up by the pupils, in order to explore the topic and find the answer to the initial motivational question.
The worksheet below shows one of such processes, which helps us to learn about the structure and functioning of the lungs.

Worksheet:
HOW DO YOUR LUNGS WORK?

1. **Make a model of lungs**

You will need: a plastic bottle, a plastic cork with an inserted tube, two balloons, scissors, sticky tape.
Instructions:
Cut the plastic bottle in such a way that the balloon, which you have in front of you will be hung within the bottle from its neck to the bottom. Place one balloon on the neck inside the bottle. Cut the narrow part of the other balloon and stretch it onto the cut part so, that you make a new bottom, which can be stretched out. Firmly attach the balloon onto the edge. Insert a plastic cork with a tube into the mouth of the bottle. Fix it with ~~a~~ sticky tape.

2. **Simulation of functioning of lungs**

Task 1:
Hold the baloon on the bottom of the bottle and pull it down. Observe what happens.

Answer the questions:

1. Write down all the changes in the plastic bottle which have occurred due to the stretching of the balloon.
2. Which muscle in our body involved in respiration is represented by the stretched balloon at the bottom of the bottle.

Task 2:
Clog the tube with play-doh. Pull down the lower balloon and observe the changes.
Answer the questions:

1. Write down all the changes in the plastic bottle which have occurred due to stretching of the balloon.
2. Why does the balloon representing the lungs respond differently in the second case in comparison to the first?

3. Compare the model of the lungs with the model in the torso. Write down the comparison. (Which part of the model represents a particular part of the human body involved in breathing?)

NATURE IS THE BEST LABORATORY – EDUCATIONAL TRAIL KARST FOREST

The educational trail Karst Forest has been created to learn the content in the field of geology, relief forms, vegetation on the plateau, as well as other topics. Since it is located in the vicinity of school, the classroom can be replaced by nature almost anytime. Pupils are willing to work in nature and explore it. A direct contact to nature makes learning of natural sciences faster, easier and more efficient. The teacher as the leader and organiser of the process, however, requires more preparation and his/her own commitment during the teaching process.

INDEPENDENT RESEARCH AND PRESENTATION OF CONTENT

The work consists of an introductory research work and final presentation. Through a variety of sources, pupils learn about certain learning content and accomplish a research task. Accumulated knowledge enables them to prepare ingenious presentations. It can be a simple powerpoint presentation or a roleplay of content. It is presented in front of classmates or even another audience.

Agrupamento de Escolas José Silvestre Ribeiro
NEW TRENDS IN TEACHING

The José Silvestre Ribeiro School Group in Idanha-a-Nova is an educational area of priority intervention. Schools are located in a socially and economically disadvantaged region, characterised by poverty and social exclusion. Insecurity, violence, truancy and failure in school are a reality. Teachers and other characters deal daily with these problems and aim to reduce early school dropout, fight pupils' truancy and promote educational success with a majority of needy and unmotivated pupils. It is in this context that the need for innovative pedagogical strategies and diversified teaching methodologies arises.

Over the last few years there have been many changes in the Portuguese educational system and, in particular, in the teaching of sciences. At present, pupils' assessment is based on curricular goals that are more comprehensive than those previously existing. This perspective on the goals to be achieved at the end of each teaching cycle allows schools and teachers to organise their activities taking into account a varied range of situations. Natural sciences teachers have been adapting to reality and science themes continue to be considered interesting by most pupils.

This has contributed to the dynamic posture of teachers, their open-mindedness to new methodologies and participation in projects that require the involvement of pupils and push them towards discovering the contents in an autonomous way.

- **CHANGING ROLES – THE PUPIL BECOMES THE TEACHER.**

Traditional lecture classes are increasingly aided by audiovisual media, new technologies and laboratory activities. Pupils develop concentration skills and are called upon to argue and discuss the issues together. From time to time, pupils from more advanced classes are asked to analyse topics and prepare presentations on these subjects. It is the pupils themselves who, after teacher-led construction, will be the protagonists in the promotion of these subjects to lower-grade pupils. The dynamics created is extremely productive, since it promotes the search for knowledge, the development of argumentative skills and the selection of an adequate language, not only but also scientific, in order to be able to convey the knowledge to younger colleagues. For them, these

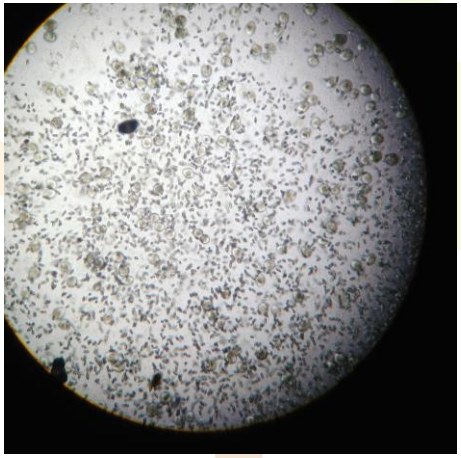
classes are always extraordinary and allow teachers to develop the subjects in subsequent classes, according to the doubts shown.

- **LEAVING THE CLASSROOM IN SEARCH FOR KNOWLEDGE.**

Participation in different projects with the coming of different communicators and specialists to the school or the visit to places of scientific interest, in natural environment or in museums and institutions, are frequent and allow contact with nature, the real world or with scientific and cultural value collections. Lessons outside the classroom, in areas near the school that allow contact with different aspects from different subjects, such as ecology, chemistry, geography, biology and geology tend to be popular. In these fleeting field trips, sometimes teachers of sciences are joined by other teachers from other subjects: history, physical education, Portuguese language, for example, which allows the sharing of knowledge and the accomplishment of multidisciplinary activities.

