Transnational Training Action

FullSTEAM: an approach to teaching science in non-formal contexts

Portugal

6-9 September 2022

General Introduction

Nowadays, citizens living in democratic societies are often asked to take part in decision-making processes focusing in issues that often have to do with scientific matters and are relevant for societies and individuals living in them. This decision-making happens every time citizens engage into problem-solving processes whether they focus on issues with a global dimension (e.g., in order to preserve the ozone layer) or on a smaller scale, like local needs or demands (e.g., to improve the waste management systems of the locality they live in, to react to a project for settling a wind farm nearby, to save energy at home, or to acknowledge the growing of genetically modified organisms in their neighborhood). The success of having increasing numbers of informed citizens is linked to the ability of our societies to educate smart, creative and entrepreneurial individuals with the confidence and capability to think autonomously and critically as well as the ability to generate new knowledge, social and technological innovation and utilize and adapt to technological change.

We live in a time when the educational system still normalizes and standardizes, considering the "good student" to be the one who sits and replicates in tests the " subject given ", while having a society that expects autonomous, creative citizens who think and act critically about their lives and their surroundings. 30 years ago, the focus was on the development of technical skills, today, when we project the citizen of the 21st century, for today and for the future, we highlight transversal skills as essential. However, if the education system remains in the exercise of routine In this context, the Full STEAM project aims to make an approach to science teaching (pure and applied) strongly based on interdisciplinary relationships, in particular, with the arts. To do this, several training sessions are planned for 2nd and 3rd cycle teachers of the following subjects: Natural and Physical-Chemical Sciences, Mathematics, Technologies, Visual Arts and Music.

As an alternative to the more traditional teaching-learning models, the training experiences to be developed will be, above all, outdoor activities, exploring nature in full contact with it. Guided by the documents that define the current curricula of the various disciplines mentioned above, the work will aim to create learning scenarios applicable/adaptable to the students' educational needs.

Since this is an international project - with teachers from Finland, Iceland, Latvia and Portugal - the training sessions will have English as common language (the working groups will all be multinational). This group of teachers has varied backgrounds within the disciplinary areas mentioned above and, as it is easy to predict, they will bring to this training session the novelties inherent to their teaching experiences in education systems different from ours.

In this way, it is hoped that, at the end of the training action, the trainees will return to their schools richer from a pedagogical point of view and motivated to create STEAM activities in articulation with their colleagues, making full use of the natural environment surrounding our schools.

Full STEAM – An approach to the teaching of science in non-formal contexts

September 6 - Tuesday

Morning

Presentations

The project: "Full STEAM"

The participants (trainers and trainees):

Breaking the ice

Sharing experiences in teaching with science

BREAK

The teacher training program

Training teachers in pedagogical isomorphism

Teaching science in diverse settings

Assessing – Building an Ephemeral Map

Afternoon

Activity 1 – *Geodiversity and biodiversity at the seashore* - Field Trip

Topics to be addressed: Biodiversity, Taxonomy, Food Chains, Food Webs, Seashore Topography.

Disciplinary areas covered: Biology, Geology, Math and Arts.

Starting point: Exploring a "Field Guide" book about ocean species; Exploration question - Which kinds of creatures you would like to find in this environment?

Field activity: describing seashore topography (drawing and taking pictures respecting the scale); observing and identifying different species of living beings; gathering data about the distribution, in space, of certain species; finding trophic relations between different species. Discussion and conclusion.

September 7 - Wednesday

Morning

Activity 2 – *Biodiversity in blue* - Cyanotypes

Topics to be addressed: Biodiversity, Taxonomy, Algal anatomy, Exotic Species, Environmental Threats, Symmetries, Patterns, Scales, Photography.

Disciplinary areas covered: Biology, Math and Visual Arts.

Starting point: Organizing and analyzing the specimens collected during the field trip to the beach. Exploration question – How can we present the pros and cons of algal biodiversity?

Workshop: Identifying algae specimens (Taxonomy); Investigating algal Biology and Ecology; Researching about the uses for different kinds of algae; Organizing algae according to a chosen criterion; Creating Cyanotypes to present different facts about the studied algae.

BREAK

Building an Ephemeral Map (part 1)

Afternoon

Activity 3 – *Geodiversity and biodiversity in the forest* - Field Trip

Topics to be addressed: Biodiversity, Geodiversity, Soil, Taxonomy, Senses, Sound.

Disciplinary areas covered: Biology, Geology, Visual Arts and Music.

Starting point: Collecting evidence from the forest; Exploration question - Which adaptations do some creatures have to better adapt to living in a forest?

Field activity: collecting parts of organisms who live in the forest (roots, leaves, flowers, fruits, seeds, exoskeletons, droppings…); recording sounds from the forest; gathering samples of rocks and soils; organizing all the materials collected to integrate in the ephemeral map.

September 8 - Thursday

Morning

Activity 4 – *Visit to the Museum of Gunpowder Factory*

Topics to be addressed: Chemical Elements, Natural Elements, Engineering, Problem Solving, Hydric Resources, Cyclic Phenomena, Timelines, Musical Sounds, Reflection and Refraction.

Disciplinary areas covered: Chemistry, Physics, Math, Visual Arts and Music.

Starting point: Collecting information during the visit to the Museum. Exploration question – What is the importance of the chemical and natural elements to produce gunpowder?

