D2.1

Blue education in Europe: a stocktaking exercise

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Authors	Yolanda Koulouri, Evy Copejans, Evelyn Paredes Coral, Dominika Wojcieszek, Farhat Nascimento Bajwa, Manon Berge, Pierre Strosser
Contributing Partners	ALL
Reviewers	
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List of Tables

List of Figures

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- Key enablers
- Impacts
- Funding
- Blue stakeholders
- EU Blue School Program

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Table of Contents

1. Introduction & Background

1.1. Purpose of the report

The purpose of this BlueLightS report is to provide a comprehensive overview of the current state of blue education in Europe, highlighting the progress, challenges, and opportunities within this rapidly evolving field. Blue education, which encompasses teaching and learning related to the marine and freshwater environments, is increasingly recognized as vital for fostering a sustainable and resilient future. This report aims to map out existing initiatives, policies, and educational practices across Europe, examining how countries are embedding marine and freshwater literacy into their educational systems.

While the blue economy grows and gathers focus, Europe faces significant environmental challenges, from climate change to biodiversity loss. The need for an informed and engaged population has never been more urgent. This report seeks to assess how blue education is contributing to this need by equipping learners of all ages with the knowledge and skills required to understand, protect, and sustainably manage aquatic ecosystems. By analyzing the current landscape of blue education, the report also aims to identify gaps and areas for improvement.

Based on this report, the BlueLightS project will later offer recommendations to policymakers, educators, and stakeholders on how to enhance and expand these crucial educational efforts across Europe by developing a Framework to Strengthen Blue Education in Europe that will be tested in 9 experimentation countries.

1.2. Definition of Blue Education

In short, blue education stands for **teaching and learning related to the marine and freshwater environments**. So far, the term Ocean Literacy has been recognized around the world to describe all education on the ocean, seas and coasts. But as this report assesses both the state of freshwater and marine education, we adopted the term ‘blue education’. No clear definition of blue education was found in scientific publications, apart from references to education in maritime professions and the blue economy.

For purpose of research in this report, the consortium of BlueLightS defined a more detailed working definition based on several keywords (**Figure 1**):

> ***Blue education*** *encompasses a broad spectrum of learning experiences designed to deepen individuals' connection with aquatic environments by increasing awareness, understanding, and appreciation of marine and freshwater ecosystems and the pressures they face. This approach educates individuals on the potential for economic development and innovation within the blue economy, while promoting values and responsible behaviours essential for the protection and sustainable use of aquatic resources. Blue education spans formal educational programs and non-formal initiatives focused on ocean literacy, aquatic conservation, sustainability, and blue careers. It plays a crucial role in empowering individuals to become informed citizens capable of addressing the challenges facing our aquatic environments.*

Figure 1. Keywords associated to the definition of blue education

1.3. Importance of Blue Education

Blue education is increasingly recognized as a vital component in addressing the environmental and societal challenges of the 21st century. As our planet faces mounting pressures from climate change, overfishing, pollution, and habitat destruction, the health of our marine and freshwater ecosystems has never been more critical. Blue education plays a crucial role in fostering an understanding of these challenges and the complex interconnections between human activities and aquatic environments.

Ocean literacy, a key aspect of blue education, equips individuals with the knowledge and skills needed to understand the ocean's influence on our lives and our impact on the ocean. This awareness is essential for developing informed citizens who can make responsible decisions and advocate for sustainable practices. By integrating blue education into curricula and public outreach, we can cultivate a generation that values and protects aquatic resources, recognizes the economic and ecological benefits they provide, and understands the urgency of conservation efforts.

Moreover, blue education is vital for driving innovation and sustainable development within the blue economy. As sectors like marine biotechnology, renewable energy, and sustainable fisheries grow, there is a growing need for a workforce equipped with the knowledge and skills to lead these industries responsibly. Blue education not only prepares individuals for careers in these fields but also installs a sense of stewardship that is essential for long-term sustainability.

"To be truly green, we also need to think blue"
Virginijus Sinkevičius, EU Commissioner for Environment, Oceans and Fisheries

said when addressing how the EU blue economy will help to deliver both the European Recovery and the European Green Deal.

Blue education, with its focus on marine and freshwater environments, serves as a natural extension of green education, which traditionally emphasizes land-based ecosystems and sustainability. By highlighting the interconnectedness of land and water systems, blue education complements green education, offering a more holistic understanding of environmental issues like climate change and biodiversity loss. Integrating blue education into green education ensures that learners grasp the vital role aquatic environments play in supporting life on earth and fostering sustainable practices across both land and sea, enriching the overall approach to environmental education.