- **HOMEWORK THAT ARE SURPRISES – TAKING THE SCHOOL HOME.**

Homework should not be a punishment. From time to time, pupils are suggested tasks involving the development of simple practical activities outside school, at home for instance, with subsequent presentation and discussion of results in class. These actions allow pupils to go through the process of performing the activity, individually or in groups through experimentation. They motivate them to enhance reasoning and to choose paths autonomously. Sometimes, a simple job of collecting information about a particular subject, searching for the news in the media, conducting street interviews or searching online, can be a starting point for the analysis of certain themes and the approach of various topics. A simple photography contest, with pictures usually obtained with their mobile phone, interesting and easy work sometimes brings to light situations and data whose relevance proves to be quite high and allows an interesting discussion on that subject.

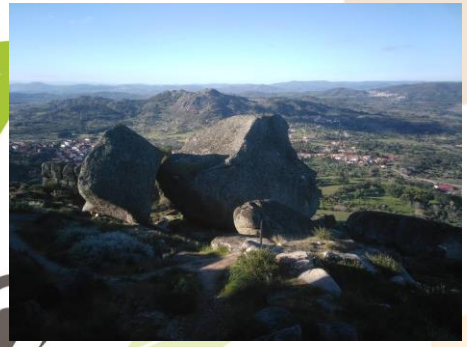


- **USE THE LABORATORY – LEARN TO EXPERIMENT.**

The laboratory class, with students arranged in groups and tasks defined by a protocol, promotes the development of autonomy and allows students to try, experiment, fail and look for solutions. Although it requires greater care and requires an organised attitude, which is not always easy to obtain with a larger group of young people, when the results of activities are those expected, the analysis of themes and learning are reinforced. When the results fall short of expectations, the discussion of procedures and results leads to conclusions that are equally valid. The materials and equipment available sometimes are insufficient or even inadequate, but this handicap requires adaptations and overcoming of problems, and sometimes it is from the sum of the setbacks that knowledge is perceived. The use of the mobile phone is controlled but can be a useful tool in performing laboratory activities; images obtained with this common tool that serves as a support to reports or presentations on different themes are frequent.

- NATURE IS THE BEST LABORATORY – DARE TO EXPERIMENT.

Being the school located in the rural countryside and integrated in the area of a Geopark, the accomplishment of joint activities is a constant. Whether participating in competitions, the development of works, discussions guided by the Geopark technicians and field trips are a fundamental activity in the acquisition of knowledge of scientific nature and in the development of notions on ecology and protection of the environment through contact with nature.



Norway

NEW TRENDS IN TEACHING

In 2006, the Norwegian Board for Education and Training introduced a new reform in schools, from Primary to Upper Secondary school. This reform meant clear learning goals for each subject, an increase in the number of hours of Natural Sciences in Primary school, and a higher focus on the teachers' competence development.

As part of the new Natural Sciences learning goals, the "Budding researcher" was introduced. The goal of the budding researcher is to teach pupils about the development of hypothesis, experimentation, systematic observations, discussions, critical assessment, argumentation, grounds of conclusion and presentation, leading the pupil to get the training to implement these processes in all aspects of the Natural Sciences subject. In Lower Secondary school, a learning goal is that the pupil is supposed to gather and process data, calculate and present the result in a graph manner.

With new learning goals, a higher amount of fieldwork was introduced as part of the curriculum. For a pupil in Primary school this would mean using scientific terms to describe and present own observations, suggest and talk about possible explanations for what was observed as part of the Natural Sciences subject. In Upper Secondary school, when a pupil has Geosciences, the learning goal is to map hydrological conditions and to discuss the access of fresh water in that area. There is an increasing focus on the implementation of new technologies in the Norwegian schools, which is also included as part of the national curriculum for all pupils in Primary and Secondary school. This means that pupils are supposed to develop digital skills and to learn about the possibilities of new technologies. Pupils are supposed to learn how to gather critical information, netiquette, to present digital information and to read, calculate and write with the help of computers and tablets. At school, there is an increasing access to interactive boards, computers and tablets, and in Upper Secondary school it is now

mandatory for all pupils to use computers daily. There is still a challenge for teachers to keep updated on the new technological tools and programmes and to get the necessary training to make to full use of the available technology.

Furthermore, the Norwegian schools has put a higher focus on formative learning assessments. With the goal of increasing pupils' motivation for subjects and results, continuous assessments are performed. The focus during formative assessment is for pupils to present their goals, and for the teacher, together with the pupil, to find a way to reach that goal and what needs to be done to reach the next step. These formative assessments can be time consuming and many teachers have started to solve the issue by using digital programmes as a tool for more effective feedback to the pupils.

"Flipped classroom" teaching is used with an increasing frequency, aiming at releasing time at school by giving the pupils online lessons as homework. This way, time traditionally spent at school for teaching can be used for activities with a higher degree of participants. Examples of such activities are experiments, role-play, fieldwork, excursions and group projects. There are several programmes coming to the market with the purpose of making flipped classroom easier (e.g. Campus increment, Screencast-O-Matic).

6. CHAPTER

CONCLUSIONS

The ESTEAM project is co-financed by the ERASMUS+ programme of the European Union, it started on September 2016 and will run in 36 months. The coordination of the project will be done by the Idrija Heritage Centre, which is the coordinator of the Idrija Geopark activities. The association of the seven partners comprises three UNESCO Global Geoparks (Idrija Geopark, Magma Geopark and Naturtejo Geopark), two schools within the Geopark areas, 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 & nature) that links National curriculum goals in Natural Sciences education with the development of mobile teaching/users experience platform (ICT) combined with outdoor activities. Additionally, developments and findings will result in a guide for Teachers of Natural Sciences – ESTEAM Methodology Step by Step Guide. 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, Geoparks staff and employees in educational institutions.