Visit to the museum: Gathering information about gunpowder's history; Identifying the main challenges to the production of gunpowder and the solutions found to overcome them.

Afternoon

Building an Ephemeral Map (part 2)

September 9 - Friday

Morning

Finishing and presenting the Ephemeral Maps

Review of the highlights of this training course.

Recommendation:

Because our training course will revolve around non formal settings to develop STEAM activities, we are planning three field trips (FT):

FT 1 – *Geodiversity and biodiversity at the seashore*

FT 2– *Geodiversity and biodiversity in the forest*

FT 3– *Visit to the Museum of Gunpowder Factory*

Therefore, we would like to recommend that you choose clothing and footwear compatible with those settings, namely:

- Good walking shoes or sandals (with stripe around ankle) that can get wet. Soles must have good grip for maximum security when walking over the rocky terrain (see example in the image on the right).

- A spare set of shoes or sandals to change.
- Shorts, bathing suit or pants which will get wet during our visit to the seashore.
- Extra set of pants or shorts to change.
- Warm sweater because seashore can be windy and (often) chilly.
- Hat

-

STEAM Education in Non-Formal Contexts, a brief overview

The integration of the STEAM approach (Science, Technology, Engineering, Arts, and Mathematics) with non-formal learning scenarios represents a powerful and dynamic method for fostering creativity, critical thinking, and problem-solving skills among learners. Unlike traditional classroom settings, non-formal learning occurs outside the formal education system and often includes activities such as workshops, community projects, field trips, and maker spaces, which allow for hands-on, experiential learning.

In this context, the combination of STEAM and non-formal learning scenarios offers several benefits:

1. Encouraging Interdisciplinary Learning

One of the primary strengths of the STEAM approach is its emphasis on the interconnectedness of disciplines. Science and technology are not isolated from the arts and mathematics; rather, they complement and inform one another. Non-formal learning environments provide the flexibility to explore these interdisciplinary connections in real-world settings.

2. Fostering Creativity and Innovation

Non-formal learning spaces are often less structured than formal classrooms, which allows for greater freedom and creativity. The integration of the arts within the STEAM framework enhances students' ability to think innovatively and approach problems from multiple perspectives. By engaging in artistic activities—such as visual arts, music, or storytelling—students are encouraged to express themselves in ways that traditional STEM disciplines may not always facilitate. This creative expression is particularly important in problem-solving, as it fosters adaptability and out-of-the-box thinking.

3. Promoting Active, Hands-On Learning

Non-formal learning emphasizes experiential learning, where students engage actively with the content, often through practical activities or projects. The STEAM approach thrives in this context, as it encourages learners to experiment, test hypotheses, and engage in real-world applications of theoretical knowledge. Whether through coding a robot, designing a bridge, or creating a piece of interactive art, students are empowered to apply what they learn in meaningful ways. This hands-on approach not only deepens understanding but also helps learners develop valuable skills like collaboration, perseverance, and critical thinking.

4. Catering to Diverse Learning Styles

Non-formal learning environments tend to be more flexible in terms of teaching methods and assessment, which is particularly beneficial for students with different learning styles. Some students may excel in traditional academic settings, while others thrive in environments where they can learn through doing, creating, and exploring. By combining STEAM with non-formal learning, educators can cater to a broader range of learners. For example, students who struggle with abstract concepts in mathematics might find it easier to grasp these ideas by building physical models or engaging in interactive simulations.

5.Encouraging Collaboration and Social Learning

Non-formal learning environments often emphasize group activities and collaboration, which aligns well with the STEAM approach's focus on teamwork and communication. By working together on projects, students learn how to share ideas, resolve conflicts, and develop collective solutions. This collaborative aspect is essential in the modern world, where many of the challenges we face require interdisciplinary teams.

6. Building Real-World Connections

Non-formal learning also offers students the opportunity to connect their academic learning with real-world contexts. STEAM activities in these settings often involve partnerships with local businesses, museums, universities, or other organizations, helping learners understand how their skills are applied in various professions.

7. Nurturing Lifelong Learning

Finally, non-formal learning fosters a mindset of lifelong learning. The flexible, often self-directed nature of these settings encourages curiosity and self-motivation. When combined with the diverse, hands-on, and multidisciplinary elements of the STEAM approach, it inspires learners to continue exploring, creating, and learning long after the activity ends. This is particularly important in today’s rapidly changing world, where the ability to adapt and keep learning is essential for success.

Conclusion

The synergy between the STEAM approach and non-formal learning scenarios represents a dynamic model for education that prepares students for the complexities of the modern world. By blending science, technology, engineering, arts, and mathematics in creative, collaborative, and real-world contexts, learners are empowered to think critically, innovate, and approach challenges with confidence. This combination not only enhances academic outcomes but also equips students with the skills and mindset needed for lifelong learning and active participation in society.

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To begin:

FullSTEAM:an approach to science teaching in non formal settings.