Land-based economies have a significant impact on the ocean through activities such as agriculture, industry, and urban development. These activities contribute to pollution, including runoff of chemicals, plastics, and waste, which flow into waterways and ultimately reach the ocean, affecting marine ecosystems and biodiversity. Educating pupils about these connections is essential to fostering a holistic understanding of ocean health.

In summary, blue education and ocean literacy are fundamental to creating a society that is more informed, engaged, and capable of addressing the complex challenges facing our aquatic environments. By empowering individuals with knowledge and fostering a deeper connection to the ocean and freshwater systems, we can better equip society to protect and sustainably use these vital resources for future generations.

Blue education plays a crucial role in shaping ocean literate and responsible citizens who are equipped to address current and future challenges related to marine and freshwater.

1.4. Historical context of Blue Education

The modern **Environmental Education** movement gained significant momentum in the late 1960s and early 1970s, as more people started getting concerned about radiation, the chemical pesticides mentioned in Rachel Carson's Silent Spring, as well as the air pollution and waste. Along with the birth and development of Environmental Education, education focusing on the aquatic world arose. It was the time when the first photos of the Earth from outer space revealed the magnitude of how blue our planet is.

> How inappropriate to call this planet “Earth” when it is quite clearly “Ocean”
> Arthur C. Clark, British science fiction writer and under-sea explorer

The term **Marine and Aquatic Education** was adopted for the next couple of decades and in parallel with the progress in Environmental Education followed a similar path in the ’70s and ’80s through a series of grassroots publications (see Mogias et al., 2022 and references therein).

However, in the mid-’90s Marine and Aquatic Education was highly marginalized, while a lack of ocean-related subjects was realized by US educators in their school curriculum. As a result, different workshops were carried out (2000-2004) by organizations such as National Science Foundation, Center for Ocean Sciences Education Excellence, National Geographic Society, College of Exploration, National Marine Educators Association, National Oceans and Atmospheric Administration Office of Education, Lawrence Hall of Science, University of Berkeley, Sea Grant College Program, bringing together educators, scientists and policy makers to share their ideas regarding the important concepts that every person should understand about the ocean and its resources.

The definition of **Ocean Literacy (OL)** -understanding the ocean's influence on us and our influence on the ocean- was developed through this community-wide consensus-building process. According to this definition, an ocean-literate person understands ocean science issues, can communicate about the ocean in a meaningful way and is able to make informed and responsible decisions regarding the ocean and its resources (Cava et al., 2005). As a result, a comprehensive framework was developed including: a) a set of seven principles and 45 concepts (OL Guide); b) a pedagogical guide for teachers to use ocean content to teach science in schools from kindergarten to high school (OL Scope & Sequence for Grades K-12); c) a guidance about when and how ocean concepts should be strategically inserted into the K-12 science curriculum (Alignment of OL to the Next Generation Science Standards); d) a community-based measurement tool (International OL Survey) that allows the comparison of levels of ocean science knowledge among 15 to 17 years old to show progress of the OL campaign (Fauville et al., 2018a).

The OL Guide proved to be so successful that influenced other disciplines and became a model for additional "literacy guides", not only within the context of the aquatic world (e.g., Great Lakes, Estuarine, Mediterranean Sea Literacy) but within other targeted environmental contexts such as Climate, Energy, Earth science, and Forest Literacy. The ongoing evolution of OL was explored in depth by Brennan et al. (2019) and McKinley et al. (2023) who expanded the original education-based framing of OL, proposing other dimensions of OL: (i) awareness, (ii) knowledge, (iii) attitude, (iv) communication, (v) behaviour, (vi) activism, vii) emotional connections, viii) access and experience, ix) adaptive capacity, x) trust and transparency. Stoll-Kleemann (2019) also highlighted key internal (e.g., emotions and values) and external factors (e.g., socio-cultural and politico-economic), as well as the internal (e.g., social norms and moral involvement) and external drivers (e.g., economic incentives) that impact behaviour change and can therefore increase the effectiveness of ocean literacy. Respective associations and networks around the world were created that could facilitate the integration and enhancement of OL guide to the specificities of the various regions. As such, the International Pacific Marine Educators Network (IPMSN) was formed in 2007, while the European Marine Science Educators Association (EMSEA) was founded in 2011. Soon after that, the Canadian Network for Ocean Education (CaNOE) was formed in 2014, a year later the Asia Marine Educators Association (AMEA), and the Latin American Education Network for the Ocean (RELATO) followed. In parallel, several initiatives were developed at the regional and/or national level, such as the Korean Marine Education Association, the EMSEA regional groups (EMSEA-Baltic, EMSEA-Atlantic, EMSEA-Northern Seas, EMSEA-Med), and the Ocean Literacy Italia. Multiple important parallel concepts were also incorporated, including marine citizenship, stewardship, and ocean connectedness (see McKinley et al., 2023 and references therein).