This eBook is the first output of the ESTEAM project (O1) – Research of National curricula with guidelines and this document will be the basis for the O2 – Development of teaching methodology: mobile teaching/users experience platform and O3 – Guide for teachers in Natural Sciences education: ESTEAM methodology Step by Step guide.

In Chapter 1 – Introduction - we described the project, the objectives and we present all the partners in general.

In Chapter 2 – Description of the UNESCO Global Geoparks - we presented the territory of the three Geoparks partners and we describe the types of educational activities organised by them and the target audience. The three Geoparks organise educational activities for their territory schools and have previous experience of using modern ICT technologies on the activities. At Naturtejo Geopark, the participants are pupils and teachers from the Geopark's territory, from all over the country and abroad.

In Chapter 3 – Current methodology in teaching Natural Sciences in elementary schools - we can refer that the organisation of the schools system is distinct in the three countries. However, the teachers of those countries use several didactic methodologies (including ICT Technologies, such as computers, interactive white board, smartphones and tablets) and they select and change them depending on the content and on the characteristics of the pupils they have. An active teaching method is essential to develop creativity, critical thinking, interest and active participation and it is also important to offer a variety of learning environments, class, nature, lab experiments and visits to museums to allow a sense of wonder and interest on caring about nature, mainly in their local area.

In Chapter 4 – Research of National curricula and needs - we have the results from the desk research and an analysis of the national curricula on Natural Sciences Teaching in the three countries of the project. In general, the subjects where Natural Sciences are taught are: Natural Sciences, Biology, Geology, Physics, Chemistry and Geography, but it depends on the country. Most of the themes are different. The amount of contents and number of pedagogical hours of Geology is bigger in Portugal than in the other two countries. In Norway, there is no specific number of pedagogical hours for each subject. The relevant data obtained during the research of national curricula were gathered in tables, one for each country. This chapter also includes the presentations of results, the analysis and comparison of the on-line research to understand the improvement needs of the Natural Sciences learning/teaching process addressed to pupils, teachers, future Natural Sciences teachers and of the personal interview for teachers. Four questionnaires were previously elaborated to conduct this

research. The number of participants per country on the online questionnaire was different (and we also had some participants from Albania, Andorra, Brazil, Hong Kong, France and Hungary), but the number of participant teachers on the personal interview was the same, four teachers from each Geopark. In total, 792 pupils, teachers and future teachers answered the online questionnaires. In the questionnaire for pupils, most of them pointed out they are quite satisfied with Natural Sciences learning at school, but when considering the teaching methods pupils would rather having new ones (such as apps, group work, etc.), but the teachers use standard methods, in general. Based on the analysis of the data of the four questionnaires, the majority of pupils, teachers and future teachers do not know anything about the Unesco Global Geoparks. The ones that do, are seeking for help in the preparation of materials, fieldtrips, expert help and organisation of activities. Thus, there is definitely some place for improvement here. Concerning the data, we can refer that the teachers only rarely or never use tablets or mobile phones during classes (and also at home) while pupils use them all the time. The frequency of outdoor activities is appalling. 95% of all pupils and teachers have less than five days of outdoor activities a year. But everyone would love to do them more. From the personal interviews we have learned that this is a problem mainly related to the almost impossible organisation (not enough time to go out), and also lack of motivation (for both pupils and teachers). Pupils would really like to use modern technology in the outdoor activities, especially games. Teachers are not so keen on this. The majority of teachers would not use payable apps. However, they are prepared to pay for the app if it is simple, interdisciplinary, and if it features training material and results collection for the teacher. With the ESTEAM Project we hope we can contribute to improve the awareness and the number of activities in partnership with local schools, the use of apps and the number of outdoor classes, in the three Geoparks territory and their countries. In order to create a mobile application on Output 2 (02) of this project, the common topics selected from the national curricula of Natural Sciences in the three countries (referred on the three tables of the desk research) are: 1 – Man's impact on Earth; 2 - Ecosystems; 3 – Geology.

In Chapter 5 – New trends and good practices in Natural Sciences teaching in elementary schools - the University of Ljubliana presents the modern trends in teaching purpose: pupil centred learning; supplying relevant sources; engaging to active study; promoting learning; teamwork; formative assessment. The Elementary School Črni Vrh (Slovenia) and the Agrupamento de Escolas José Silvestre Ribeiro (Portugal) presents new trends in teaching in Slovenia and Portugal schools in general, providing some examples of good practices in Natural Sciences Teaching and showing some activities. The Magma Geopark presents new trends in teaching Natural Sciences in Norway, in general.

As a general conclusion we can point out this eBook is the basis, the theorethical suport and the justification for the existence of the coming Output of the ESTEAM Project - Output 2 – Development of teaching methodology: mobile teaching/users experience platform.

ANNEXES:

- Questionnaries (3)

- Interviews (1)

PROJECT **ESTEAM**

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

ESTEAM QUESTIONNAIRE FOR PUPILS

The ESTEAM project, Enhancement of School Teaching Methods, by linking schools, experts and Geoparks with outdoor activities and ICT technologies, aims at improving the quality of teaching/ learning through an innovative methodology that connects national curricula goals in Natural Sciences education with the development of a mobile platform combined with outdoor activities.

This questionnaire is associated with the research of national curricula in Natural Sciences and intends to assess personal experience, difficulties and expectations, advantages and disadvantages of different activities in Natural sciences learning and the use of different methods and pedagogical approaches.