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Erasmus+ Programme
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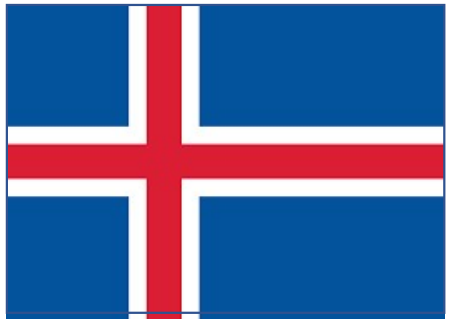

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Full STEAM

Main objectives:

- Implementation of teaching/learning activities through a STEAM approach
- Using of non-formal/informal contexts

  - Teachers 2nd and 3rd cycle (students 10-14 years old)

Activities

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Full STEAM

- Join training actions (2)
  - September 2022 in Portugal
  - ?? 2023 in Finland

4 days
2 teachers/PT partner
4 teachers /others partners

Outcomes:

- motivation to apply the methodologies after training
- new collaborations
- share the knowledge with others

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TEACHER TRAINEES' PROFILE

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Full STEAM

Training teachers to LEAD in teaching with a STEAM approach, in diverse settings

Inspiring those who need to be inspired!

8

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Full STEAM

Training teachers to LEAD in teaching with a STEAM approach, in diverse settings

Inspiring those who need to be inspired

This teacher training course was designed for teachers who:

- Help other teachers to implemente activities with a STEAM approach, in diverse settings – Do it willingly!
- Believe in the importance of learning in multidisciplinar contexts – If you believe, it will show!
- Expect results on the long run – Stay positive!

Training teachers to lead in teaching with a STEAM approach, in diverse settings

The role of the teachers taking the lead:

- Be humble enough so that you (really) listen to your colleagues, setting a good example when you need to be heard;

- Be ready to tell you colleagues what to do, being prepared to show them how to do it (if needed).

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Full STEAM

Training teachers to lead in teaching with a STEAM approach, in diverse settings

Planning and organizing STEAM activities implicates:

- ✓ Deep knowledge of *curricula*: natural sciences, social sciences, math, IT, mother language and arts;
- ✓ Planning for the moment and for the future;
- ✓ Planning ahead allows for discussion and managing resources;
- ✓ Delegate when possible.

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THE CHARACTERISTICS OF THIS TEACHER TRAINING PROGRAM

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The characteristics of this teacher training program

- Training teachers in pedagogical isomorphism
- Teaching science in diverse settings
- Assessing – Building an Ephemeral Map

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Training teachers in pedagogical isomorphism

- Most of the time, during this teacher training action, teachers will be experiencing the activities as if they were their own students.

- Pedagogical isomorphism helps to develop empathy towards our students, since we experience the same difficulties, frustrations, curiosities… and (above all) the pleasure of discovering the world around us.

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Teaching science in diverse settings

- The STEAM approach to teaching provides plenty of diverse settings to study Science, Technology, Engineering, Art and Math, in a very integrated manner.

- Stepping outside the classroom (garden, stream, beach, forest, museum, research lab, …) to teach demands creativity and planning. But the outcome is excellent, for (usually) students find motivation in situated learning and, therefore, tend to get more involved in the activities, showing skills that are seldom required in classroom.

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Assessing – Building an Ephemeral Map

- Evanescent elements such as memories, stories, sensations and perceptions are just as much a part of places as more physical and tangible objects such as landmarks, biodiversity distribution, rock formations and topography.

- The ephemeral map is a strategy to display information gathered during an outdoor activity; this information is then used to create a narrative about the activity. All kind of information is welcome, as long as it will be included in the narrative presented at the end.

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Full STEAM

Assessing – Building an Ephemeral Map

- Because of the its ephemeral essence, in the end of its presentation, the map is disassembled and discarded. Therefore, the educational focus should be in the creative process rather then the final outcome. This approach potentiates the engagement of students in every step of their creation.

- The ability to collect and display information for an ephemeral map requires accuracy and creativity. Consequently, it is a methodology well suited for a STEAM activity.

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GEODIVERSITY AND BIODIVERSITY AT THE SEASHORE
FIELD TRIP

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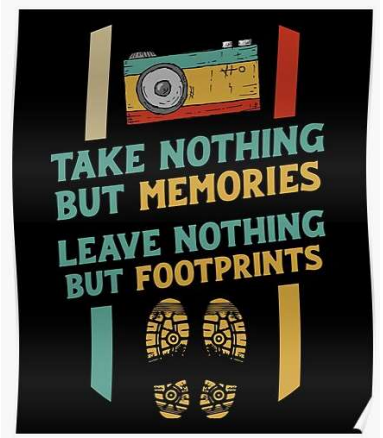
Pedagogical approaches to a field trip

- Connecting the classroom to real world
- Training students to investigate outside: use the school grounds often
- Choosing a problem to investigate
- Taking the most out of a field trip: pre-visit lesson(s) and post-visit lesson(s)

Planning for a field trip

- Encouraging other teachers to include field trips in their practice (any field trip can be “used” in several school subjects!)
- Organizational Issues (people, place, security…)
- Working documents for the students
- Listing the materials needed



