BLUE MINDS 4 TEACHERS

BOOKLET OF

LESSON PLANS

Table of contents

Authors: Francesca Alvisi, Maria Cheimonopoulou, Valentina Ferrante, Yolanda Koulouri, Maria Filomena Loreto, Melita Mokos, Camilla Palmiotto, Ivana Zubak Čižmek

Graphics by: Debora Mazza, Maria Cheimonopoulou

#EU4Ocean #Youth4Ocean #EUBlueSchools

The project BlueMinds4Teachers is implemented with the support of the EU4Ocean Coalition funded by the European Commission.

Ocean Literacy: the concept

The concept of Ocean Literacy (OL) was defined in the early 2000s by a community of US marine educators and researchers as the understanding of how the ocean affects humans and how humans affect the ocean. This community demonstrated the lack of marine topics and content in formal education in the US and the need to include ocean science in national and state curricula. The conceptual framework is considered the ABC's of the ocean and includes fundamental knowledge and understanding about the ocean and its connection to climate, ecosystem functioning and human society (https://oceanliteracy.unesco.org/principles/). It consists of 7 main principles:

1. Earth has one big ocean with many features.
2. The ocean and life in the ocean shape the features of Earth.
3. The ocean is a major influence on weather and climate.
4. The ocean makes Earth habitable.
5. The ocean supports a great diversity of life and ecosystems.
6. The ocean and humans are inextricably interconnected.
7. The ocean is largely unexplored.

The ocean covers more than 70 per cent of the Earth's surface and is therefore a fundamental feature of planet Earth. Its importance to the Earth's ecosystem, including human society, is fundamental. The ocean provides essential services including oxygen production, climate regulation, biogeodiversity contribution, food supply and economic value. However, human activities in recent decades such as the consumption of fossil fuels, overexploitation of its resources, pollution and habitat destruction, population growth along the coasts have put significant pressure on the ocean, leading it to deterioration and jeopardising the stability and future of coastal and deep-sea environments and marine ecosystems. For this reason, ocean literacy can help create a society that is more aware of these issues, but also empower it to take more responsible actions that lead to a more sustainable use of the ocean.

The project BlueMinds4Teachers

Following the first European conference on OL, held in 2012, the European Marine Science Educators Association (EMSEA: https://www.emseanet.eu/) was formed to promote OL and be a reference point in Europe and beyond. Over the past 12 years there have been many European OL projects and initiatives and BlueMinds4Teachers was one of them. Funded by the European Commission through the EU4Ocean Coalition, it aimed to strengthen the OL skills of teachers and educators at all levels through collaboration with marine researchers, educational and social scientists, the European Blue Schools Network and the Youth4Ocean Ambassadors. Furthermore, the project aimed to shed light on the connection between marine and freshwater environments, which is one of the missing links in many curricula. BlueMinds4Teachers contributed to improving the ability of teachers and educators to address OL issues and to integrate them into the school curriculum and non-formal education towards sustainability education.

The BlueMinds4Teachers project was coordinated by the Institute of Marine Biology, Biotechnology and Aquaculture of the Hellenic Centre for Marine Research (HCMR-IMBBC, Greece) in partnership with the Institute of Marine Science of the Italian National Research Council (CNR-ISMAR, Italy) and the University of Zadar (UNIZD, Croatia).

LESSON PLAN

PRINCIPLE #1

LET'S DISCOVER THE OCEAN FLOOR!

By Francesca Alvisi, Valentina Ferrante, Maria Filomena Loreto, Camilla Palmiotto

LESSON PLAN	PRINCIPLE #1
Title	**Author(s) Name(s) Surname(s)**
Let's discover the ocean floor!	Francesca Alvisi, Valentina Ferrante, Maria Filomena Loreto, Camilla Palmiotto

OL principles	Duration of the activities	Target age	Main SDG(s)	Other SDG(s)
1, 2, 3, 4, 5, 6, 7	60 min (lesson) + 2 hours (lab)	8+	14 (14.2; 14.4; 14.5; 14.7; 14a; 14c)	4, 7, 8, 9, 10, 11, 12, 13, 15, 16

Cognitive learning objectives	I. The learner is aware of the different shape of seas and oceans basins and morphology of the seabed, as well as their geological history/origins. II. The learner understands the need of different management approach to different spatial context of the maritime zones. III. The learner better understands the connection between land and sea, coastal area and deep sea, as well as the human influence on the marine environment and life there, including the role of geodiversity as a determinant of biodiversity.
Socio-emotional learning objectives	I. The learner can understand/accept the natural complexity. II. The learner can influence groups that engage in unsustainable use of high seas ocean resources. III. The learner can empathize with people with a different cultural approach to marine resources use.
Behavioral learning objectives	I. The learner can research their country's (inter)dependence on the sea. II. The learner can share knowledge and experience with their representatives and peers to discuss about marine issues. III. The learner can raise awareness on marine issues in the local community and beyond.
Focus on, with reference to UNESCO ESD* multi-perspective approach	✓ The scientific perspective ✓ The historical perspective ✓ The geographic perspective

	✓ The gender equality perspective ✓ The values perspective ✓ The cultural diversity perspective ✓ The sustainability perspective
Introduction or background information/ content necessary for teachers to conduct the activity	This activity could be well developed with teachers from different disciplines i.e. geography, science, history, biology, civics, economy. They will need some knowledge of basic geology (i.e., plate tectonics, rock cycle), geomorphology, cartography, and some skills to find topographic/bathymetric maps online to use in the lab. Watch this video by GEBCO (General Bathymetric Chart of The Oceans) to focus on the topic: https://www.youtube.com/watch?v=A-zIiM6uAzE Read the book of Charles Darwin "A Naturalist's Voyage Round the World" (chapter n. 1, 9, 17, 18, 20, 21) to: ● understand how plate tectonics on a global scale creates geodiversity, in this case of oceanic islands, which in turn underlies the biodiversity of our planet; ● convey to the pupils the wonder of the work of the marine geologist, showing images of some oceanographic campaigns research scientists participated over the years.
A list of necessary materials and included attachment to conduct activity, e.g., Pupil Instruction Sheet(s), Diagrams, Maps, Tables, Data Sets, etc.	✓ Pen/pencil, bathymetric map of a marine area (n. 2 copies), glue for paper, scissors, recycled cardboard sheets (enough sheets to complete the 3D model), colours for paper (e.g. brown, blue, white, black), toilet or kitchen paper ✓ How to make a 3D map: https://www.youtube.com/watch?v=AZ7lWrqidgk ✓ Site analysis 3D model: https://www.youtube.com/watch?v=j6BQ3VZt_tE
Steps the pupils will need to complete	1. Read the book of Charles Darwin "A Naturalist's Voyage Round the World" (chapter n. 1, 9, 17, 18, 20, 21). 2. Watch introductory videos and tutorials. 3. Explore a map of the world without water to discover the main characteristics of ocean morphology (i.e., seamounts, abyssal valleys, mid-ocean ridges…). 4. Discuss in the classroom which oceanic or marine feature (e.g., oceanic islands, ocean basins, submarine volcanoes) to represent

	with the 3D sketch model, why and how (vertical and horizontal scales, themes, legenda, etc.). 5. Get the topographic/bathymetric map of the chosen area and print it in two copies (full area in 1 sheet or enlarge it and print on more sheets). 6. Define working groups in charge of building the 3D model (each group will contribute a piece of the model or a part of the job). 7. Within each group, each pupil should choose his/her own role (designer, cutter, tracer, assembler, finisher, etc.). 8. After building the model they should add the themes and legenda, etc. 9. They could present their results in public events such as school days, science festival, local community celebration, etc.
Teaching tips and strategies, including eventually discussion questions	➢ Navigate and observe the different setting of oceanic and marine basins, and seafloor structures. ➢ Try to explain why they are different (geomorphology, geology, geographic. location, marine resources, threads, etc.) and how (shape, depth, relationship with the continents, etc.). ➢ Make sure that pupils choose on the base of an interest and not by chance. ➢ Circulate their decision and position papers within the classroom and discuss them. ➢ Make sure pupils get to the final realization of the 3D model and related information.
Assessment Strategies, and learning outcomes defined	I. Capacity to do teamwork and to participate in class discussions II. Constructive feedback III. Creativity demonstrated in outputs (e.g., 3D models and hands-on activities) IV. Filling in a questionnaire pre- and post the activity by pupils and teachers V. Ability to reflect on learning and make between land and sea, coastal area and deep sea, as well as the human influence on the marine environment and life there, including the role of geodiversity as a determinant of biodiversity
Additional suggestions for conducting the activity with younger and/or	**Younger pupils** Reduce the complexity of the area to be represented (i.e. smaller area, simplified isobaths, few layers, use different materials such as paper or clay, etc.). Choose an example close to home (even a lake basin).

older audiences and in a non-formal setting	**Older pupils** Deepen the study of the basin characteristics, its marine resources, uses and management, to produce a raise in the awareness on the link between shape and characteristics (i.e., geodiversity vs. biodiversity). **Non-formal settings** This activity can be used as a hands-on activity during public events, even with a former preparation of the different layers/sections to be used as 3D puzzles.
Additional resources, e.g., websites, printed material, software, data sets, etc.	Introduction to Topographic Maps: https://www.youtube.com/watch?v=zqPMYGDxCr0 Understanding Topographic Maps: https://www.youtube.com/watch?v=L1AWNR-Y0pQ Visualizing Contour (Topographic) Maps In Google Earth: https://www.youtube.com/watch?v=55BNufFfXdc Global Seafloor Update in Google Earth: https://www.youtube.com/watch?v=_NBFjVY6kKc Google Earth Bathymetry and Nautical Charts: https://www.youtube.com/watch?v=P8T4KiRSV-M Workshop *How deep is the sea?* (Ocean Literacy section: Activity & Material, page bottom) (in Italian): https://sites.google.com/view/camminandosulletraccedelmare/ocean-literacy/attivita-e-materiali Video-tutorial for building 3D models: https://sites.google.com/view/camminandosulletraccedelmare/ocean-literacy/attivita-e-materiali/com%C3%A8-profondo-il-mar
References used to develop the activity	Palmiotto C., 2022. CNR-ISMAR Technical Report, 14: 1-16 (in Italian): https://www.ismar.cnr.it/wp-content/uploads/2022/11/rapporto-tecnico-14-ismar-cnr.pdf HMS Beagle: Darwin's Trip around the World: https://education.nationalgeographic.org/resource/hms-beagle-darwins-trip-around-world/
EU Blue Schools criteria	**Compulsory criteria** ✓ Produce a clear output (e.g., 3D models, maps, presentations). ✓ Develop a project interlinked with other school subjects. ✓ Involve all pupils. ✓ Collaborate with a local partner (e.g., marine geologist). ✓ Communicate project results (e.g., write an article for school journal).