In 2012, the first international conference on OL in Europe, organized in Bruges, brought together marine scientists, educators and policy makers to address the lack of marine content in science education and emphasized the importance of formal and non-formal education for public involvement and active participation. While OL started as a grassroots movement in the US and was eventually incorporated into the US curricula, the situation in Europe was different as OL received no legal validation or endorsement of its existence. Despite this, several institutional frameworks were being put in place at the time (Mokos et al., 2022). In 2013, the Marine Institute in Galway hosted an international meeting to promote transatlantic ocean research cooperation, issuing the Galway Statement. The agreement -signed by the EU, the US and Canada- aimed to align ocean observation efforts as to better understand the Atlantic Ocean, to promote the sustainable management of its resources and to promote OL with their citizens. An OL Working Group was established and charged with defining a strategic path forward for Transatlantic Ocean Literacy, to be informed by international stakeholders representing ocean science, formal and non-formal education, government, marine education, business, industry and policy (Mokos et al., 2022). In 2017, the Belem Statement was launched with the aim of uniting research in the north and south Atlantic through enhancing cooperation between Brazil, South Africa, and the EU. In response to its commitment to promoting OL to EU citizens, the European Commission stepped forward and supported large OL projects and initiatives within the framework of Horizon 2020. The SeaChange project aimed to make a profound "Sea Change" in the way European citizens view the sea, by

empowering them to make environmentally responsible decisions. The goal of the ResponSEAble project was to encourage European citizens to improve their understanding of the human-ocean relationship.

In parallel, the work of the United Nations Decade of Education for Sustainable Development (2005-2014) and the Global Action Programme (GAP) on Education for Sustainable Development (2015-2019) were in progress continued later by UNESCO, the UN leading agency for Education for Sustainable Development (ESD) and responsible for the implementation of the current global framework of ESD for 2030. The 2030 Agenda for Sustainable Development was adopted by all United Nations Member States in 2015 including 17 Sustainable Development Goals (SDGs), which are an urgent call for action by all countries. The approval of a stand-alone goal on the ocean (i.e., SDG 14) has been a major achievement for the global ocean community. In 2017, UNESCO with support from the Swedish government held an "Ocean literacy for all" Conference in Venice while the "Ocean Literacy for All: A Toolkit" and an OL platform were developed to introduce the principles and methods of OL. Even though OL started as a knowledge concept, it evolved to a multi-perspective approach (the scientific, the historical, the geographic, the gender equality, the value, the cultural, and the sustainability) that promotes interdisciplinary and intercultural competencies. This is the time when the United Nations declared the Decade of Ocean Science for Sustainable Development (2021-2030), seeking to contribute to the achievement of the SDG14 of the UN Agenda 2030 and to extend its scope to fill the gap from "the ocean we have" to "the ocean we want". The concept of OL is central to operationalizing Challenge 10 and United Nations Ocean Decade legacy.

The aim of Challenge 10 is to:

> ensure that the multiple values and services of the ocean for human well-being, culture, and sustainable development are widely understood, and identify and overcome barriers to behaviour change required for a step change in humanity's relationship with the ocean

In 2020, the European Ocean Coalition (EU4Ocean) was established to connect different organizations, projects and people to collaboratively advance OL across European countries. The aim was to increase awareness and engagement of different stakeholders involved in the sustainable management of ocean and seas, and to put OL high on the policy agenda, contributing to the implementation of the EU marine and maritime policies and the achievement of the SDG 14. This Coalition established three different components aiming at different stakeholders: a) EU4Ocean Platform, which connects organizations, initiatives and people, to join forces to deliver a more coordinated approach to OL activities in Europe, including the exchange of expertise, knowledge, and best practices; b) Youth4Ocean Forum, a platform for young people between 16-30 where members can develop projects and initiatives addressing ocean challenges; and c) Network of European Blue Schools (see **chapter 4**), where teachers have a key role in promoting OL to their students and communities by including the ocean into their classroom. Blue Schools are new school ecosystems that foster the acquisition of ocean knowledge, skills and competencies. Blue education will allow students to address local to global challenges and will enable them to become independent while able to perform active, critical and responsible teamwork. This is the step forward to the inclusion of OL in formal education in several European countries.