- **Activity 1 – *Geodiversity and biodiversity at the seashore* - Field Trip**
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  - **Disciplinary areas covered:** Biology, Geology, Math and Arts.
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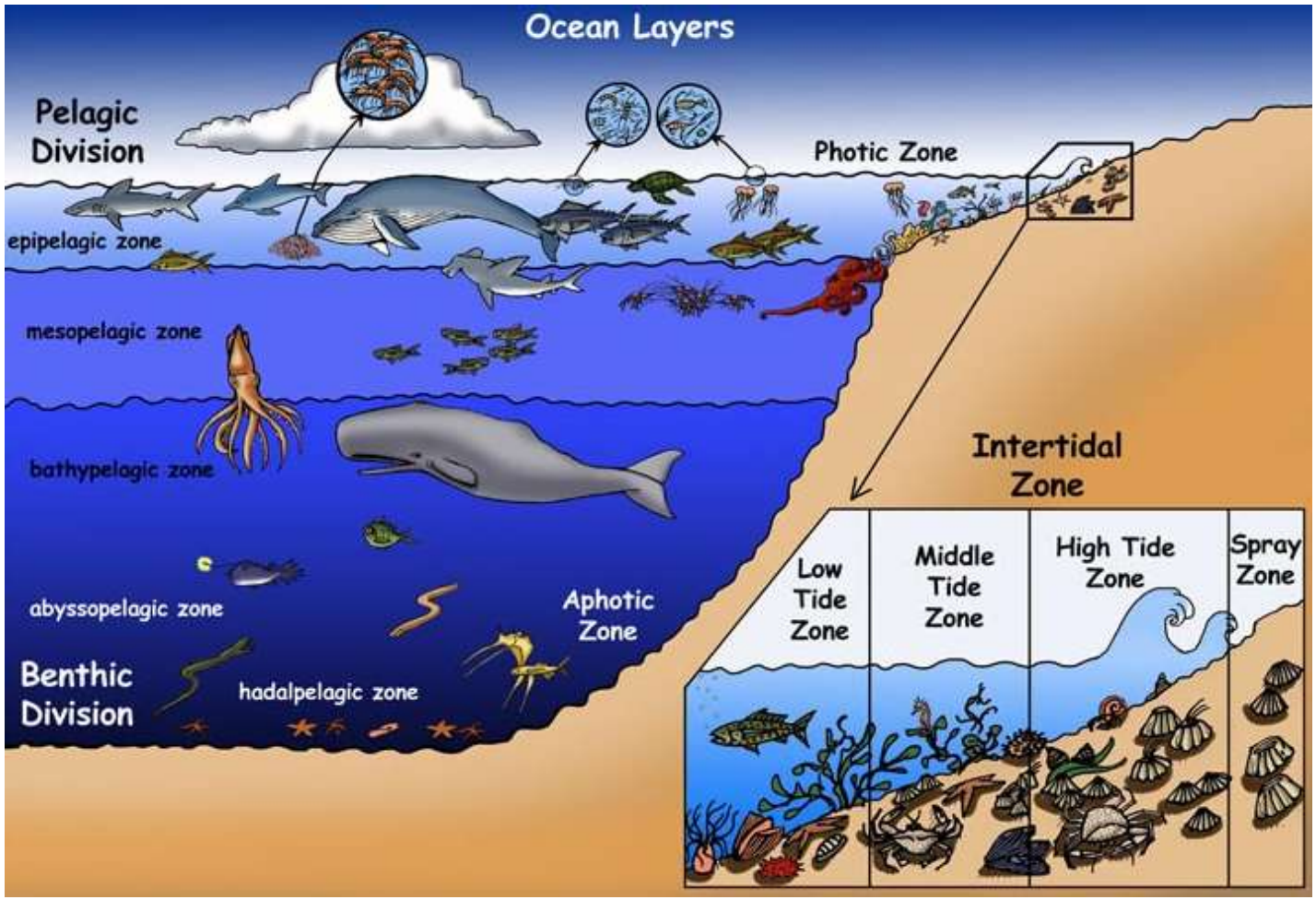
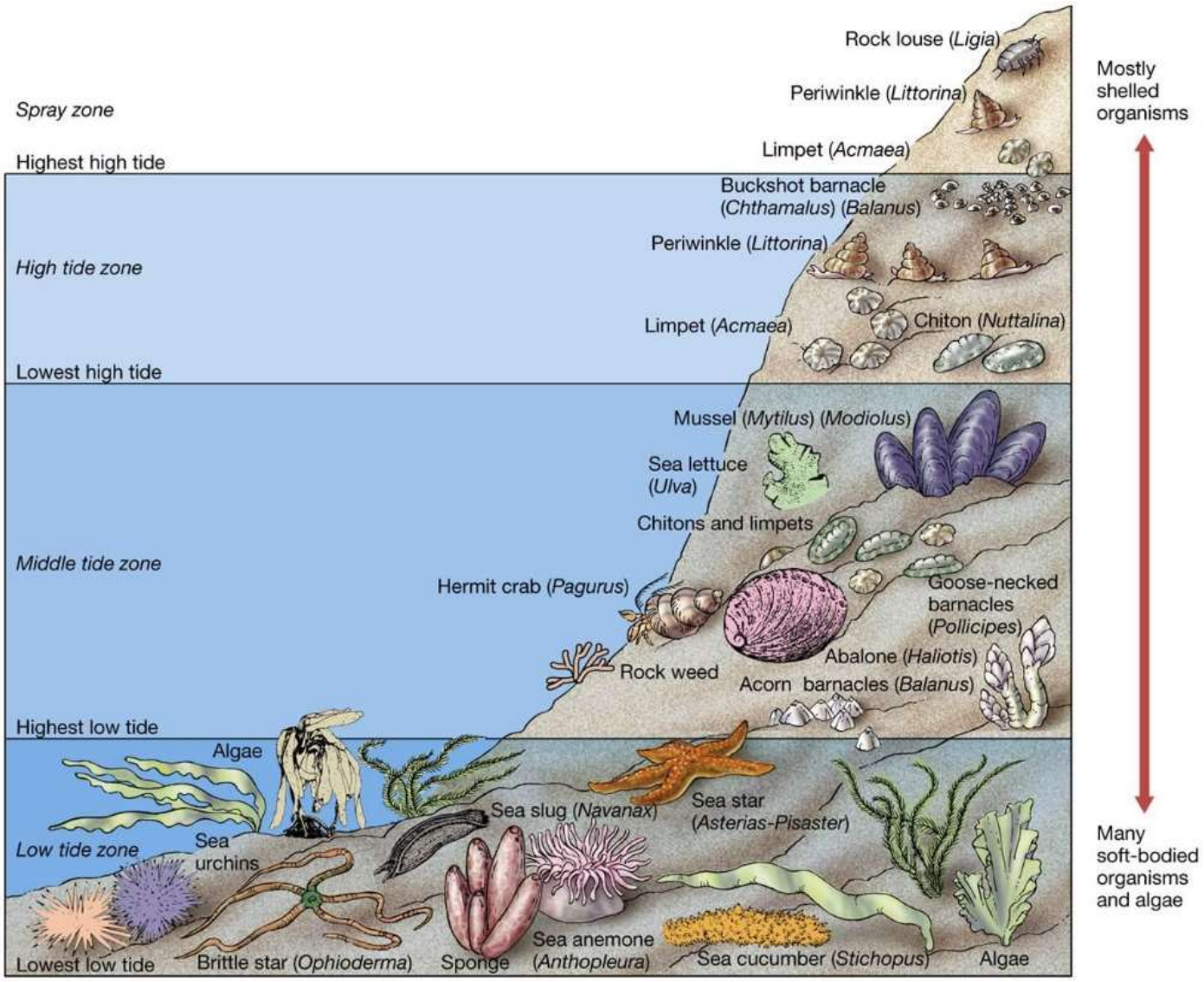
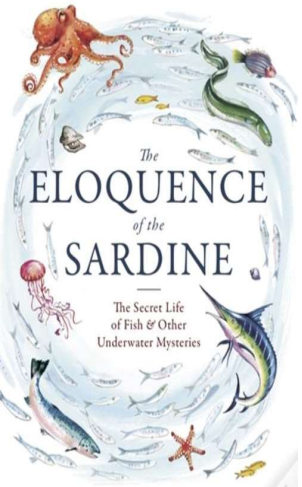
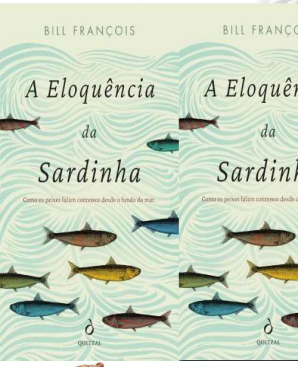
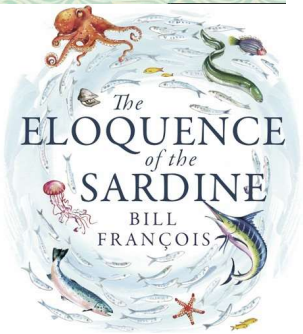