	Optional criteria ✓ Provide authentic learning experiences (e.g., fieldwork and lab activities). ✓ Work multi- or interdisciplinary (e.g., language, geology, music, arts). ✓ Mobilize beyond the classroom (e.g., peer-to-peer education). ✓ Foster a land-sea interaction. ✓ Bring in a European dimension (e.g., e-Twinning).

Note: *ESD = Education for Sustainable Development

LESSON PLAN

PRINCIPLE #2

FROM THE DEEP SEA TO THE MOUNTAIN AND BACK: DISCOVER THE LONG TRIP OF THE ROCKS!

By Francesca Alvisi, Valentina Ferrante, Maria Filomena Loreto, Camilla Palmiotto

LESSON PLAN	PRINCIPLE #2
Title	**Author(s) Name(s) Surname(s)**
From the deep sea to the mountain and back: discover the long trip of the rocks!	Francesca Alvisi, Valentina Ferrante, Maria Filomena Loreto, Camilla Palmiotto

OL principles	Duration of the activities	Target age	Main SDG(s)	Other SDG(s)
1, 2, 3, **4, 5, 6, 7**	60 min (lesson) + 2 hours (lab) + 2 hours (tour)	9+	14 (14.1; 14.2; 14.3; 14c)	4, 9, 11, 12, 13, 15

Cognitive learning objectives	I. The learner is aware of the presence of a rock cycle. II. The learner knows about the three families of rocks and their main characteristics, origins and fate. III. The learner understands better the connection between land and sea and the influence of humans on the marine environment and its geo-resources, including the ocean role as a provider of raw materials, as well as their economic value.
Socio-emotional learning objectives	I. The learner can understand/accept the natural complexity. II. The learner can influence groups that engage in unsustainable use of high seas ocean resources. III. The learner can empathize with people with a different culture approach for marine resources use.
Behavioral learning objectives	I. The learner can research their country's (inter)dependence with the sea. II. The learner can share knowledge and experience with their representatives and peers to discuss about ocean issues. III. The learner can raise awareness on ocean issues in the local community.
Focus on, with reference to UNESCO ESD* multi-perspective approach	✓ The scientific perspective ✓ The historical perspective ✓ The geographic perspective

	✓ The human rights perspective ✓ The gender equality perspective ✓ The values perspective ✓ The cultural diversity perspective ✓ The sustainability perspective
Introduction or background information/ content necessary for teachers to conduct the activity	This activity could be well developed with teachers from different disciplines i.e. geography, science, history, biology, civics, economy. They will need some knowledge of basic geology and petrography, some skill/contact to find geological maps as well as know about regional geology, and local historical buildings info online to use in the lab. Watch the series of videos of "*Professor Dave explains*" to focus on the rock cycle topic: https://www.youtube.com/ProfessorDaveExplains ● Igneous rocks: https://youtu.be/k6MH4K35xiE?list=PLybg94GvOJ9E5VK94UujanWk45qM8rQuz ● Sedimentary rocks: https://youtu.be/HwBVL4AT7Wc?list=PLybg94GvOJ9E5VK94UujanWk45qM8rQuz ● Metamorphic rocks: https://youtu.be/0QTkumoJnuU?list=PLybg94GvOJ9E5VK94UujanWk45qM8rQuz ● Rock cycle: https://youtu.be/VByCLpj-I_s ● Physical weathering: https://youtu.be/NqF1per99lE ● Chemical weathering: https://youtu.be/JzsmkVUEy0Q Videos from IODP outreach: https://iodp.tamu.edu/outreach/education.html And some videos about the Use of stones in buildings: e.g., https://youtu.be/Y6O8Lo0cPak
A list of necessary materials and included attachment to conduct activity, e.g., Pupil Instruction Sheet(s), Diagrams,	✓ Samples of the most used local and non-local rocks ✓ Regional geological map ✓ Specimen trays; hammer and anvil; chisels, files, and awl; mortar and pestle; clamps; magnifying glass; work gloves and protective

Maps, Tables, Data Sets, etc.	goggles; little flasks with HCl, H_2O and H_2O_2 ✓ Pencils and note sheets ✓ If available for the city: N. 10 -15 Rock cards; N. 6 Architecture cards (n. 4 cards + n. 2 pavements) ✓ Each learner may express personal ideas and comments through an evaluation test.
Steps the pupils will need to complete	1. Watch introductory videos and tutorials. 2. Navigate with Google Earth, or similar, to investigate ocean as well as regional morphology / settings. 3. Meet expert at school / research centre to learn more about regional geology, continental margin geology, physical, petrological and geological characteristics of rock samples coming from different part of sub-seafloor as well as local town history / buildings. 4. Define working groups in charge of preparing the practical activity = each group will help build the demonstration/hands-on workshop. Within each group, each pupil will choose his/her own role. 5. Collect the rock samples in the field or by museums / research centres = one big piece for observation + a lot of small pieces for handling. 6. Choose the buildings + pavements to explore and use for the cards. 7. Create all rock and architecture cards by exploring the peculiar rock characteristics and their local use. 8. Test the rock technical / architectural characteristics in relation to their physical-chemical-mineralogical ones in the classroom. 9. Participate to the outdoor guided tour to visit the historical buildings with an expert and take notes. 10. Present and manage this hands-on activity as well as organise / manage the guided tour to / for peers in the school or in other schools or during citizens/families' public events such as school days, science festival, local community celebration, etc.
Teaching tips and strategies, including eventually discussion questions	➢ Navigate and observe the different characteristics of rock families and their relationship with their native environment. ➢ Focus on similarities and differences (shapes, colours, gloss, transparency, hardness, etc.) and relate them to technical

	characteristics and use in the building sector (historical vs. modern). ➢ Make sure that pupils choose on the base of an interest and not by chance. ➢ Ensure co-creation and participatory approach. ➢ Ensure that the pupils complete the final practical workshop and all the necessary materials. ➢ Make them practice both as workshop and guided tour leaders.
Assessment Strategies, and learning outcomes defined	I. Capacity to do teamwork and to participate to class discussions. II. Constructive feedback. III. Creativity demonstrated in outputs (e.g., hands-on activities). IV. Filling in a questionnaire pre- and post the activity by pupils and teachers. V. Ability to reflect on learning and make connections between land and sea, the human influence on the marine environment and its geo-resources, including the ocean role as a provider of raw materials, as well as their economic value.
Additional suggestions for conducting the activity with younger and/or older audiences and in a non-formal setting	**Younger pupils** Reduce the number of rock samples to be used (i.e., most common, beautiful, useful, well-known, etc.). Choose an example close to home. **Older pupils** Deepening the study of rock characteristics, its marine origins, its uses and its handling as a raw material, to produce an increased awareness of the link between lithological and technical characteristics, and the sustainability use of them. **Non-formal settings** This activity can be used as a hands-on activity during public events, with a former preparation of the material and the tour according to the local context.
Additional resources, e.g., websites, printed material, software, data sets, etc.	Available rock cards (in Italian): https://sites.google.com/view/camminandosulletraccedelmare/ocean-literacy/attivita-e-materiali/ Available Architecture cards (in Italian): https://sites.google.com/view/camminandosulletraccedelmare/ocean-literacy/attivita-e-materiali/

	Commission for the Geological Map of the World: https://ccgm.org/en/ UNESCO World Heritage List: https://whc.unesco.org/en/list/
References used to develop the activity	ISPRA Regional Geological Map 1:50.000 (in Italian): https://www.isprambiente.gov.it/Media/carg/
EU Blue Schools criteria	**Compulsory criteria** ✓ Produce a clear output (e.g., toolkit, maps, presentations). ✓ Develop a project interlinked with other school subjects. ✓ Involve all pupils. ✓ Collaborate with a local partner (e.g., marine geologist, architect, historian). ✓ Communicate project results (e.g., write an article for school journal). **Optional criteria** ✓ Provide authentic learning experiences (e.g., fieldwork and lab activities). ✓ Work multi- or interdisciplinary (e.g., language, geology, architecture, arts). ✓ Mobilize beyond the classroom (e.g., peer-to-peer education). ✓ Foster a land-sea interaction. ✓ Bring in a European dimension (e.g., e-Twinning).

LESSON PLAN

PRINCIPLE #3

TRACES OF TROPICAL MARINE SPECIES (LESSEPSIAN MIGRANTS) IN THE MEDITERRANEAN SEA

By Yolanda Koulouri inspired by the teachers Irinni Skoula, Nikos Papadimitropoulos, Chara Stamataki and the lesson plans of the teachers/educators Antonia Perdikaki, Tanja Šalamon, Efi Ntaliani

LESSON PLAN	PRINCIPLE #3
Title	**Author(s) Name(s) Surname(s)**
Traces of tropical marine species (Lessepsian migrants) in the Mediterranean Sea	Yolanda Koulouri inspired by projects of the teachers Irini Skoula, Nikos Papadimitropoulos, Chara Stamataki and the lesson plans of the teachers/educators Antonia Perdikaki, Tanja Šalamon, Efi Ntaliani

OL principles	Duration of the activities	Target age	Main SDG(s)	Other SDG(s)
1, 2, 3, 4, 5, 6, 7	During 1 school year (~10 hours depending on the number of experiments)	9+	14 (14.3; 14.3.1; 14.A)	4, 13

Cognitive learning objectives	I. The learner understands the role of the ocean in moderating our climate and weather. II. The learner understands the role of the ocean on the carbon cycle and the balance of pH. III. The learner is aware of the consequences of CO_2 increase. IV. The learner is aware of global warming and its consequences (e.g., migration of marine species, Lessepsian migration in the Mediterranean Sea).
Socio-emotional learning objectives	I. The learner can perceive the human connection with impacts of climate change on the ocean. II. The learner can show people the impacts of climate change that humanity has on the ocean and human well-being. III. The learner can empathise with people whose livelihoods are already affected by impacts of climate change on the ocean.
Behavioural learning objectives	I. The learner can research their country's (inter)dependence with the sea. II. The learner can share knowledge and experience with their representatives and peers to discuss climate and ocean.