In 2022, a Charter for Blue Education in Europe "Supporting transformative changes to deliver ocean sustainability" was issued and signed by different EU organizations who share common ambition and philosophy to engage pupils in ocean knowledge and conservation and to inspire youth to integrate the ocean in their education, careers and lives. Life-long and community-wide approaches to education for sustainable development, global challenges and citizenship is critical to instigate and deliver the required transformative changes. It will require specific attention in

the years to come so all citizens acquire the necessary knowledge, skills, values and attitudes that can support a (pro-) active (individual and collective) role delivering these changes. This collective effort, in line with the European Commission's Council Recommendation COM/2022/11 on learning for environmental sustainability will support the EU4Ocean Coalition and its Network of European Blue Schools. It will contribute to the blue education and OL efforts carried out within the frame of the United Nations (UN) Decade of Ocean Science for Sustainable Development including the IOC-UNESCO initiative on Blue education Curricula.

Previous studies and pilot projects indicate that youth and school mobilisation and engagement and ocean and water literacy activities need to be linked with clearly defined goals and be focused on concrete actions and projects. Mission "Restore our ocean and waters by 2030" offers the opportunity to develop and implement projects by the students themselves, with the support and contribution of their schools, teachers and wider community, based on the established principles and practices of OL and the general framework on education for sustainability. The sister projects BlueLightS, SHORE and ProBlue (see **Chapter 3**) are expected to contribute, beyond being a pre-requisite for accreditation under the Network of European Blue Schools, to the implementation of Mission objectives.

2. Methodology

2.1. Scope of the assessment

The purpose of this section is to ensure a clear understanding of what was assessed and the rationale behind the chosen scope. The geographical scope of the analysis is at the European level. This coverage allows for a comprehensive examination of trends, patterns, and impacts across sea basins. By doing so, the analysis ensures that findings are representative of the entire European Union (EU), facilitating the identification of both common challenges and unique regional and national variations. This scope is crucial for developing holistic recommendations relevant to the diverse contexts within the EU.

The temporal scope of the assessment covers the period from 2003 to 2023, providing a comprehensive 20-year period for analysis. This timeframe allows for the examination of trends, the identification of patterns, and the assessment of temporal variations. By encompassing two decades, the assessment can explore the influence of international events, policy changes, and technological advancements relevant to blue education.

The assessment will cover the marine domain defined as the ocean, seas and coastal waters, and the freshwater domain, defined as inland water such as streams, rivers, lakes and wetlands.

The educational scope of the analysis encompasses both formal and non-formal education. Formal education refers to education that is institutionalized, intentional and planned through public organizations and recognized private bodies and, in their totality, make up the formal education system of a country. Formal education programmes are thus recognized as such by the relevant national educational authorities or equivalent (ISCED, 2011). Non-formal education refers to education that is institutionalized, intentional and planned by an education provider. The defining characteristic of non-formal education is that it is an addition, alternative and/or a complement to formal education within the process of the lifelong learning of individuals. It is often provided to guarantee the right of access to education for all. It may be short in duration and/or low intensity, and it is typically provided in the form of short courses, workshops or seminars. Non-formal education can cover programmes contributing to education for out-of-school children, as well as programmes on life skills, work skills, and social or cultural development (ISCED, 2011). Informal education, which occurs through daily interactions and experiences without a structured curriculum, will not be considered in this analysis. While informal education plays a role in the overall educational landscape, it falls outside the scope of this project due to the challenges in identifying and delineating it from non-formal education. This approach ensures that our efforts are directed towards formal and non-formal settings, where initiatives can be more precisely documented.

The analysis focuses on the educational stages of primary and secondary school, encompassing grades from the first year of primary education (equivalent to 6-12 years old) through the final year of secondary education (equivalent to >12-18 years old; this can include technical and vocational training institutes). Nursery and kindergarten levels are excluded from this study, as the assessment aims to concentrate on the more advanced stages of formal education where foundational knowledge and skills are further developed and critical academic milestones are achieved.

Data collection will build upon this foundation to present the findings and the state of play of Blue Education in Europe.