Ocean Layers
Pelagic Division
Photic Zone
epipelagic zone
mesopelagic zone
bathypelagic zone
abyssopelagic zone
Aphotic Zone
Benthic Division
hadalpelagic zone
Intertidal Zone
Low Tide Zone
Middle Tide Zone
High Tide Zone
Spray Zone




Octopus
Small octopuses are common—but very shy! They are not often seen by people.
Mussels
Mussels often grow in clumps.
Anemone
A sea anemone looks like a plant, but it's actually an animal.
Crab
Many small crabs live in tide pools.
Hermit Crab
These crabs live in the old shells of other creatures.
Sea Star
ea stars move slowly on
hundreds of tiny feet.







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Full STEAM

"The sea is full of sounds, even more so than the air we inhabit. Sound is simply a vibration of matter. Water, which is denser than air, vibrates better, and therefore transports sound better. Underwater, sound travels further than light, crossing miles and miles without fading. The voices of the sea contain sounds from far away, signals whose sources are impossible to see. Noises we'd never dream of hearing from the beach, noises that connect us to their remote origins.

Like the various instruments of an orchestra, each voice of the sea has its own distinctive note and wavelength, and sings its story in its own timbre."

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“First you hear the bass notes. Underwater, the background noise is a low-pitched sound. It rumbles and thunders like a kind of snore. This noise, the most intense sound in the sea, is the echo of various elements: waves crashing on to the shore, winds sweeping the surface, but also the earth and all its whims. You can hear in it the cracking of the polar icebergs, the grinding of earthquakes along the ocean ridges, the gust of distant storms…

Above these low notes you can distinguish long violin vibratos reverberating for dozens of miles. These are the grinding sounds of ships' engines, the screech of metal, the hissing of screws. Maritime routes are as noisy as our motorways, but can be heard from much further away. A passing container ship makes as much noise underwater as an airplane taking off does in the air, and traffic at sea generates background noise every bit as intense as a busy street.”

“Although scallops don't use this sound to talk to each other, they communicate a great deal to us. By listening to their song and studying the frequency of their clackings, we can learn whether their water is pure or polluted, and how numerous their predators are. They provide oceanographers with information about the state of the sea and the biological health of their environment. With their concert of sneezes, scallops illuminate for scientists some of the mysteries of their strange lives.