We would greatly appreciate you complete this questionnaire.

- According to your opinion, please answer all questions and do not leave blanks.
- It will take a maximum of 10 minutes.
- The answers will not be analysed individually.
- The questionnaire is anonymous.

Thank you for your contribution.

The **ESTEAM** team

Gender:

- Female
- Male

Age: _____

Form: _____

Country: _____

NATIONAL CURRICULUM GOALS

1. What do you prefer learning in school?
   Rank from 1 to 12 (1 – your favourite subject, 12 – your least favourite subject).

	Biology		Languages
	Social studies		Art and music
	Maths		Geology
	History		Chemistry
	Geography		Physics
	Sports		Another. Please, specify: _____

2. To what extent do you agree with the following statements?
(Rank: 1 – disagree, 2- partly agree, 3 – agree, 4 – strongly agree)

	1	2	3	4
Learning Natural Sciences is difficult for me.				
I spend more time learning Natural Sciences than other subjects.				
Knowledge about Natural Sciences is useful in everyday life.				
I want to upgrade my knowledge about Natural Sciences.				
Because of my knowledge about Natural Sciences, I appreciate and care more about my local environment.				
My future job will be connected to Natural Sciences.				
Because of my knowledge about Natural Sciences I can explain the natural processes in local environment.				
The ontent I learn in Natural Sciences seems too extensive.				
I achieve better results in Natural Sciences subjects than in other subjects.				
Knowledge about Natural Sciences is useful to other subjects.				

3. Please rank 1 to 4 how much do you know about the geological history of your region. (Rank: 1 – disagree, 2- partly agree, 3 – agree, 4 – strongly agree)

	1	2	3	4
I can explain geological processes in my local environment.				
I can list the types of rocks in my local environment.				
I can compare geological processes in my local environment to similar processes around the world.				
I can explain the influence of geology on daily life in my local environment.				

4. Please rank your own environmental awareness.
(Rank: 1 - never, 2 - rarely, 3 - often, 4 - always)

	1	2	3	4
I recycle waste.				
I walk to school.				
I reuse plastic.				
I attend environmental actions.				
I save water.				
I inform others about the importance of human behaviour in preserving the environment.				

CURRENT METHODOLOGY IN NATURAL SCIENCES TEACHING

1. How often do you use the following methods in Natural Sciences classes?
   (Rank: 1 - never, 2 - rarely, 3 - often, 4 - always)

	1	2	3	4
Expositive, teacher's explanation of contents				
Group discussion, round table debate				
Practical workshops				
Laboratory work and experiments				
Playing educational games, role playing				
Self-learning				
Learning by using a computer, tablet or mobile phone				
Solving worksheets				
Demonstration and observation				
Case studies				
Fieldwork, outdoor studies				

2. Which learning methods in Natural Science classes do you prefer the most and the least? (Rank: 1 – dislike, 2- partly like, 3 – like, 4 – strongly like)

	1	2	3	4
Expositive, teacher's explanation of contents				
Group discussion, round table debate				
Practical workshops				
Laboratory work and experiments				
Playing educational games, role playing				
Self-learning				
Learning by using a computer, tablet or mobile phone				
Solving worksheets				
Demonstration and observation				
Case studies				
Fieldwork, outdoor studies				

3. How often do you use the following working methods in Natural Sciences classes? (Rank: 1 - never, 2 - rarely, 3 - often, 4 - always)

	1	2	3	4
Frontal				
Groupwork				
Pairwork				
Individual work				

4. Which working methods in Natural Sciences classes do you prefer the most and the least? (Rank: 1 – dislike, 2 – partly like, 3 – like, 4 – strongly like)

	1	2	3	4
Frontal				
Groupwork				
Pairwork				
Individual work				

5. To what extent do you agree with the following statements?
(Rank: 1 – disagree, 2- partly agree, 3 – agree, 4 – strongly agree)

	1	2	3	4
Learning about Natural Sciences is easier for me when I am actively involved in the learning process (practical work, experiments, fieldwork).				
The use of new technologies in learning Natural Sciences seems very important to me.				
Learning about Natural Sciences is easier for me when I do independent work with concrete examples from my local environment.				
Learning about Natural Sciences is easier for me when I have outdoor classes.				
Learning about Natural Sciences is easier for me when I use new technologies (computer, mobile phone, tablet, interactive smart whiteboard).				

6. How often do you use the following new technologies in Natural Sciences classes?
(Rank: 1 - never, 2 - rarely, 3 - often, 4 - always)

	1	2	3	4
Computer				
Mobile phone				
Tablets				
Interactive whiteboard				

7. How often do you use the following new technologies at home?
(Rank: 1 - never, 2 - rarely, 3 - often, 4 - always)

	1	2	3	4
Computer				
Mobile phone				
Tablets				

8. What is your main purpose when using new technologies to learn about Natural Sciences? (Select up to 3 purposes)

- Searching for data on the Internet
- Playing educational and geolocated games
- Involving in interest groups on social networks
- Using e-lessons and e-learning
- I do not use new technologies for learning natural sciences
- Another. Please, specify: _____

9. Which language do you usually speak when you learn about Natural Sciences using new technologies?
- My national language
- English
- Another. Please, specify: _____

SKILLS AND COMPETENCES IN OUTDOOR ACTIVITIES

1. Have you had any experience using educational apps in outdoor activities?
   - No
   - Yes

   If you answered *Yes*, please name the used educational apps: _____

2. How many times a school year do you have outdoor classes? (Select 1 option)
   - 1- 2
   - 3 -5
   - More than 5
   - We do not have outdoor classes