	III. The learner can communicate about the climate and ocean in a meaningful way.
Focus on, with reference to UNESCO ESD* multi-perspective approach	✓ The scientific perspective ✓ The historical perspective ✓ The geographic perspective ✓ The values perspective ✓ The cultural diversity perspective ✓ The sustainability perspective
Introduction or background information/ content necessary for teachers to conduct the activity	This activity could be developed by teachers of different disciplines (e.g., physics, geography, geology, mathematics, chemistry, biology, informatics, language, arts). The teachers will need basic knowledge on physics, chemistry and biology, and skills for navigating internet resources, finding and analysing maps, charts, satellite images, storytelling, crafting, cooking. **Global context** The ocean is a major influence on weather and climate. Global climate depends on the amount of energy received by the Sun and the amount of energy that is trapped in the Earth's system. The ocean absorbs most of the solar radiation reaching the Earth. The ocean is the largest water reserve in the world and with its continuous exchanges with the atmosphere is closely related to the climate. Differential heating of Earth's surface results in circulation patterns in the atmosphere and ocean that globally distribute the heat. The ocean is the largest carbon sink on earth, as it stores carbon mediating the global greenhouse effect. Over the past century, greenhouse gases (e.g., CO_2) and other air pollutants released into the atmosphere have been causing big changes like global warming, ozone holes, and acid rain. Global climate change refers to the average long-term changes over the entire Earth including: a) warming water temperatures having impacts on marine species migration (e.g., Lessepsian migration), and b) increasing absorption of atmospheric carbon dioxide (CO_2), having impacts on the marine organisms with calcareous skeletons or shells (e.g., reefs, molluscs). Other impacts are shrinking mountain glaciers, ice melting at a faster rate than usual in Greenland, Antarctica and the Arctic, rising sea levels due to excess heat stored, more intense and frequent hurricanes,

	rainfalls and droughts, coastal erosion and flooding affecting coastal zones and habitats. Climate change impacts our society by: a) affecting food supplies, industry supply chains and financial markets, b) damaging infrastructure and cities, and c) harming human health and global development. **Local context** The introduction of tropical marine species in the Mediterranean Sea (e.g., blue crab, lionfish, silver-cheeked toadfish, yellow spotted puffer, dusky and marbled spinefoot, blue spotted cornetfish) through the Suez Canal (Lessepsian migration) due to global warming caused by climate change. Investigation of impacts on the Mediterranean Sea ecosystem and human well-being as well as seeking management interventions.
A list of necessary materials and included attachment to conduct activity, e.g., Pupil Instruction Sheet(s), Diagrams, Maps, Tables, Data Sets, etc.	✓ Charts, maps, graphs, satellite images depicting ocean currents, sea surface temperatures and historical climate data ✓ Photos and videos for Lessepsian migrants (e.g., blue crab, lionfish, silver-cheeked toadfish, yellow spotted puffer, dusky and marbled spinefoot, blue spotted cornetfish) ✓ Material for STEAM activities (experiments) ✓ Papers, markers and presentation software ✓ Tools and materials for recipes and crafts Each learner may express personal ideas and comments through an evaluation test
Steps the pupils will need to complete	1. Watch videos and photos, read articles from newspapers, magazines, and websites, discuss. 2. Conduct experiments by different working groups. 3. Meet a marine scientist/expert (e.g., meteorologist) at school/research centre to learn more about climate and ocean, climate change and its impacts on the ocean, impacts of climate change on human well-being. Get familiar with the expert's blue career profession. 4. Visit a research centre/aquarium for implementing lab activities. Get familiar with scientific material (e.g., data sheets), equipment (e.g., microscopes, stereoscopes), identification of marine species (e.g., blue crab, lionfish, silver-cheeked toadfish, yellow spotted puffer, dusky and marbled spinefoot, blue spotted cornetfish) while experience blue career professions.

	5. Visit a coastal marine area for carrying out fieldwork activities. Measure abiotic parameters (e.g., temperature, salinity, pH, dissolved oxygen) *in situ* with marine scientists using scientific instruments (or by developing simple laboratory instruments based on Arduino microcontroller technology). Discuss/interview with local fishermen and authorities. 6. Participate in a role play of climate change and its impacts on the ocean with different stakeholders and users. Propose mitigation and adaptation measures. 7. Cook recipes for edible Lessepsian migrants (e.g., blue crab, lionfish). For recipes follow the link: https://lionhare.hcmr.gr/ 8. Create crafts (e.g., origami, drawings), posters (e.g. Lessepsian migrants, Ocean and Mediterranean Sea Literacy focusing on 3, 5 and 6 principles), comics, stories, poems, articles in school's website and newspaper, board games, short videos. 9. Present hands-on activities and prepare an art exhibition for peers in the school or in other schools or during families/citizens public events such as school days, science festival, local community celebration, etc.
Teaching tips and strategies, including eventually discussion questions	➢ Start the activity by discussing climate and ocean, climate change and its impacts on the ocean (what is the issue, what causes it, why is it important, what can be done), Lessepsian migration while assessing previous knowledge of pupils on the topics. ➢ Make your pupils think from "local to global", e.g. the local issue could be the introduction of tropical marine species in the Mediterranean Sea through the Suez Canal due to increase of water temperature caused by climate change and the global issue could be ocean acidification and its impact on reefs and molluscs. ➢ Define different working groups of pupils for conduct of experiments. ➢ Prepare a script and act out scenarios for the role play. ➢ Ensure co-creation and participatory approach.
Assessment Strategies, and learning outcomes defined	I. Participation in class discussions and group work II. Quality of research and data analysis III. Clarity, effectiveness, creativity demonstrated in outputs IV. Ability to reflect on learning and make connections between theory and real-world applications
Additional suggestions for	**Younger pupils**

conducting the activity with younger and/or older audiences and in a non-formal setting	To give emphasis to conduct experiments and crafts (e.g., drawings, board games, stories, poems), to carry out outdoor activities with marine scientists (fieldwork and labs). **Older pupils** To give emphasis to the role play, writing articles, making videos, to carry out outdoor activities with marine scientists (fieldwork and labs). **Non-formal settings** This lesson plan is partly carried out in a non-formal setting by following steps 3, 4 and 5 (outdoor activities with marine scientists such as fieldwork and lab activities).
References used to develop the activity	For more information on perspectives: F. Santoro et al. (eds). 2017. Ocean Literacy for all: a toolkit. IOC Manuals and Guides, IOC-UNESCO Venice and UNESCO Paris, 85-91 https://unesdoc.unesco.org/in/documentViewer.xhtml?v=2.1.196&id=p::usmarcdef_0000260721&file=/in/rest/annotationSVC/DownloadWatermarkedAttachment/attach_import_2d3dfb02-da9b-410a-9386-dd31047e6ef0%3F_%3D260721eng.pdf&locale=en&multi=true&ark=/ark:/48223/pf0000260721/PDF/260721eng.pdf#%5B%7B%22num%22%3A996%2C%22gen%22%3A0%7D%2C%7B%22name%22%3A%22XYZ%22%7D%2C-125%2C842%2C0%5D For more information on the global context: Climate & Ocean https://beyondweather.ehe.osu.edu/issue/understanding-earths-climate/climate-a-complex-interaction The interactions between ocean and climate https://www.ocean-climate.org/wp-content/uploads/2016/10/161011_FactSheets_EN.pdf Climate and global change https://www.windows2universe.org/earth/climate/climate.html&edu=elem&dev= For more information on the local context (Lessepsian migration): https://en.wikipedia.org/wiki/Lessepsian_migration http://www.seaslugforum.net/find/lessep https://openknowledge.fao.org/server/api/core/bitstreams/288cd3f3-295d-4651-9ebb-dd979e7b0162/content https://www.youtube.com/watch?v=PvF6J_x7pVs

	https://www.youtube.com/watch?v=DRGug_4uTeg https://www.youtube.com/watch?v=i9p-a8YJO-o https://lionhare.hcmr.gr/ https://imbriw.hcmr.gr/category/video-library/ (In Greek) https://www.inaturalist.org/taxa/765083-Portunus-segnis https://www.sealifebase.ca/summary/Portunus-segnis.html https://www.cabidigitallibrary.org/doi/full/10.1079/cabicompendium.68649 For more information on experiments: MED EDUC website https://www.mededuc.eu/en/resource-center/pedagogical-guide/30-climate-change/77-marine-currents.html https://www.mededuc.eu/en/resource-center/pedagogical-guide/30-climate-change/78-what-is-the-ocean-acidification.html https://www.mededuc.eu/en/resource-center/pedagogical-guide/30-climate-change/79-melting-ice-and-rising-sea-level.html How does ocean acidification occur? F. Santoro et al. (eds). 2017. Ocean Literacy for all: a toolkit. IOC Manuals and Guides, IOC-UNESCO Venice and UNESCO Paris, 108-110 https://unesdoc.unesco.org/in/documentViewer.xhtml?v=2.1.196&id=p::usmarcdef_0000260721&file=/in/rest/annotationSVC/DownloadWatermarkedAttachment/attach_import_2d3dfb02-da9b-410a-9386-dd31047e6ef0%3F_%3D260721eng.pdf&locale=en&multi=true&ark=/ark:/48223/pf0000260721/PDF/260721eng.pdf#%5B%7B%22num%22%3A996%2C%22gen%22%3A0%7D%2C%7B%22name%22%3A%22XYZ%22%7D%2C-125%2C842%2C0%5D An ocean in the school lab: rising sea levels https://www.scienceinschool.org/article/2021/ocean-school-lab-rising-sea-levels/ An ocean in the school lab: carbon dioxide at sea https://www.scienceinschool.org/article/2021/carbon-dioxide-at-sea/ Movers and shakers: physics in the oceans https://www.scienceinschool.org/article/2012/ocean/ Climate change: why the oceans matter https://www.scienceinschool.org/article/2017/climate-change-why-oceans-matter/