Underwater ambient noise is a mishmash of sounds, a mother lode of noise, in which all the dissolved voices of myriads of invisible beings share their stories. From the storm to the water molecule, the blue whale to the shrimp, each plays its own instrument in the orchestra, tossing its own sprinkling of notes into the mix. Science and our imagination try to give meaning to this hubbub, offering various interpretations of such a confused and wonderful dream. What a delightfully dizzying idea, to think that we can hear the echo of all those stories and all those voices speaking to us through the gurgling of our waterlogged ears!

Let’s explore these secret stories together.”

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Anna Atkins' algae cyanotypes

British botanist and photographer, Anna Atkins was a pioneer in photography: she produced the first ever photographically illustrated book and is widely recognised to he first ever female photographer.

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Full STEAM

GROUP WORK

Collecting thoughts, feelings and things for our ephemeral map

The Shadows of the Plants

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Cyanotype and botany

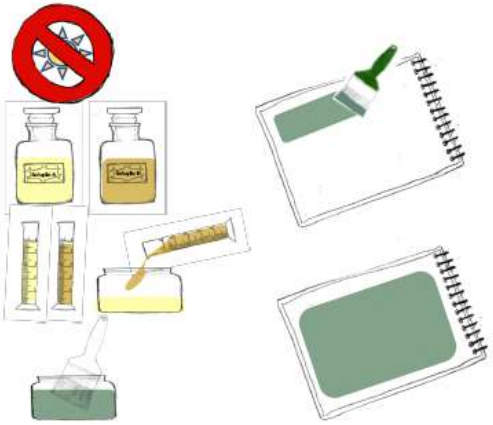
The English botanist and photographer Anna Atkins discovered in 1842 a process of photographic printing in blue tones or cyan. Using this technique, Anna Atkins produced a series of images documenting ferns and algae as well as other plants.

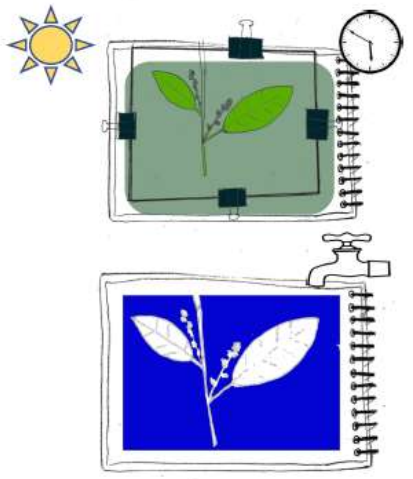
Heliography, botany and art

The Madeiran artist Lourdes Castro has captured the shadows using the technique of heliography. In 1972 the artist collected the remains of about 100 species existing on the island of Madeira and published the Large Herbarium of Shadows

Cyanotype Process:

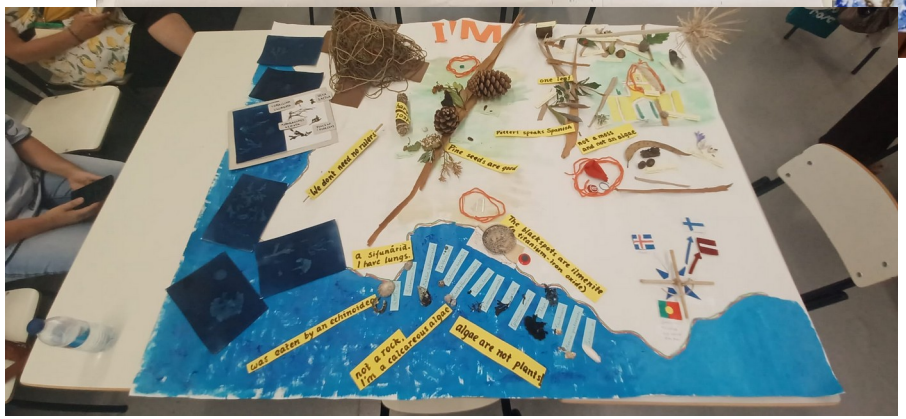
1. The process uses two aqueous solutions of 20 % ammoniacal ferric citrate ammoniacal ferric citrate (Solution A) and 16 % potassium ferricyanide potassium ferricyanide (Solution B) which are mixed in equal parts.
2. Paint a piece of paper (preferably watercolour) with this mixture and leave to dry in the dark.
3. Place the plant on the paper to capture its shade. Leave in the sun for about 10 minutes.
4. Wash the paper with water and leave to dry in the shade.





Training action outputs:

Ephemeral Map



Training action evaluation (by the trainees):

In the end of the teacher training course the trainees wrote a report about this training experience. Here, it will be presented the results of a content analysis based on those reports, targeting, in particular, the remarks made concerning the way this teacher training course was designed, as well as the expected impact that this training experience will have in the trainees' pedagogical practice.