3. According to the following statements, tick the location you find more suitable. (Tick the selected box with an X)

	IN CLASS	OUTDOORS
Learning Natural Sciences is more fun:		
It is easier to remember contents when learning activities are:		
It is easier to communicate with classmates and teachers when learning activities are:		
It is easier to concentrate when Natural Sciences learning activities are:		
I feel better and have more stamina when learning activities are:		
I achieve better results when learning activities are:		

4. What do you like the most about outdoor classes in Natural Sciences?
(Rank: 1 – dislike, 2 – partly like, 3 – like, 4 – strongly like)

____ Communication with classmates and teachers
____ Different learning methods
____ Activities in nature and fresh air
____ Independent work on concrete examples from my local environment

5. What additional knowledge do you gain with outdoor activities? (Choose up to 3 options)
- Teamwork
- Problem solving
- Decision making
- Development of independent thinking
- Another. Please, specify: _____

OUTDOOR LEARNING METHODOLOGIES

1. Do you understand the main goals and purposes of a UNESCO Global Geopark?
- Yes
- No

2. Is your school in a UNESCO Global Geopark area?
- Yes
- No
- I don`t know

3. Which of the following methods do you most commonly use when you have outdoor classes? (Rank: 1 - never, 2 - rarely, 3 - often, 4 - always)

	1	2	3	4
Observation				
Listening to the teacher or a guide				
Taking pictures				
Experimentation				
Playing educational games, role playing				
Self-learning				
Participating in Contests				
Solving worksheets				
Orientation				
Use of apps				
Collecting samples and analyzing				
Use of maps and navigation				
Investigative performance				
Another. Please, specify: _____				

4. Which of the following methods would you like to use when you have outdoor classes? (Rank: 1 – dislike to use, 2- partly like to use, 3 – like to use, 4 – strongly like to use)

	1	2	3	4
Observation				
Listening to the teacher or a guide				
Taking pictures				
Experimentation				
Playing educational games, role playing				
Self-learning				
Participating in Contests				
Solving worksheets				
Orientation				
Use of apps				
Collecting samples and analyzing				
Use of maps and navigation				
Investigative performance				
Another. Please, specify: _____				

5. Have you had an outdoor class in a geosite in the area of your Global UNESCO Geopark?
   - Yes
   - No

6. If you answered *Yes* to the above question, select the theme you learned about.
   - Rocks
   - Fossils
   - Plants
   - Animals
   - Cultural heritage
   - Environmental awareness
   - Climate change

SATISFACTION LEVEL AND SUGGESTIONS FOR IMPROVEMENTS

1. How satisfied are you with Natural Sciences learning at your school? (Choose 1 option)
   - Not satisfied
   - A little
   - Quite
   - Very

2. Would you like to use new technologies to learn about Natural Sciences? (Choose 1 option)
   - I don’t like it
   - A little
   - Quite
   - Very

3. How important are Natural Sciences games to learn about the contents? (Choose 1 option)
- Not important
- A little
- Quite
- Very

4. How important are the following suggestions for the improvement of Natural Sciences learning in your school? (Rank: 1 – not important, 2 – partly important, 3 - important 4 - very important)

	1	2	3	4
Crosscurriculum cooperation (natural sciences' connection to other subjects)				
International cooperation with students from other schools				
Increased use of ICT in Natural Sciences learning process (mobile phones, tablets, computers)				
More individual work with examples from local environment				
Playing educational games, role playing				
Involving scientific institutions in learning process				
Outdoor activities				
Fewer contents/ topics in the curricula				

5. What features should an educational app for learning Natural Sciences have? (Choose 1 option)
- Information
- Problem solving
- Fun
- Competition

6. How do you think the future of Natural Sciences education can be improved?

_____

Your additional suggestions and comments:

_____

For more information about project activities visit http://esteamproject.wixsite.com/mysite

Would you like to receive further information about the ESTEAM project?

- Yes
- No

If you answered *Yes*, please leave your e-mail: _____

PROJECT **ESTEAM**

Co-funded by the
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of the European Union

ESTEAM QUESTIONNAIRE FOR NATURAL SCIENCES TEACHERS

The ESTEAM project, Enhancement of School Teaching Methods, by linking schools, experts and Geoparks with outdoor activities and ICT technologies, aims at improving the quality of teaching/ learning through an innovative methodology that connects national curricula goals in Natural Sciences education with the development of a mobile platform combined with outdoor activities.

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We would greatly appreciate you complete this questionnaire.

- According to your opinion, please answer all questions and do not leave blanks.
- It will take a maximum of 10 minutes.
- The answers will not be analysed individually.
- The questionnaire is anonymous.

Thank you for your contribution.

ESTEAM team

Gender:

- Female
- Male

Age: _____

Country: _____

Years of teaching experience: _____

NATIONAL CURRICULUM GOALS

1. Please, classify your pupils' interest in the study of Natural Sciences themes?
   - Very Good
   - Good
   - Fair
   - Bad

2. In which of the subjects do your pupils feel more difficulties? (Please, rate: 1 – without problems, 2 – occasional problems, 3 – common problems, 4 – constant problems)
   - Biology
   - Geology
   - Chemistry
   - Physics

3. Do you teach your pupils the relationship between biodiversity and geodiversity?
    - Always
    - Often
    - Rarely
    - Never

4. Do you teach your pupils the importance of Earth's natural resources in our daily life?
    - Always
    - Often
    - Rarely
    - Never

5. Do you teach the regional geological history in class?
    - Always
    - Often
    - Rarely
    - Never

CURRENT METHODOLOGY IN NATURAL SCIENCES TEACHING

1. How often do you use the following methods in Natural Sciences classes?
   (Rank: 1 - never, 2 - rarely, 3 - often, 4 - always)