	Practical ocean literacy for all: ecology and exploration https://www.scienceinschool.org/article/2023/practical-ocean-literacy-ecology-and-exploration/ 16 Meaningful and Hands-On Climate Change Activities for Kids https://www.weareteachers.com/climate-change-activities/
EU Blue Schools criteria	**Compulsory criteria** ✓ Produce a clear output (e.g., crafts, posters, articles). ✓ Develop a project with interlinked activities (e.g., integration with the school curriculum). ✓ Involve all students (e.g., all pupils of the classroom). ✓ Collaborate with a local partner (e.g., research organisation, fishers, authorities). ✓ Communicate project results (e.g., art exhibition). **Optional criteria** ✓ Provide authentic learning experiences (e.g., fieldwork and lab activities). ✓ Work multi- or interdisciplinary (e.g., geology, physics, language, biology, arts). ✓ Mobilise beyond the classroom (e.g., all pupils of the school). ✓ Foster a land-sea interaction (e.g., collaboration with an inland school). ✓ Bring in a European dimension (e.g., eTwinning, ERASMUS+ BlueS_Med https://platform.blueschoolsmed.eu/cms/). For more examples on EU blue school projects: Copejans E., Besançon M., Lourenço C., Batista V., Soares S., Noronha A., European Commission (2020). A wave of European Blue Schools. Handbook for teachers. 2020. European Commission, Directorate-General Maritime Affairs and Fisheries, Brussels, 57-63 https://maritime-forum.ec.europa.eu/document/download/0e460a07-428c-4b0d-a4b4-2d82b999b6ee_en?filename=Handbook%20for%20Teachers%20-%20European%20Blue%20Schools_0.pdf

LESSON PLAN

PRINCIPLE #4

SECRET LIFE OF A WATER DROPLET

By Melita Mokos, Ivana Zubak Čižmek

LESSON PLAN	PRINCIPLE #4			
Title	**Author(s) Name(s) Surname(s)**			
Secret life of a water droplet	Melita Mokos, Ivana Zubak Čižmek			
OL principles	**Duration of the activities**	**Target age**	**Main SDG(s)**	**Other SDG(s)**
4	90 min	8+	14 (14.1; 14.2; 14.5)	4, 6, 12, 13, 15

Cognitive learning objectives	I. The learner describes the processes in the hydrological cycle. II. The learner understands the role of the ocean in moderating our climate and weather. III. The learner understands the role and importance of water for life on Earth and understands the ocean's role as source of water.
Socio-emotional learning objectives	I. The learner can argue for sustainable water consumption practices. II. The learner is aware of the risks for freshwater availability. III. The learner can empathize with people who lack access to freshwater.
Behavioral learning objectives	I. The learner can research their country's freshwater resources. II. The learner can demonstrate some water-saving habits at home/school and practice more sustainable behavior that leads to less water pollution. III. The learner can share knowledge and experience with their peers and families to discuss water accessibility and water consumption.
Focus on, with reference to UNESCO ESD* multi-perspective approach	✓ The scientific perspective ✓ The historical perspective ✓ The geographic perspective ✓ The values perspective ✓ The cultural perspective ✓ The sustainability perspective
Introduction or	This activity could be developed by teachers of different disciplines

background information/ content necessary for teachers to conduct the activity	(e.g., physics (water energy), geography (oceans, rivers, climate zones), chemistry (chemical features of water), biology (life in water environment, adaptation to life in water), mathematics and informatics (data analysis), language (poems and other literature related to water topics), arts. **The role and importance of water and hydrological cycle for life and climate** Water is present everywhere on our planet — in oceans, in lakes and in rivers, in wells, in the soil, and in the atmosphere. Water covers 71% of the Earth's surface. The oceans and seas contain about 96.5% of the world's water, 2.5% is freshwater, about 1% is salty water in the ground. And only 1.2% of all freshwater is surface water, which serves most of life's needs. Even though the total amount of water on earth can be considered as being constant, water is continuously moving in a closed system. The hydrological cycle, also known as the water cycle, is earth's natural water recycling system. As a result of the sun's heat, water evaporates. Most of the water evaporates from the tropical part of the ocean. As vapor rises into the atmosphere, water cools. The change in temperature causes the vapor to condense. It falls back to earth as rain, snow and other forms of precipitation. The precipitation falls back into the sea or creates runoff that travels over the ground surface and helps to fill lakes, rivers and dams. It also percolates through the soil, moves downward through ground openings and replenishes underground aquifers. Waters forming streams (surface and underground) flow toward the ocean. Subject to human needs, water may go through several other processes depending on its targeted use, e.g. for drinking water, for irrigation or for other domestic and industrial uses. Another form of evaporation is transpiration. Water is transferred from plant roots to leaves transporting nutrients through plant tissues. Water is also produced during respiration. Therefore, most of the water absorbed by plants evaporates from the leaves and the whole process is called evapotranspiration. The hydrological cycle is essential for sustaining life on Earth. It distributes fresh water across the globe, supports plant growth, regulates climate by influencing weather patterns, and maintains the balance of ecosystems. Through the continuous exchange of water between the atmosphere, land, and ocean, the water cycle ensures that water is available to support the numerous life forms that depend on it. The relationship between the water cycle and climate is complex and diverse, where changes in one element frequently trigger ripple effects in the other. Comprehensive understanding of these connections is essential for forecasting weather patterns, effectively managing water supplies, and mitigating the impacts of climate change.

	Water overconsumption occurs when the demand for water exceeds the available supply or the sustainable rate at which water can be replenished. This issue is increasingly significant as global populations grow, economies expand, and climate change alters precipitation patterns and water availability. Water pollution also causes lack of clean water availability. All of this leads to depletion of freshwater sources, negative impact on ecosystems, which ultimately can cause societal and economic problems.
A list of necessary materials and included attachment to conduct activity, e.g., Pupil Instruction Sheet(s), Diagrams, Maps, Tables, Data Sets, etc.	✓ Charts, maps, globe ✓ Water, sea or salty water, plastic bag or a transparent cup with the lid ✓ Color markers, watercolors ✓ Paper/cardboard ✓ Yellow, transparent, blue, white, green bracelet beads and a thin string: https://www.bgsu.edu/content/dam/BGSU/COSMOS/Documents/waterCycleBraclet-envirn.pdf ✓ Pot with the lid, stove ✓ Watery 'snakes and ladders' game
Steps the pupils will need to complete	1. Discuss the role and importance of water for any form of life. 2. Find different bodies of water in their country on the map. 3. Draw their own water cycle on the paper or make a water cycle diorama. 4. Make a water cycle bracelet. 5. Conduct a 'kitchen water cycle' experiment (at home, supervised by an adult). 6. Research different water related topics and do the presentation. 7. Play a game.

Teaching tips and strategies, including eventually discussion questions	➢ Start the activity by asking questions such as: What is water? Why is it important for you? Why is it important for all living beings? Where does it come from? How does natural water end up in your house? ➢ Do the experiment: put some water in a transparent cup with the lid or a bag and put it on direct sunlight. After a while, droplets will appear, and 'rain' will start forming. Explain to pupils all the steps of the water cycle (evaporation, condensation, precipitation…). ➢ Let the pupils draw their own water cycle, label different parts and steps of the water cycle and/or do the water cycle bracelets. ➢ After the experiment, discuss with pupils about the connection between the ocean and freshwater through the water cycle. ➢ Homework task: do the kitchen water cycle and discuss the outcomes in the classroom. ➢ Encourage group discussions: organize pupils into 4 groups and give them a topic to research: a) distribution and availability of freshwater in their country, b) distribution and availability of freshwater in some other geographical area, c) impact of climate change on water availability, d) water pollutants. After this, pupils present their findings to each other and discuss their findings. ➢ Play a Watery snakes and ladder game. ➢ Ensure co-creation and participatory approach.
Assessment Strategies, and learning outcomes defined	I. Participation in class discussions and group work. II. Writing a short article about your personal connection with the water cycle and your role in the water cycle. III. Group discussions presentations.
Additional suggestions for conducting the activity with younger and/or older audiences and in a non-formal setting	**Younger pupils** Above mentioned tasks need to be adapted to pupils' age. Less complex questions and terms should be used for younger pupils. Kitchen water cycle must be done with or under the supervision of an adult. **Older pupils** Collect daily/weekly data about water consumption in their household, organize data in excel sheets, and graphically present the results. **Non-formal settings** Visit the closest water body and recognize its role in the water cycle and how it relates to the ocean.

References used to develop the activity	https://worldwatermap.nationalgeographic.org/ https://media.nationalgeographic.org/assets/file/freshwater-full-teacher-guide.pdf https://www.usgs.gov/special-topics/water-science-school/science/how-much-water-there-earth https://www.usgs.gov/special-topics/water-science-school/science/where-earths-water https://marine.copernicus.eu/explainers/why-ocean-important/water-reservoir https://medies.net/water-in-the-mediterranean/ https://letstalkscience.ca/educational-resources/stem-explained/ringwoodite-and-deep-water-cycle Water cycle bracelet: https://www.bgsu.edu/content/dam/BGSU/COSMOS/Documents/waterCycleBraclet-envirn.pdf Watery snakes & ladder game: https://medies.net/a-watery-snakes-ladders-floor-game/
EU Blue Schools criteria	**Compulsory criteria** ✓ Produce a clear output (e.g., crafts, articles, presentations). ✓ Develop a project interlinked with other school subjects. ✓ Involve all students (e.g., all pupils of the classroom). ✓ Collaborate with a local partner (water management facility). ✓ Communicate project results (e.g., write an article for a school journal). **Optional criteria** ✓ Provide authentic learning experiences (e.g., fieldwork and lab activities). ✓ Work multi- or interdisciplinary (e.g., language, geology, biology, music, arts). ✓ Mobilize beyond the classroom (e.g., all pupils of the school). ✓ Foster a land-sea interaction. ✓ Bring in a European dimension (e.g., eTwinning).