Course valued characteristics:

O Trainers observed and valued trainees' abilities individually;

O Trainees were not afraid of being judged;

O Peaceful environment where working was really enjoyable;

O Very pleasant working atmosphere;

O A good way to face professional burn-out;

O Project work was very well prepared;

O Trainees had to act as their students, potentially experiencing their feelings;

O Know more about the educational realities of other countries;

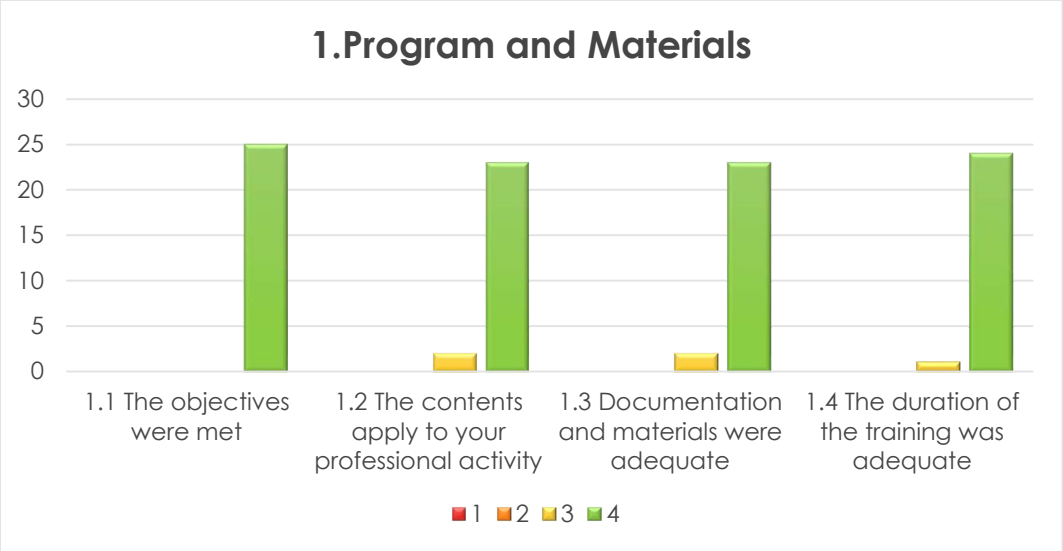
O Group work in multinational members;

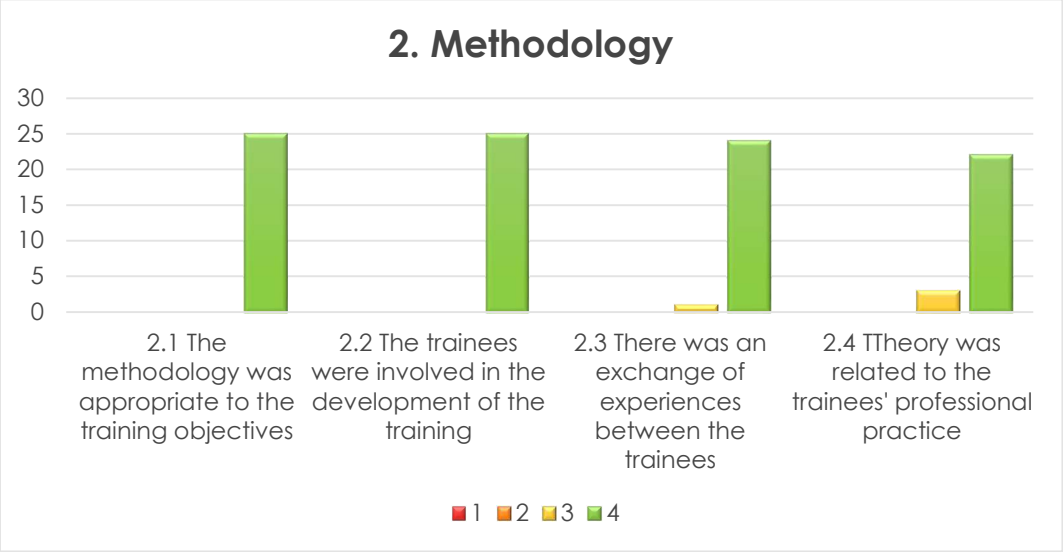
O Sharing of experiences from different people with the same professional goals;

O Good communication skills of the trainers helped to build group complicity and stimulate trainees' participation;

O Realize that field trips are, in essence, fundamental to creating effective links between the classroom and the real world.

Also, a 6 questions evaluation survey was applied. The results are presented in the graphs below:


1.Program and Materials
30
25
20
15
10
5
0
1.1 The objectives were met
1.2 The contents apply to your professional activity
1.3 Documentation and materials were adequate
1.4 The duration of the training was adequate
1
2
3
4