	1	2	3	4
Expositive, teacher's explanation of contents				
Group discussion, round table debate				
Practical workshops				
Laboratory work and experiments				
Playing educational games, role playing				
Self-learning				
Learning by using a computer, tablet or mobile phone				
Solving worksheets				
Demonstration and observation				
Case studies				
Fieldwork, outdoor studies				

2. Which learning methods in Natural Sciences classes do you prefer the most and the least? (Rank: 1 – dislike, 2- partly like, 3 – like, 4 – strongly like)

	1	2	3	4
Expositive, teacher's explanation of contents				
Group discussion, round table debate				
Practical workshops				
Laboratory work and experiments				
Playing educational games, role playing				
Self-learning				
Learning by using a computer, tablet or mobile phone				
Solving worksheets				
Demonstration and observation				
Case studies				
Fieldwork, outdoor studies				

3. How often do you use the following working methods in Natural Sciences classes?
   (Rank: 1 - never, 2 - rarely, 3 - often, 4 - always)

	1	2	3	4
Frontal				
Groupwork				
Pairwork				
Individual work				

4. Which working methods in Natural Sciences classes do you prefer the most and the least? (Rank: 1 – dislike, 2- partly like, 3 – like, 4 – strongly like)

	1	2	3	4
Frontal				
Groupwork				
Pairwork				
Individual work				

5. How often do you use the following new technologies in Natural Sciences classes?
   (Rank: 1 - never, 2 - occasionally, 3 - often, 4 - always)

	1	2	3	4
Computer				
Mobile phone				
Tablets				
Interactive whiteboard				

6. How often do you use the following new technologies at home?
(Rank: 1 - never, 2 - occasionally, 3 - often, 4 - always)

	1	2	3	4
Computer				
Mobile phone				
Tablets				

7. What is your main purpose of using new technologies when teaching Natural Sciences? (Choose up to 3 purposes)
- Searching for data on the Internet
- Playing educational and geolocated games
- Involving in interest groups on social networks
- Using e-lessons and e-learning
- I do not use new technologies to teach Natural Sciences.
- Another. Please, specify: _____

8. Which language do you usually speak when you teach Natural Sciences using ICT?
- My national language
- English
- Another. Please, specify: _____

9. Would you use an educational app if it was not free?
- No
- Yes

10. If the educational app was paid for, what extra features would you expect from it beyond what is offered in a free app? (Choose up to 4 options)
- Interdisciplinary features
- Results collection for the teacher
- Ability to download the results to integrate in the school's platform
- Perform statistical analysis of the results
- Aesthetics
- Simple to use
- Multimedia
- Training material for the teacher
- Support from the provider
- Regular upgrades
- Another. Please, specify: _____

11. What features do you consider an educational app should have?
(Choose up to 2 options)
    - Information
    - Problem solving
    - Fun
    - Competition

12. What do you think would be your most preferred teaching method?

_____

SKILLS AND COMPETENCES IN OUTDOOR ACTIVITIES

6. Have you had any experience using educational apps in outdoor activities?
    - No
    - Yes

    If you answered *Yes*, can you name the used educational apps: _____

7. How many times a school year do you have outdoor classes?
    - 1 - 2
    - 3 -5
    - More than 5
    - We do not have outdoor classes

8. What additional knowledge do you gain with outdoor activities? (Choose up to 3 options)
    - Teamwork
    - Problem solving
    - Decision making
    - Development of independent thinking
    - Another. Please, specify: _____

9. Which of the themes below are the most suitable for outdoor activities? (Choose up to 4 options)

- mineralogy
- rock cycle and rocks
- paleontology
- historical geology
- tectonics
- pedology
- geomorphology
- seismology
- vulcanology
- hydrogeology
- geohazard
- ecology
- sustainability
- biodiversity (flora, fauna)
- cultural heritage
- another

OUTDOOR LEARNING METHODOLOGIES

1. Do you know and understand the main goals and purposes of a Global UNESCO Geopark?

- Yes
- No

2. Is your school in a Unesco Global Geopark area?

- Yes
- No
- I don`t know

3. According to your opinion, select the roles a Global UNESCO Geopark plays to reach the educational goals? (Choose up to 4 options)
   - Guidance in field trips
   - Expert help
   - Organisation and promotion of activities
   - Preparation of material
   - Financing projects
   - Project coordination
   - Promotion and preservation of heritage
   - Cooperation with other institutions (municipality or other educational institutions)

4. Assistance of experts and technical support would be beneficial in outdoor activities.
   - Yes
   - No

5. Describe how could a Global UNESCO Geopark support you when organising outdoor activities.

_____
_____

6. The achievement of goals could be improved with outdoor activities.
   - Yes
   - No

7. Which of the following methods do you most commonly use when you have outdoor classes? (Rank: 1 - never, 2 - occasionally, 3 - often, 4 - always)

	1	2	3	4
Observation				
Listening to the teacher or a guide				
Taking pictures				
Experimentation				
Playing educational games, role playing				
Self-learning				
Making a Contest				
Solving worksheets				
Orientation				
Use of apps				
Collecting samples and analyzing				
Use of maps and navigation				
Investigative performance				
Another. Please, specify: _____				

8. Which of the following methods would you like to use more often when you have outdoor classes? (Rank: 1 – strongly dislike to use, 2- dislike to use, 3 – like to use 4 – strongly like to use)