LESSON PLAN

PRINCIPLE #5

MARINE FOOD WEB

By Melita Mokos, Ivana Zubak Čižmek

LESSON PLAN	PRINCIPLE #5			
Title	**Author(s) (Name Surname)**			
Marine food web	Melita Mokos, Ivana Zubak Čižmek			
OL principles	**Duration of the activities**	**Target age**	**Main SDG(s)**	**Other SDGs**
5	45 min	10+	14.2, 14.4, 14.5	4, 12

Cognitive learning objectives	I. The learner explains food chains and food webs, and predator-prey relationships. II. The learner understands the connectivity of organisms in nature. III. The learner understands the connection of many people to the sea and the life it holds.
Socio-emotional learning objectives	I. The learner can argue for sustainable marine resources consumption practices. II. The learner can show the impact humanity is having on the ocean's biological resources and the value of clean healthy oceans. III. The learner is aware of the risks of anthropogenic activities on the stability of the food web.
Behavioral learning objectives	I. The learner can research their country's dependence on a healthy and stable ecosystem. II. The learner can recognize and support sustainable seafood choices, and advocate for marine protection policies.
Focus on, with reference to UNESCO ESD* multi-perspective approach	✓ The scientific perspective ✓ The geographic perspective ✓ The values perspective ✓ The sustainability perspective
Introduction or background information/ content	This activity could be developed by teachers of different disciplines (e.g., geography (migrations of marine organisms), biology (biodiversity, food webs), IT (online quizzes and resources), arts (create your own food web

necessary for teachers to conduct the activity	by drawing, collage, etc.). **Food webs** Each ecosystem is structured by trophic relations, in which every organism represents a prey or a predator for another one. Those relations can be viewed as chains, symbolizing "who is eaten by whom". Feeding relationships are often shown as simple food chains, but these relationships are much more complex because an organism can be a prey and a predator at the same time. So, the term 'food web' more accurately shows the links between producers, consumers, and decomposers. Autotrophic organisms such as phytoplankton, seaweed, and seagrass form the basis of every food web. They can produce their food using light, water, and carbon dioxide. Therefore, we consider them to be "primary producers." Autotrophs are eaten by heterotrophs, which are incapable of producing their food. Heterotrophic organisms can be grouped into several categories, such as primary, secondary, or tertiary consumers, depending on their position in the food web (if they directly eat the autotrophs, or instead they eat heterotrophs that eat autotrophs, and so on). On average, only 10% of the energy from an organism is transferred to its consumer. The rest is lost as waste, movement energy, heat energy, etc. As a result, each higher trophic level supports a smaller number of organisms – in other words, it has less biomass (the total mass of organisms in each area or volume) than the previous, meaning that a top-level consumer, such as a shark, is supported by millions of primary producers from the base of the food web or trophic pyramid. Decomposers, primarily bacteria that break down dead organisms, play a crucial role in the ecosystem. Their main function is to recycle the nutrients that are absorbed by primary producers (autotrophs). This process releases nutrients that support the producers as well as the consumers that feed by absorbing organic material in the water column. The role of decomposers in nutrient recycling is vital for the health and balance of the ecosystem. All organisms, from the smallest bacteria to the largest blue whale, are interconnected through the food web. This interconnectedness means that even the slightest disruption in a species population, or the loss of a single species, can have far-reaching effects on all others that depend on it directly or indirectly. Organisms also require specific environmental conditions, including specific climatic conditions, to survive. Any disruption in these conditions can lead to an imbalance in the entire food web, with widespread consequences in the ecosystem.

A list of necessary materials and included attachment to conduct activity, e.g., Pupil Instruction Sheet(s), Diagrams, Maps, Tables, Data Sets, etc.	✓ Printed photos of different marine organisms with names ✓ Long strings ✓ Computer / laptop / tablet
Steps the pupils will need to complete	1. Discuss about the importance of food and the origin of that food. The marine/freshwater food they eat – what these organisms eat? 2. Play a food web game. 3. Check and fill in online teaching resources. 4. Participate in the discussion about different impacts on food webs.
Teaching tips and strategies, including eventually discussion questions	➢ Start the activity by asking questions such as: Why do we eat, why do we need food? What is the situation in the sea – what do animals eat in the sea? ➢ Explain the terminology of the food chain and food web. ➢ Play a 'food web' game: https://keepwalestidy.cymru/wp-content/uploads/2022/05/Food-Web-Game_ENG.pdf. ➢ Show online resources and materials and solve online tasks such as feeding connections in ecosystems from different geographical areas: https://www.oce.global/en/resources/multimedia-activities/ocean-food-webs-multimedia-activity. ➢ Discuss what kind of natural and anthropogenic impacts can disturb the food web and what are the consequences to human health and society.
Assessment Strategies, and learning outcomes defined	I. Participation in class discussions and group work. II. Solving online materials.
Additional suggestions for conducting the activity with younger and/or older audiences and in a non-formal setting	**Younger pupils** Make separate food chains, simplify the size of the food web. **Older pupils** Create a food web of your closest sea/river/lake/creek. **Non-formal settings** Visit local fishers, marine protected areas, or aquaculture facilities and

	check how they impact food webs.
References used to develop the activity	https://www.oce.global/en/resources/multimedia-activities/ocean-food-webs-multimedia-activity https://www.oce.global/sites/default/files/2020-01/Ocean-and-Cryosphere-web-final_1.pdf https://www.sciencelearn.org.nz/resources/143-marine-food-webs

LESSON PLAN

PRINCIPLE #6

HYDROELECTRIC POWER.
HOW ENVIRONMENTALLY FRIENDLY IS IT?

Alternative title for younger pupils

MEET ELAINE THE EEL AND FIND OUT WHY SHE IS IN TROUBLE!

By Maria Cheimonopoulou

LESSON PLAN	PRINCIPLE #6
Title	**Author(s) (Name Surname)**
Hydroelectric power. How environmentally friendly is it? *Alternative title for younger pupils* **Meet Elaine the eel and find out why she is in trouble!**	Maria Cheimonopoulou

OL principles	Duration of the activities	Target age	Main SDG(s)	Other SDGs
1, 2, 3, 4, 5, 6, 7	45 min (presentation by an expert) + 20 min (presentation by a fisher/farmer) + 1,5 hours (lab) + 1-2 hours tour).	14+ adapted 8+	14 (14.1; 14.2; 14.5; 14C)	4, 6, 7, 11, 12, 13, 15, 16, 17

Cognitive learning objectives	The learner will be able to: I. realise that all water bodies (freshwater and marine) are connected; II. discover the ways freshwater and marine ecosystems are connected; III. familiarise with the impacts of dams on freshwater and marine ecosystems and eventually on human communities.
Socio-emotional learning objectives	The learner will be able to: I. understand the importance of free-flowing rivers for healthy freshwater and marine ecosystems as well as their importance for the well-being of human communities; II. spread the word for the need for having healthy freshwater and marine ecosystems and influence groups that engage in the unsustainable use of water resources; III. empathize with people that are already impacted by the

	absence of Integrated Water Resources Management; IV. understand the importance of not wasting resources (e.g. electricity) in a daily basis.
Behavioral learning objectives	The learner will be able to: I. arise a consideration behaviour in a daily basis about healthy freshwater and marine ecosystems; II. think and act to preserve healthy freshwater and marine ecosystems, along with family and friends; III. minimize the consumption of electricity, along with family and friends.
Focus on, with reference to UNESCO ESD* multi-perspective approach	✓ The scientific perspective ✓ The historical perspective ✓ The geographic perspective ✓ The value perspective ✓ The cultural diversity perspective ✓ The sustainability perspective
Introduction or background information/ content necessary for teachers to conduct the activity	This activity could be developed by teachers of different disciplines (e.g., biology, physics, geography, geology, chemistry, informatics, language, arts). Hydroelectric power (electricity generated by waterpower), a renewable type of energy, has multiple advantages but also disadvantages. Its production can intensify the greenhouse effect, climate crisis, coastal erosion, salinization of groundwater and soil in coastal areas and biodiversity loss in riverine and marine ecosystems. Many migratory fish species are threatened and close to extinction. The European eel (*Anguilla anguilla*) is a migratory fish species (catadromous) that spawns and hatches in the sea, but it migrates to freshwater systems to feed and grow. The last two decades, there has been a significant decrease in the number of eels reaching European freshwater systems. Therefore, the European eel is listed as 'critically endangered' on the IUCN Red List. One major cause for the decrease of eels' populations are barriers up- and downstream their migration route, including damming of river systems to produce hydro-electric power. In order not to compromise sustainability of freshwater and coastal ecosystems, mitigation of impacts resulting from the construction of

	hydroelectric dams is needed. Taking measures such as the use of fish friendly turbines, fish ladders in dams, modernization of mechanical infrastructure in hydroelectric units versus creation of new hydroelectric units, demolition of river barriers that are no longer in use and sustainable sediment management in reservoirs are among the solutions. Integrated Water Resources Management (IWRM) is fundamental for the water management to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital aquatic ecosystems. Also, very important is the change in our electricity consumption behaviour by sustainably saving electricity. Suggested resources for teachers are mentioned in the References section.
A list of necessary materials and included attachment to conduct activity, e.g., Pupil Instruction Sheet(s), Diagrams, Maps, Tables, Data Sets, etc.	✓ Oxygen-, conductivity-, pH- and turbidity metres. A collaboration with the local Fisheries Department or a nearby Research Institutions is necessary for the provision of the metres. ✓ Pencils and note sheets about: 1) oxygen, conductivity, pH, turbidity and temperature measurements in a free-flowing river and in an artificial reservoir, 2) observations about the diversity of different water flow types (e. g. running water, stagnant water, waves) and substrate composition (e.g., presence of coarse- or fine-grained substrate, e.g., boulders, cobbles, sand) in the two under comparison ecosystems. ✓ Proposed questions to be answered by its team: e.g., What differences are identified between the two water bodies? What are the effects on aquatic organisms when a part of the river is turned into an artificial lake? What are the consequences on aquatic organisms when temperature and turbidity increase? ✓ Each pupil may express personal ideas and comments through an evaluation test.
Steps the pupils will need to complete	1. Watch some or all introductory videos and read the resources proposed in the Reference section. Teachers can make the selection. 2. Navigate with *Google Earth*, or similar, to investigate the under-study river, its dams and delta area. 3. Search old photos and up to today photos of the river delta, try to make a comparison and draw some conclusions about a possible change in its surface area. The example of the Elwha

River (https://youtu.be/7tfsn233l9c?feature=shared) could be used here by the teachers especially if pupils cannot find relative information about their local river (Restoration efforts in Elwha river in USA, Fish Passage Conference 2021-Americas session). At minutes 01:08:00-01:13:14 is the presentation about the changes of the shoreline and the interception of coastal erosion.