Definitions

- **Formal education**: Education that is institutionalized, intentional and planned through public organizations and recognized private bodies and, in their totality, make up the formal education system of a country. Formal education programmes are thus recognized as such by the relevant national educational authorities or equivalent, e.g. any other institution in co-operation with the national or sub-national educational authorities. Formal education consists mostly of initial education. Vocational education, special needs education and some parts of adult education are often recognized as being part of the formal education system (ISCED, 2011).
- **Non-formal education:** (including extracurricular activities carried out by schools): Education that is institutionalized, intentional and planned by an education provider. The defining characteristic of non-formal education is that it is an addition, alternative and/or a complement to formal education within the process of the lifelong learning of individuals. It is often provided to guarantee the right of access to education for all. It caters for people of all ages but does not necessarily apply a continuous pathway-structure; it may be short in duration and/or low intensity, and it is typically provided in the form of short courses, workshops or seminars. Non-formal education mostly leads to qualifications that are not recognized as formal qualifications by the relevant national educational authorities or to no qualifications at all. Non-formal education can cover programmes contributing to adult and youth literacy and education for out-of-school children, as well as programmes on life skills, work skills, and social or cultural development (ISCED, 2011).
- **Informal education:** Informal learning is learning by activities that are not undertaken with a learning purpose in mind. Informal learning is involuntary and an inescapable part of daily life; for that reason, it is sometimes called experiential learning. While informal education plays a role in the overall educational landscape, **it falls outside the scope of this project** due to the challenges in identifying and delineating it from non-formal education. This approach ensures that our efforts are directed towards formal and non-formal settings, where initiatives can be more precisely documented.

2.2. Data collection

2.2.1. Scientific mapping of publications on blue education

Publications on blue education were obtained from Web of Science (WoS) database from May to July 2024. The search criteria were restricted to publications which title, abstract or keywords included the terms: “blue/marine/ocean/aquatic/water education”, “blue/sea schools”, “education for sustainable development”, “blue/ocean connection”, “water education”, “ocean/sea literacy”, “water literacy”, “blue/ocean/marine awareness”, “blue curricula”, “blue careers”, “blue economy”, "eco schools" and "sustainable schools".

The keywords used for the search criteria were obtained from the working definition of blue education and the keywords proposed by the partnership. Publications were retrieved from the database’ custom data until 2023. Documents published in 2024 were also retrieved for referential purposes but were not included in the analysis. Only documents published in peer-reviewed journals such as article, review and conference paper categories were used. A total of 79 publications on marine education and 26 publications on freshwater education were retrieved and used for analysis. Publications retrieved from WoS were manually analysed to checked for duplicates, and then classified in thematic topics. In addition, 592 publications on sustainability education, education for sustainable development and teacher’s training were collected. Despite they did not explicitly mention the marine or freshwater domain, they were relevant for referential purposes.

2.2.2. Mapping initiatives and projects on blue education

To collect data on blue education initiatives and projects, a comprehensive methodology was employed. We compiled a list of relevant projects and initiatives related to blue education in Europe, ensuring to include both experimentation and non-experimentation countries to capture diverse initiatives. In a collective effort, multiple open data sources were used, including the Ocean Edge Directory (SeaChange project), the Online Directory of Black Sea Literacy Initiatives (BRIDGE-BS project), contribution from project partners, from sources such as government and non-governmental organization websites, institutional repositories, and online platforms dedicated to project documentation. To organize the data into a structured database, we categorized each entry by title, URL, description, affiliation type, target audience, activity type, country, language and starting year. Data on initiatives was collected between May and July 2024. In addition, a repository of related references was set up and include grey literature on blue education.

Results from the survey[1] carried out from May 1 to May 30, 2024, in the framework of WP3 targeting experimentation countries was used to complement the database on blue education initiatives as well as to complement results from scientific mapping regarding impacts, bottlenecks and optimal conditions to mainstreaming blue education. Moreover, examples on national and regional initiatives were gathered from the presentation of experimentation countries carried out in the framework of WP3.

An additional survey targeting teachers from the Network of European Blue Schools (NEBS) was conducted in June 2023 by the NEBS' secretariat to gather information on the bottlenecks and optimal conditions for establishing blue schools (see **Chapter 4**).