	1	2	3	4
Observation				
Listening to the teacher or guide				
Taking pictures				
Experimentation				
Playing educational games, role playing				
Self-learning				
Making a Contest				
Solving worksheets				
Orientation				
Use of apps				
Collecting samples and analyzing				
Use of maps and navigation				
Investigative performance				
Another. Please, specify: _____				

9. What are the most important reasons that influence a teacher's choice of teaching methods? (Choose up to 3 reasons)
   - Time execution
   - Effective achieving goals
   - Teachers' and pupils' skills and competences
   - Pupils' safety
   - Pupils' motivation
   - Pupils' needs
   - Availability of technical equipment
   - Another. Please, specify: _____

10. Have you had an outdoor class in a geosite in the area of your Geopark?
   - Yes
   - No

11. If you answered Yes to the above question - select the theme you learned about.
   - Rocks
   - Fossils
   - Plants
   - Animals
   - Cultural heritage
   - Environmental awareness
   - Climate change

SATISFACTION LEVEL AND SUGGESTIONS FOR IMPROVEMENTS

1. Do you think you have the necessary skills to organise outdoor activities and take pupils on field trips?
   - Yes
   - No

2. Do you consider it important for pupils to interact with other peers, in real time, working on the same subject?
- Yes
- No

3. If you answered *Yes* to the question above, select the origin of the pupils working together. (Check all that apply)
- Same school and same classes
- Same school and different classes
- Another school in the country
- Another school from a different country (speaking a different language)

4. Do you think the possibility of choosing different languages in an app when solving projects is important for the teacher and pupil to learn another language?
- Yes
- No

5. How important are the following suggestions for the improvement of NST in your school? (Rank: 1- not important, 2 – partly important, 3 - important 4 - very important)

	1	2	3	4
Crosscurriculum cooperation (Natural Sciences connection with other subjects)				
International cooperation with students from other schools				
Increased use of ICT in Natural Sciences learning process (mobile phones, tablets, computers)				
More individual work with examples from local environment				
Playing educational games, role playing				
Involving scientific institutions in learning process				
Outdoor activities				
Fewer contents/ topics in the curricula				

6. How do you think the future of education and the role of the teacher can be improved and evolve?

_____

_____

Your additional suggestions and comments:

_____

For more information about project activities visit http://esteamproject.wixsite.com/mysite

Would you like to receive further information about the ESTEAM project?

- Yes
- No

If you answered *Yes*, please leave your e-mail: _____

PROJECT **ESTEAM**

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

ESTEAM QUESTIONNAIRE FOR FUTURE NS TEACHERS

The ESTEAM project, Enhancement of School Teaching Methods, by linking schools, experts and Geoparks in combination with outdoor activities and ICT technologies, aims at improving the quality of teaching/ learning through an innovative methodology that connects national curricula goals in Natural Sciences education with the development of a mobile platform for outdoor activities.

This questionnaire is associated with the research of national curricula in Natural Sciences and intends to assess personal experience, difficulties and expectations, advantages and disadvantages of different activities in Natural Sciences teaching and the use of different methods and pedagogical approaches.

We would greatly appreciate you complete this questionnaire.

- According to your opinion, please answer all questions and do not leave blanks.
- It will take a maximum of 10 minutes.
- The answers will not be analysed individually.
- The questionnaire is anonymous.

Thank you for your contribution.

ESTEAM team

Gender:

- Female
- Male

Age: _____

Study area: _____

NATIONAL CURRICULUM GOALS

1. Are Earth sciences covered equally in your teaching curriculum in comparison to other Natural Sciences (Chemistry, Physics, Biology, Astronomy)?
   - Yes
   - They are less covered
   - They are more covered

2. Which Earth science topics are covered in your curriculum? (multiple choice)
   - pedology
   - geomorphology
   - geology
   - geophysics
   - ecology
   - hydrology
   - atmospheric sciences
   - glaciology

3. Which geology topics are covered in your curriculum? (multiple choice)
   - mineralogy
   - rock cycle and rocks
   - paleontology
   - historical geology
   - tectonics
   - seismology
   - vulcanology
   - hydrogeology
   - geomorphology
   - geohazard

4. From a teaching perspective, select the four most important science topics. (multiple choice)
   - mineralogy
   - rock cycle and rocks
   - paleontology
   - historical geology
   - tectonics
   - pedology
   - geomorphology
   - seismology
   - vulcanology
   - hydrogeology
   - geohazard
   - ecology
   - sustainability
   - biodiversity (flora, fauna)
   - cultural heritage
   - another

5. The selected topics (study areas) are covered equally within the university's curriculum.
   - Agree
   - Disagree

6. The selected topics (study areas) are covered with enough depth for you to interpret them to pupils as a Natural Sciences teacher.
   - Agree
   - Disagree

7. The balance between theoretical/ didactics and practical/ teaching practice is a correct one in order to fulfill future needs in NS teaching.
   - Correct
   - More theoretical
   - More practical

8. Select the means you would use to assess the goals in the curriculum for the selected subjects.
   - Tests
   - Projects
   - Applying knowledge
   - Another. Please, specify: _____

METHODOLOGY

1. Which learning methods in Natural Sciences classes do you prefer the most and the least? (Rank: 1 – dislike, 2- partly like, 3 – like, 4 – strongly like)

	1	2	3	4
Expositive, teacher's explanation of contents				
Group discussion, round table debate				
Practical workshops				
Laboratory work and experiments				
Playing educational games, role playing				
Self-learning				
Learning by using computer, tablet or mobile phone				
Solving worksheets				
Demonstration and observation				
Case studies				
Fieldwork, outdoor studies				

2. Which working methodes in Natural Sciences classes do you prefer the most and the least? (Rank: 1 – dislike, 2- partly like, 3 – like, 4 – strongly like)

	1	2	3	4
Frontal				
Groupwork				
Pairwork				
Individual work				

3. To what extent do you agree with the following statements?
(Rank: 1 – disagree, 2- partly agree, 3 – agree, 4 – strongly agree)

	1	2	3	4
The use of ICT technologies is beneficial in teaching.				
The use of smartphones/ tablets in the classroom should be an option.				
The use of smartphones/ tablets would distract the pupil from the subject.				
The use of apps in field trips/ outdoor activities and inside the classroom is beneficial in teaching.				
Teaching should happen outside the classroom more often.				
The teacher/ school should be able to select freely approved software (apps and games) useful in teaching, both for indoor and outdoor activities.				