4. Search for articles about the reduction of fisheries production in the river's delta area, erosion and salinization of groundwater and soil in coastal areas.
5. Define working groups for the hands-on lab about the physico-chemical measurements and the filling in of the note sheet and the answering of questions. Within each group, each pupil will choose his/her own role.
6. A presentation by a hydrobiologist at school / research centre (max 45 minutes) to learn about:
    a) the importance of a diverse aquatic habitat (e.g. different flow types and substrate for biodiversity in aquatic ecosystems);
    b) the impact of dams on a) aquatic organisms and migrating fish as eels and the consequent biodiversity loss and b) coastal areas and communities;
    c) the intensifying of the greenhouse effect by methane produced in artificial reservoirs and the connection to the climate crisis;
    d) the importance of healthy aquatic ecosystems, mitigation measures for dam impacts (fish friendly turbines, fish ladders in dams, modernization of mechanical infrastructure in hydroelectric units versus creation of new hydroelectric units and demolition of river barriers that are no longer in use);
    e) Integrated Water Resources Management;
    f) the structure/operation of a hydroelectric production unit that uses the water constrained by a dam to produce electricity.
7. An interview with a fisher about the reduction of fish stocks (eels) or a farmer about the salinization of soil in coastal areas, and economic consequences (max 20 minutes).
8. Familiarisation with water quality parameters (oxygen concentration, conductivity, pH, turbidity, temperature).
9. Hands on Lab:

	a) make measurements of oxygen concentration, conductivity, pH, turbidity and temperature in a free-flowing river and in an artificial reservoir; b) answer the questions in the note sheet regarding the comparison of the two under-study ecosystems (1,5 hours). 10. After having the theoretical background, the pupils can visit a hydroelectric production unit and have a tour, see how it works, check whether there is a fish ladder or not, ask about mechanisms that prevent the gathering of sediment which is so important for the coastal areas, ask when the hydroelectric production unit was constructed, whether its turbines are fish friendly or not and if they are not whether there is a plan to be replaced with new friendly ones. 11. An online meeting with an expert (e.g. From the World Fish Migration Foundation, https://worldfishmigrationfoundation.com/) about the demolition of river barriers that are no longer in use and how this is important for local communities and ecosystems. 12. It is very important that pupils realise that we may use mitigation measures for reducing the impacts of dams in rivers but if we do not try to reduce the amount of electricity we use every day, our needs would keep increasing which means more dams to produce hydroelectricity. 13. Drawing and hand-craft activities, especially for younger pupils. 14. Present the activity and their conclusions to peers in their school or in other schools or during citizens/families public events such as school days, science festival, local community celebration, etc. 15. Participate in the "World Fish Migration Day" event: https://worldfishmigrationfoundation.com/portfolio-item/world-fish-migration-day/. 16. Download, in their cell phones, Barrier Tracker App and record barriers in streams/rivers https://amber.international/european-barrier-atlas/. The Barrier Tracker App is part of a citizen science program used to build a Pan-European Atlas of In-Stream Barriers.
Teaching tips and strategies, including eventually discussion questions	➢ Getting to know pupils' experiences. ➢ Focus on: the fact that all water bodies are inextricably connected;

	similarities and differences between a river and an artificial lake; dam impacts not only in your inland area but also in the rivers' delta and coastal areas. This way pupils will understand that local environmental issues cause consecutively environmental issues far away. ➢ Ask for observations. ➢ Ask about reasons or rationales for observations. ➢ Ask about the meaning of data/numbers. ➢ Explain the meaning of the data, tying it to the pupils' experiences. ➢ Encourage co-creation and participatory approach. ➢ Affirm the pupil's questions. ➢ Correlations between impacts and hypotheses. ➢ Ask questions to guide pupils. ➢ Ask questions to help pupils to reach conclusions.
Assessment Strategies, and learning outcomes defined	I. Group work, data analysis and class discussions. II. Constructive feedback. III. Creativity demonstrated in outputs (e.g., drawing and hand-craft activities). IV. Ability to reflect on learning and make connections between theory and environmental issues. Humans, rivers and the ocean are inextricably connected. Healthy rivers and ocean mean healthy human communities. Economic and social welfare resulting from the exploitation of rivers needs to be done in an equitable manner without compromising their sustainability, along with the oceans' sustainability. Our production and consumption patterns need to be changed.
Additional suggestions for conducting the activity with younger and/or older audiences and in a non-formal setting	**Younger pupils** Younger pupils could watch only videos number 6, 8, 10 and 11 from the References section. No measurements of parameters, just simple observations on how water flows in a river and in an artificial lake so that children can understand that when humans turn a river into a lake aquatic organisms face serious problems. They can watch the videos of: a) the eels' life cycle (ref. number 6), b) how an eel can lose its way when there is a barrier (reference number 11), and c) how a fish ladder works and fish can overcome the obstacle (ref. number

	10). They can watch the video about hydropower (ref. number 6) and visit a dam created for hydroelectric production and realise how huge it is and how it must be impacting migratory fish. Learning about vampire energy could motivate them to change their electricity consumption behaviour (ref. number 19). Drawing and handcraft activities could follow. Also, pupils could read *Yuru y Ara: A story at the Mamore River* a book about migratory fish for kids, offered in many languages and free to download (https://baediciones.com/en/yuru-y-ara-a-story-at-the-mamore-river). The book could be the basis for a drama activity. **Older pupils** All the suggested steps could be followed by older pupils. A visit to an estuary area and a boat tour by a fisher where glass eels can be found would be ideal. **Non-formal settings** Along with a visit to an estuary, a visit to an eel farm could be added to the activities' program.
References used to develop the activity	1. Information on perspectives: https://unesdoc.unesco.org/in/documentViewer.xhtml?v=2.1.196&id=p::usmarcdef_0000260721&file=/in/rest/annotationSVC/DownloadWatermarkedAttachment/attach_import_2d3dfb02-da9b-410a-9386-dd31047e6ef0%3F_%3D260721eng.pdf&locale=en&multi=true&ark=/ark:/48223/pf0000260721/PDF/260721eng.pdf#%5B%7B%22num%22%3A996%2C%22gen%22%3A0%7D%2C%7B%22name%22%3A%22XYZ%22%7D%2C-125%2C842%2C0%5D , pp. 88-91 2. Healthy Rivers, Healthy Ocean: https://www.gwp.org/en/we-act/themesprogrammes/Transboundary_Cooperation/healthy-rivers-healthy-ocean-programme/ 3. European eel (*Anguilla anguilla*), European Commission: https://oceans-and-fisheries.ec.europa.eu/ocean/marine-biodiversity/eel_en#:~:text=As%20a%20result%2C%20the%20European,on%20the%20IUCN%20Red%20List.&text=Other%20potential%20causes%20include%20parasites,Asia%20are%20additional%20pressing%20concerns. 4. *Anguilla anguilla*, The IUCN Red List of Threatened Species: https://www.iucnredlist.org/species/60344/152845178 5. How hydroelectricity is being produced: https://www.youtube.com/watch?v=q8HmRLCgDAI&t=5s&ab_channel=StudentEnergy 6. 5 Cool Facts About Hydro Power for Kids | What is Hydro Power?

| How does Hydro Power Work? | Hydro https://www.youtube.com/watch?v=HUTe72-6Hlw&ab_channel=LearningMole

7. What is a migratory fish? https://worldfishmigrationfoundation.com/portfolio-item/world-fish-migration-day/
8. The eels' (*Anquilla anquilla*) life cycle: https://www.youtube.com/watch?v=BR1enXROmgA&t=15s&ab_channel=TED-Ed. Subtitles are provided in many different languages e.g. Greek, Italian, Portuguese, Spanish, French, Turkish. **You may skip the last minute of the video.**
9. How dams impact rivers:
   a) Sediment trapped behind dams makes them 'hot spots' for greenhouse gas emissions: https://phys.org/news/2013-07-sediment-hot-greenhouse-gas-emissions.htmlq ;
   b) River Damming Impacts on Fish Habitat and Associated Conservation Measures: https://www.researchgate.net/publication/376642644_River_Damming_Impacts_on_Fish_Habitat_and_Associated_Conservation_Measures ;
   c) Dams: Ecological Impacts and Management: https://link.springer.com/chapter/10.1007/978-3-319-73250-3_6 ;
   d) World's largest dam removal reverses coastal erosion: https://www.nature.com/articles/s41598-019-50387-7 ;
   e) Our freshwater 2020, Issue 3: Changing water flows affect our freshwater: https://environment.govt.nz/publications/our-freshwater-2020/issue-3-changing-water-flows-affect-our-freshwater/
10. How a vertical-slot fishway works: https://www.youtube.com/watch?v=os1Y0S6s3fs&ab_channel=Murray%E2%80%93DarlingBasinAuthority
11. Journey of an eel: https://www.youtube.com/watch?v=WaNuY81lloM&t=5s&ab_channel=TimOlley
12. Water Quality - Importance of Dissolved oxygen, pH, turbidity, temperature in a river: https://www.grc.nasa.gov/WWW/k-12/fenlewis/Waterquality.html
13. Water quality indicator: Electrical conductivity: https://www.qmul.ac.uk/chesswatch/media/chesswatch/Electrical-conductivity-leaflet.pdf
14. The Barrier Atlas-Barriers in European Rivers and the Barrier Tracker App: https://amber.international/european-barrier-atlas/
15. Removal of obsolete dams in Europe. Dam Removal Europe:

	https://www.youtube.com/watch?v=RDDP6NYuNjw&ab_channel=DamRemovalEurope 16. EU Biodiversity strategy for 2030-Barrier removal for river restoration: https://op.europa.eu/en/publication-detail/-/publication/0146a7ba-2f20-11ed-975d-01aa75ed71a1, available in all EU languages. 17. Integrated Water Resources Management (IWRM): https://www.un.org/waterforlifedecade/iwrm.shtml 18. How to Stop Energy Vampires from Attacking Your Home: https://www.energy.gov/energysaver/articles/how-stop-energy-vampires-attacking-your-home 19. Kids Animation on Vampire Voltage: https://www.google.com/search?q=vampire+energy+electricity&sca_esv=cb67a1539fa9fe2a&tbm=vid&sxsrf=ADLYWIIc2ZZrpNdWgCUyhylm6O5mUn4nGw:1720870074030&ei=umSSZuusAeWG9u8Po5GewA8&start=20&sa=N&ved=2ahUKEwjr8d3L9KOHAxVlg_0HHaOIB_g4ChDw0wN6BAgFEBk&biw=1280&bih=585&dpr=1.5#fpstate=ive&vld=cid:7cb093c1,vid:9JECumDmUs0,st:0 20. Το standby στις ηλεκτρικές συσκευές μάς κοστίζει… https://www.ertnews.gr/eidiseis/oikonomia/to-stand-by-stis-ilektrikes-syskeyes-mas-kostizei-15-kilovat-to-mina-pos-tha-meiosoyme-toys-logariasmoys-energeias-video/
Additional resources, e.g., websites, printed material, software, data sets, etc.	1. Living Planet Index for Migratory Freshwater Fish: https://worldfishmigrationfoundation.com/living-planet-index-2020/ 2. Eel: https://oceans-and-fisheries.ec.europa.eu/ocean/marine-biodiversity/eel_en#:~:text=Unfortunately%2C%20there%20has%20been%20a,on%20the%20IUCN%20Red%20List. 3. Convention on the Conservation of Migratory Species of Wild Animals: https://www.cms.int/en/news/european-eel-remains-critically-endangered-latest-iucn-red-list 4. Sustainable Sediment Management in Reservoirs and Regulated Rivers: Experiences from Five Continents: https://www.researchgate.net/publication/261376579_Sustainable_Sediment_Management_in_Reservoirs_and_Regulated_Rivers_Experiences_from_Five_Continents 5. Types of Hydropower Plants: https://www.energy.gov/eere/water/types-hydropower-plants#:~:text=of%20hydropower%20plants.-,IMPOUNDMENT,river%20water%20in%20a%20reservoir. 6. Toward Achievement of the UN OceanDecade: Does “CANAL STUDY” in CentralTokyo Bay Area Enhance Ocean Literacy? https://www.researchgate.net/publication/361484182_OceanLiteracyTsuyoshiSasaki

	7. F. Santoro et al. (eds). 2017. Ocean Literacy for all: a toolkit. IOC Manuals and Guides, IOC-UNESCO Venice and UNESCO Paris, 120-122: https://unesdoc.unesco.org/in/documentViewer.xhtml?v=2.1.196&id=p::usmarcdef_0000260721&file=/in/rest/annotationSVC/DownloadWatermarkedAttachment/attach_import_2d3dfb02-da9b-410a-9386-dd31047e6ef0%3F_%3D260721eng.pdf&locale=en&multi=true&ark=/ark:/48223/pf0000260721/PDF/260721eng.pdf#%5B%7B%22num%22%3A996%2C%22gen%22%3A0%7D%2C%7B%22name%22%3A%22XYZ%22%7D%2C-125%2C842%2C0%5D 8. Saving Energy Through ADVANCED POWER STRIPS: https://www.nrel.gov/docs/fy14osti/60461.pdf
EU Blue Schools criteria	**Compulsory criteria** ✓ Produce a clear output (e.g., crafts, posters, articles). ✓ Develop a project with interlinked activities (e.g., integration with the school curriculum/pH, conductivity, greenhouse effect, biodiversity, economy, etc.). ✓ Involve all pupils (e.g., all pupils of the classroom). ✓ Collaborate with a local partner (e.g., research organization, fishers, farmers, authorities). ✓ Communicate project results (e.g., art exhibition). **Optional criteria** ✓ Provide authentic learning experiences (e.g., fieldwork and lab activities). ✓ Work multi- or interdisciplinary (e.g., language, geology, physics, biology, chemistry, arts). ✓ Mobilise beyond the classroom (e.g., pupils of the whole school). ✓ Foster a land-sea interaction (e.g., collaboration with an inland school). ✓ Bring in a European dimension, e.g., e-Twinning, ERASMUS+ BlueS_Med (https://platform.blueschoolsmed.eu/cms/). For more examples on EU blue school projects Copejans E., Besançon M., Lourenço C., Batista V., Soares S., Noronha A., European Commission (2020). A wave of European Blue Schools. Handbook for teachers. 2020. European Commission, Directorate-

	General Maritime Affairs and Fisheries, Brussels, 70 and 91: https://maritime-forum.ec.europa.eu/document/download/0e460a07-428c-4b0d-a4b4-2d82b999b6ee_en?filename=Handbook%20for%20Teachers%20-%20European%20Blue%20Schools_0.pdf

LESSON PLAN

PRINCIPLE #7

EXPLORE THE OCEAN WITH THE “ADOPT A FLOAT” EDUCATIONAL PROGRAM*

By Maria Cheimonopoulou

**Adapted from the “Adopt a Float” educational program - https://adoptafloat.com/*

LESSON PLAN	PRINCIPLE #7
Title	**Author(s) (Name Surname)**
Explore the ocean with the "Adopt A Float" educational program	Maria Cheimonopoulou (adapted from the "Adopt a Float" educational program https://adoptafloat.com/)

OL principles	Duration of the activities	Target age	Main SDG(s)	Other SDGs
1, 2, 3, 4, 5, 6, 7	Throughout the school year	14+ adapted <14	14 (14.3; 14.5; 14A)	4, 9, 13

Cognitive learning objectives	The learner will be able to: I. realise that there is one ocean, as all oceans and seas are interconnected, which is largely unexplored; II. understand that exploration, experimentation, and discovery are required to better understand ocean systems and processes; III. learn that new technologies are necessary for the ocean exploration; IV. realise that by exploring the ocean humans are capable of managing it sustainably.
Socio-emotional learning objectives	The learner will be able to: I. understand the importance of familiarising with the ocean systems and that managing them sustainably is a prerequisite for the well-being of human communities and life in general; II. influence groups about the importance of technology innovation in ocean exploration and its protection.
Behavioral learning	The learner will be able to:

objectives	I. arise a consideration behavior in daily life about the sustainable use of ocean resources and the oceans' conservation through technology innovation and monitoring; II. to think and act to preserve the ocean along with family and friends; III. collaborate with international school partners.
Focus on, with reference to UNESCO ESD* multi-perspective approach	✓ The scientific perspective ✓ The historical perspective ✓ The geographic perspective ✓ The gender equality perspective ✓ The values perspective ✓ The cultural diversity perspective ✓ The sustainability perspective
Introduction or background information/ content necessary for teachers to conduct the activity	This activity could be developed by teachers of different disciplines (e.g., physics, geography, geology, mathematics, chemistry, biology, informatics). It could be implemented by taking part in the "Adopt a float" educational program (https://adoptafloat.com/). A float is an autonomous oceanographic device able to dive and surface by changing its buoyancy, by pumping oil from inside the float to an external bladder and vice-versa. This way it can move vertically through the water column. It is battery-powered and hosts a suite of sensors to monitor physical and chemical aspects of the ocean e.g. temperature, salinity, pH. The collected data, when the float reaches the surface, are transmitted via satellites and can be accessible in real time on an interactive map. The "Adopt A Float" is a multidisciplinary educational program that offers pupils the opportunity to discover the one ocean and how crucial its study is to better understand and protect it by following the journey of a float and using its data. It was founded in 2011 in France at the marine station of Villefranche-sur-Mer. Schools all over the world can participate in this program and it extends throughout the school year. Registration takes place about the end of July each year by teachers: https://adoptafloat.com/adopt-a-float-educational-program/#in-brief . Suggested resources for teachers and relevant links are mentioned in the References section.
A list of necessary	✓ A good knowledge of the English or French language

materials and included attachment to conduct activity, e.g., Pupil Instruction Sheet(s), Diagrams, Maps, Tables, Data Sets, etc.	✓ Computers, printers, internet connection ✓ The interactive map: https://adoptafloat.com/map ✓ Pencils and note sheets ✓ Tin foil, Styrofoam, objects made of different materials (e.g., wood, glass, marbles, coins, plastic), a container filled with water ✓ Each pupil may express personal ideas and comments through an evaluation test
Steps the pupils will need to complete	1. Learn basic information about how a float is constructed and works (ref. n. 2, 3). 2. Hands-on lab: Familiarise with buoyancy and how it can be changed for an object, as a fish or a float, to move up and down the water column. (ref. n. 4-9). 3. Familiarise with parameters that the float is measuring as pH, oxygen concentration, nitrate, chlorophyl concentration in water and their importance to organisms, their changing patterns according to depth and their position and how these parameters are affected by human activities. (ref. n. 10-14). 4. Get informed about the importance of satellites in transmitting environmental data and exploring the ocean (ref. n. 15). 5. Watch informative videos about profiling floats (ref. n. 16-21). Following steps (6-11) are mentioned (ref. n. 22-26), among others, in the "Adopt a float" educational programs' webpage https://adoptafloat.com/. 6. Adopt a float and name it in the "Adopt A Float" program. 7. Read the "GUIDE TO UNDERSTANDING AND USING PROFILING FLOAT" of the "Adopt A Float" program. 8. Monitor the changing in the observed parameters values. 9. Participate in class sessions throughout the school year in the "Adopt A Float" program. 10. Participate in wrap-up sessions at the end of the school year in the "Adopt A Float" program. 11. Present in person the final productions in the schools, scientific institutes involved and/or by videoconferencing in the "Adopt A Float" program. 12. Present the activity and their conclusions to their school and other local schools or during citizens'/families' public events such