2. Methodology
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25
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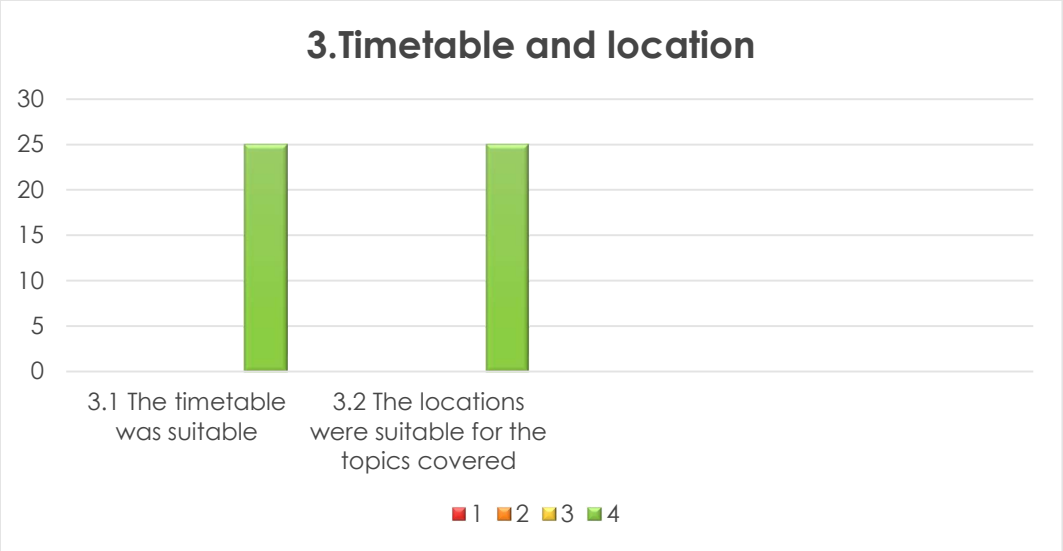
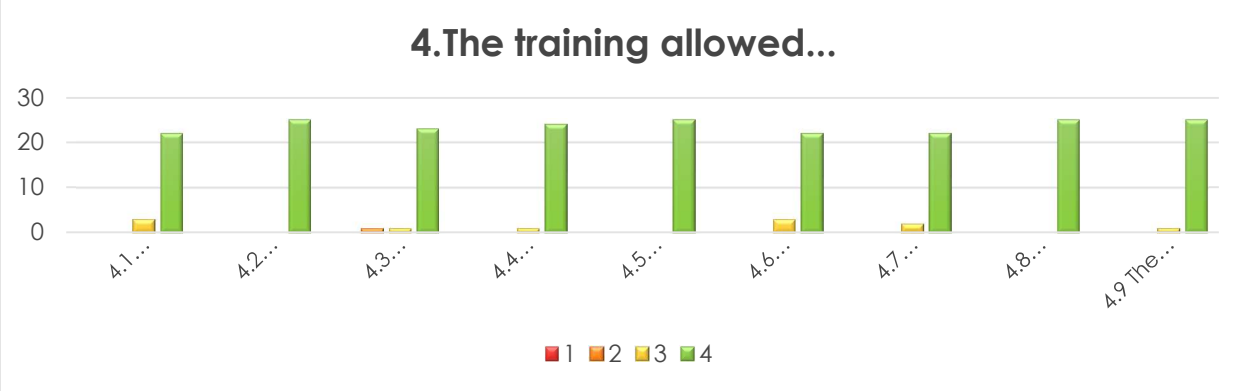
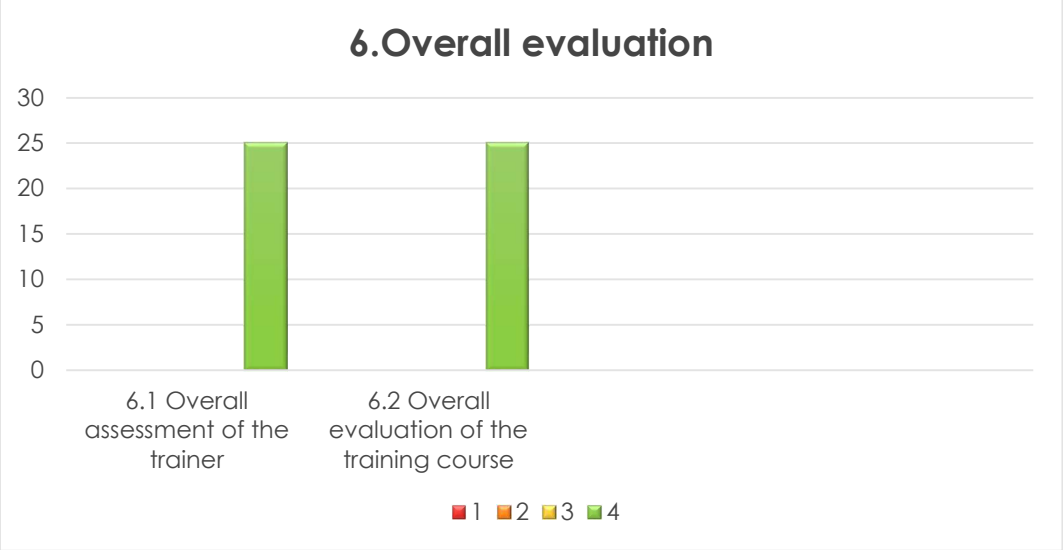
10
5
0
2.1 The methodology was appropriate to the training objectives
2.2 The trainees were involved in the development of the training
2.3 There was an exchange of experiences between the trainees
2.4 TTheory was related to the trainees' professional practice
1
2
3
4





4.1 Provide a better basis and framework for planning
4.2 Developing/improving teaching strategies
4.3 Developing/improving assessment strategies
4.4 Improving communication with students
4.5 Managing outdoor activity
4.6 Recall/consolidate acquired knowledge
4.7 Acquiring new knowledge about the subjects
4.8 Reflecting on practice
4.9 The training met my training needs


5.Trainer
30
25
20
15
10
5
0
5.1 The trainer communicated effectively
5.2 The trainer promoted the participation of the trainees
5.3 The trainer showed proficiency and up-to-date knowledge of the topics
5.4 The trainer was able to clarify the issues raised
1 2 3 4


6.Overall evaluation
30
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6.1 Overall assessment of the trainer
6.2 Overall evaluation of the training course
1 2 3 4