4. Would you use an educational app if it was not free?
   - Agree
   - Disagree

5. If the educational app was paid for, what extra features would you expect from it beyond what is offered in a free app? (Choose up to 4 options)
   - Interdisciplinary features
   - Results collection for the teacher
   - Ability to download results and integrate them in the school's platform
   - Performance of statistical analysis of the results
   - Aesthetics
   - Simple to use
   - Multimedia
   - Training material for the teacher
   - Support from the provider
   - Regular upgrades
   - Another. Please, specify: _____

6. What features do you consider an educational app should have? (Choose up to 2 options)
   - Information
   - Problem solving
   - Fun
   - Competition

7. What do you think would be your most preferred teaching method?

_____

SKILLS AND COMPETENCES

1. Have you had any experience using educational apps in outdoor activities?
   - Yes
   - No

If you answered *Yes*, name some of the educational apps used in your teaching experience: _____

2. How often should outdoor activities be a part of the teaching methods?
   - Every day
   - Once a week
   - Every other week
   - Once a month
   - Another: _____

3. What additional knowledge does the pupil gain with outdoor activities?
   - Teamwork
   - Problem solving
   - Decision making
   - Development of independent thinking
   - Another

4. Which of the themes below are the most suitable for outdoor activities?
   - mineralogy
   - rock cycle and rocks,
   - paleontology
   - historical geology
   - tectonics
   - pedology
   - geomorphology
   - seismology
   - vulcanology
   - hydrogeology
   - geohazard
   - ecology
   - sustainability
   - biodiversity (flora, fauna)
   - cultural heritage
   - another

LEARNING METHODOLOGIES

1. Do you know and understand the main goals and purposes of a Global UNESCO Geopark?
   - Yes
   - No

2. In your opinion, select the roles a Global UNESCO Geopark plays to reach the educational goals? (Choose up to 4 options)
   - Guidance in field trips
   - Expert help
   - Organisation and promotion of activities
   - Preparation of material
   - Financing projects
   - Project coordination
   - Promotion and preservation of heritage
   - Cooperation with other institutions (municipality or other educational institutions)

3. Assistance of experts and technical support would be beneficial in outdoor activities.
   - Yes
   - No

4. Describe how could a Global UNESCO Geopark support you when organising outdoor activities.

_____

5. The achievement of goals could be improved with outdoor activities.
   - Yes
   - No

6. Which of the following methods would you like to use more often when you have outdoor classes? (Rank: 1 – dislike, 2- partly like, 3 – like, 4 – strongly like)

	1	2	3	4
Observation				
Listening to the teacher or a guide				
Taking pictures				
Experimentation				
Playing educational games, role playing				
Self-learning				
Making a Contest				
Solving worksheets				
Orientation				
Use of apps				
Collecting samples and analyzsing				
Use of maps and navigation				
Investigative performance				
Another. Please, specify: _____				

7. In your opinion, what are the most important reasons that influence a teacher's choice of teaching methods? (Choose up to 3 reasons)

a) Time execution
b) Effective achievement of goals
c) Teachers' and pupils' skills and competences
d) Pupils' safety
e) Pupils' motivation
f) Pupils' needs
g) Availability of technical equipment
h) Another. Please, specify: _____

SATISFACTION LEVEL AND SUGGESTIONS FOR IMPROVEMENTS

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   - No

2. Do you consider important for pupils to interact with other peers, in real time, working on the same subject?
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4. Do you think the possibility of choosing different languages in an app when doing projects is important for the pupil to learn another language?
   - Yes
   - No

5. How do you think the future of education and the role of the teacher can be improved and evolve?

_____

Your additional suggestions and comments:

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PROJECT ESTEAM

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ESTEAM QUESTIONNAIRE FOR PERSONAL INTERVIEWS – NS TEACHERS

National Curricula goals

1. What are, in your opinion, the main strengths and weaknesses of Natural Sciences national curricula?
2. What are your suggestions for the improvement of Natural Sciences national curricula?

Current methodology in Natural Sciences Teaching

1. Which teaching methods are the most frequently used ones in your Natural Sciences lessons? Justify.
2. Show some examples of your best practices (teaching methods) when teaching Natural Sciences.

Use of ICT Technologies

1. For what purposes do you use new technologies during your Natural Sciences lessons?
2. What are, in your opinion, the advantages and disadvantages of using modern technology in your Natural Sciences lessons?
3. What are your suggestions to improve the use of new technologies in Natural Sciences teaching?

Outdoor NS teaching methodology

1. What kind of teaching methods do you most commonly use when you have NS outdoor activities?
2. What are the main advantages and disadvantages of NS outdoor activities?
3. Show some examples of your best practices of teaching methods for NS outdoor activities.

Cooperation with a UNESCO Global Geopark

1. Where do you see the opportunities for a cooperation between schools and a UNESCO Global Geopark?

Suggestions for improvement of NS teaching

1. Do you have any suggestions to improve Natural Sciences teaching in class and outdoor?

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