	as school days, science festival, local community celebration, etc.
Teaching tips and strategies, including eventually discussion questions	➢ Getting to know pupils' experiences. ➢ Focus on the following concepts of OL Principle 7: the ocean is largely unexplored; technology fundamental to explore it; oceanography is an interdisciplinary science where math, physics, chemistry, biology and geology intersect in order to study the ocean; exploration, experimentation, and discovery are required to better understand ocean systems and processes; by understanding and managing sustainably the Ocean we ensure the balance of all living systems on Earth. ➢ Ask for observations. ➢ Ask about reasons or rationales for observations. ➢ Ask about the meaning of data/numbers. ➢ Explain the meaning of the data, tying it, if possible, to the pupils' experiences. ➢ Ensure co-creation and participatory approach. ➢ Affirm the pupil's questions. ➢ Ask questions to guide pupils. ➢ Ask questions to help pupils to reach conclusions.
Assessment Strategies	I. Group work and class discussions. II. Constructive feedback. III. Creativity demonstrated in outputs (e.g. drawing and hand-craft activities). IV. Ability to reflect on learning and make connections between technology and ocean exploration. V. Filling in a questionnaire pre- and post the activity by pupils and teachers.
Additional suggestions for conducting the activity with younger and/or	**Younger pupils** In the "Adopt A Float" educational program classes of all school levels with various backgrounds, coming from various countries, can participate. Alternatively, younger children could watch the videos "Argo Floats: How do we measure the ocean? (ref. n. 21) and Biogeochemical

older audiences and in a non-formal setting	Profiling Floats in the Southern Ocean (ref. n. 19) and conduct experiments about buoyancy (ref. n. 4-9). **Older pupils** Older pupils could fulfil all mentioned steps in this lesson plan. **Non-formal settings** An in-person demonstration of a float (how it is built, how it works etc.) by a scientist. Plus, a demonstration of how it moves up and down the water column.
References used to develop the activity	1. Information on perspectives: https://unesdoc.unesco.org/in/documentViewer.xhtml?v=2.1.196&id=p::usmarcdef_0000260721&file=/in/rest/annotationSVC/DownloadWatermarkedAttachment/attach_import_2d3dfb02-da9b-410a-9386-dd31047e6ef0%3F_%3D260721eng.pdf&locale=en&multi=true&ark=/ark:/48223/pf0000260721/PDF/260721eng.pdf#%5B%7B%22num%22%3A996%2C%22gen%22%3A0%7D%2C%7B%22name%22%3A%22XYZ%22%7D%2C-125%2C842%2C0%5D , pp. 88-91 2. Information on the Biogeochemical floats used by the GO-BGC Array project: https://www.go-bgc.org/floats 3. Float (oceanography): https://en.wikipedia.org/wiki/Float_(oceanography)#:~:text=Profiling%20floats%2C%20such%20as%20APEX,depths%20(%22profiles%22). 4. Buoyancy: https://flexbooks.ck12.org/cbook/ck-12-middle-school-physical-science-flexbook-2.0/section/12.6/primary/lesson/buoyancy-ms-ps/ 5. Archimedes' Principle and Buoyancy: https://pressbooks.bccampus.ca/universityphysicssandbox/chapter/archimedes-principle-and-buoyancy/ 6. Real science for real life: buoyancy KENTUCKY TEACHER+ suggested activities: https://www.kentuckyteacher.org/subjects/science/2016/10/real-science-for-real-life-buoyancy/#:~:text=If%20there%20is%20salt%20%E2%80%93%20or,boat%20will%20be%20less%20buoyant. 7. Experiment 12 Archimedes' principle: https://www.tumwater.k12.wa.us/cms/lib/WA01001561/Centricity/Domain/1375/buoyancy%20force%20lab.pdf 8. Buoyancy, sinking and floating - free experimentation: https://www.ingridscience.ca/node/411 (Challenge 2 as an activity on fish movement in water can be used to resemble the movement of floats in the water column) 9. Some things sink while other things float. Why is this? Let's find

	out! (video and experiments): https://www.bbc.co.uk/bitesize/articles/z33d7v4#zdr7h4j 10. The pH scale: https://www.bbc.co.uk/bitesize/articles/z38bbqt#zd7ccmn 11. Introduction to oceanography, Roger Williams University, 5.5 Dissolved Gases: Carbon Dioxide, pH, and Ocean Acidification: https://rwu.pressbooks.pub/webboceanography/chapter/5-5-dissolved-gases-carbon-dioxide-ph-and-ocean-acidification/ 12. Introduction to oceanography, Roger Williams University, 5.4 Dissolved Gases: Oxygen: https://rwu.pressbooks.pub/webboceanography/chapter/5-4-dissolved-gases-oxygen/#:~:text=Well%2Doxygenated%20surface%20water%20may,aptly%2Dnamed%20oxygen%20minimum%20layer. 13. Introduction to oceanography, Roger Williams University, 5.6 Nitrogen and Nutrients: https://rwu.pressbooks.pub/webboceanography/chapter/5-6-nitrogen-and-nutrients/ 14. Introduction to oceanography, Roger Williams University,7.4 Patterns of Primary Production (chlorophyl concentration): https://rwu.pressbooks.pub/webboceanography/chapter/7-4-patterns-of-primary-production/ 15. Environmental Satellites NOAA Ocean Exploration: https://oceanexplorer.noaa.gov/technology/satellites/satellites.html 16. A global array of robotic floats is transforming how scientists observe ocean health: https://www.youtube.com/watch?v=jCC8UOsKNvo&ab_channel=MBARI%28MontereyBayAquariumResearchInstitute%29 17. SOCCOM brings a fleet of robotic floats to the Southern Ocean to monitor ocean health: https://www.youtube.com/watch?v=30XfCTb6ja0&ab_channel=SOCCOMProject 18. Ocean's breath: Autonomous robotic floats measure seasonal cycles in the ocean: https://www.youtube.com/watch?v=rYQ-uQp4hIw&ab_channel=SOCCOMProject 19. Biogeochemical Profiling Floats in the Southern Ocean: https://www.youtube.com/watch?v=5kTJs4rtooI&ab_channel=MBARI%28MontereyBayAquariumResearchInstitute%29 20. The cycle of an Argo Float: https://www.youtube.com/watch?v=YkctZlQgU0g&ab_channel=BureauofMeteorology 21. Argo Floats: How do we measure the ocean? https://www.youtube.com/watch?v=WGbanFvBX38&ab_channel

	=IMOS5395 The following references are included in the “Adopt a float” educational programs’ webpage. 22. THE ADOPT A FLOAT EDUCATIONAL PROGRAM: https://adoptafloat.com/ 23. The adopt a float handbook Everything you need to know about the school year: https://doc.adoptafloat.com/en/documents/guides/Guide-Adopt-a-Float-annee-scolaire(Handbook)-EN.pdf 24. Adopt A float Program, Guide to understanding and using profiling flow data: https://doc.adoptafloat.com/en/documents/guides/interactive-map-handbook-adopt-a-float.pdf 25. Share research with the oceanographers and discover our oceans: http://www.monoceanetmoi.com/web/index.php/en/ 26. Share research with the oceanographers and discover our oceans Quiz and Games: http://www.monoceanetmoi.com/web/index.php/en/quizzes-and-games
Additional resources, e.g., websites, printed material, software, data sets, etc.	F. Santoro et al. (eds). 2017. Ocean Literacy for all: a toolkit. IOC Manuals and Guides, IOC-UNESCO Venice and UNESCO Paris, pp. 100-107, 117-119, 125-127: https://unesdoc.unesco.org/in/documentViewer.xhtml?v=2.1.196&id=p::usmarcdef_0000260721&file=/in/rest/annotationSVC/DownloadWatermarkedAttachment/attach_import_2d3dfb02-da9b-410a-9386-dd31047e6ef0%3F_%3D260721eng.pdf&locale=en&multi=true&ark=/ark:/48223/pf0000260721/PDF/260721eng.pdf#%5B%7B%22num%22%3A996%2C%22gen%22%3A0%7D%2C%7B%22name%22%3A%22XYZ%22%7D%2C-125%2C842%2C0%5D
EU Blue Schools criteria	**Compulsory criteria** ✓ Produce a clear output (e.g., crafts, posters, articles). ✓ Develop a project with interlinked activities (e.g., integration with the school curriculum/pH, carbon cycle, nitrogen cycle, primary production etc.). ✓ Involve all pupils (e.g., all pupils of the classroom). ✓ Collaborate with a local partner (e.g., research organization, authorities). ✓ Communicate project results (e.g., art exhibition, posters).

	Optional criteria: ✓ Provide authentic learning experiences (e.g., fieldwork and lab activities). ✓ Work multi- or interdisciplinary (e.g., physics, language, geology, STEM, ICT, biology, chemistry, arts). ✓ Mobilize beyond the classroom (e.g., all pupils of the school). ✓ Bring in a European dimension (e.g., eTwinning, ERASMUS+ BlueS_Med https://platform.blueschoolsmed.eu/cms/). For more examples on EU blue school projects Copejans E., Besançon M., Lourenço C., Batista V., Soares S., Noronha A., European Commission (2020). A wave of European Blue Schools. Handbook for teachers. 2020. European Commission, Directorate-General Maritime Affairs and Fisheries, Brussels, pp. 59-62, 75, 78, 96-100: https://maritime-forum.ec.europa.eu/document/download/0e460a07-428c-4b0d-a4b4-2d82b999b6ee_en?filename=Handbook%20for%20Teachers%20-%20European%20Blue%20Schools_0.pdf

A project by

hcmr ΕΛΚΕΘΕ

iMBBC ΙΘΑΒΒΥΚ

CNR ISMAR ISTITUTO DI SCIENZE MARINE

Sveučilište u Zadru
Universitas Studiorum
Jadertina | 1396 | 2002 |

In collaboration with

ΔΗΜΟΚΡΙΤΕΙΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΘΡΑΚΗΣ DEMOCRITUS UNIVERSITY OF THRACE

emsea

SEA TEACH

BIBLIOTECA DARIO NOBILI

Graphics by

Debora Mazza, Maria Cheimonopoulou

BLUE MINDS 4 TEACHERS

#EU4Ocean
#Youth4Ocean
#EUBlueSchools

BlueMinds4Teachers is implemented with the support of the EU4Ocean Coalition funded by the European Commission