2.2.3. Targeted interviews

To collect data on blue education and to validate the categorization of thematic areas obtained from the analysis of scientific publications, we conducted targeted interviews with experts. We identified and selected a diverse group composed of experts from the project Advisory Panel and external experts in relevant fields such as "curricula development", "education for sustainable development", "marine education programmes", among others, ensuring a broad representation of perspectives. A structured interview guide comprising five open-ended questions was developed and covered key thematic areas of blue education. The interviews were conducted in June and July 2024, either in person or via Teams and Zoom, allowing for flexibility and deeper exploration of topics. **Annex 8.1** includes all questions used during the interviews with experts.

Additional data collected from complementary interviews with experimentation countries carried out from July 4-11, 2024, in the framework of WP3 (Task 3.1), was used to gather insight from experimentation countries in which some questions from the survey conducted in Task 3.1 needed clarifications. These countries included: France, Croatia, Spain, Portugal and Finland. Prior to the interviews, a list of questions was sent to be used as guidelines during the interviews.

Interviews with experimentation countries, building on the ongoing work in WP3 were carried out from July 3 to August 19, 2024, to develop detailed assessment of specific programmes and initiatives that have been institutionalised to support the strengthening of blue education in the following experimentation countries: Sweden, Greece, Croatia, Portugal, Spain, Romania, Finland, France and Belgium. These interviews aimed at capturing: (1) the history and

[1] D3.1-A report on proposed blue education experimentation in selected countries

chronology of the development of the initiative/programme (from an initial idea to a fully institutionalised programme); (2) factors that have helped supporting, or constraining, the development of specific programmes, networks or collective initiatives over time; and (3) how these have been translated into impacts.

While complementary interviews conducted as part of Task 3.1 were carried out with some experimentation countries, detailed descriptions of (national or regional) initiatives and programmes supporting the development of blue education were done only for experimentation countries for which such initiatives and programmes have been developed.

Additional data collected from complementary interviews with selected experimentation countries was used to provide insights on the development, historical influences and status of key instruments to deliver blue education aiming to support the development of Blue Education in Europe. These countries included: Greece, Ireland, Portugal, Sweden, France and Spain (6 out of 9 experimentation countries). The semi-structured interviews were carried out between July and August 2024, as follows: Sweden (03/07), Greece (11/07), Croatia (12/07), Portugal (17/07), Spain (18/07), Romania (31/07), Ireland (01/08), Finland (07/08), and France (19/08). The formal interviews had the duration of 1 hour, exception of Ireland (2 hours), with a set of guided questions that was previously shared with the partners and adapted for each country's instrument. The questions started on the development of blue education in the respective country (formal and non-formal education), followed to a targeted interview on the main instrument contributing to blue education, including: (a) functioning of the instrument; (b) historical perspective; (c) challenges; and (c) impacts. This flexible approach allowed gathering detailed information on the country's instrument and understand key events that contributed to the development or constrains of a certain program or initiative. For more information, see **Annex 8.2.**

2.3. Data analysis

2.3.1. Scientific mapping of publications on blue education

Bibliometric analysis was carried out using Bibliometrix R package. Bibliometrix is an open-source tool that enables a descriptive and quantitative analysis of the bibliographic data as well as data visualization (Paredes Coral et al., 2021). The analysis focused on the identification of the main features, including indicators of growth, such as number of publications per year, number of authors, institutions and publishing outlets. Publications were categorized as marine or freshwater, according to their primary focus and context of the research by conducting content analysis of titles, keywords, and abstracts of each publication. This process not only provided clarity and organization to the body of literature but also facilitated targeted research and further description of each domain, enhancing the overall understanding of trends and priorities in both marine and freshwater environments.

In addition, publications collected for referential purposes together with the ones on blue education (n=694) were categorized into thematic areas following a rigorous content analysis of their titles, keywords, and abstracts. This approach ensured that each publication was accurately assigned to relevant themes based on the core concepts it addressed. By analysing the titles, we identified the primary focus of each publication, while the keywords provided insight into specific areas of interest and methodology. The abstracts were examined to understand the broader context, objectives, and conclusions of the studies. This thorough content analysis allowed us to classify the publications into several themes facilitating a structured and comprehensive review of the existing literature on blue education.

2.3.2. Mapping initiatives and projects on blue education

The database of initiatives was meticulously compiled, checked for duplicates and entries that were not projects or initiatives were removed. Each initiative was classified by country considering the country's coordinator organisation, allowing for a geographic segmentation that facilitated the identification of regional trends and patterns. Furthermore, these initiatives were categorized by sector, considering the coordinator organisation. The sector categories included: (1) Research organisation/centre/institute, (2) Academia: private/public educational institutions, (3) Private sector, (4) Public sector, (5) Learning infrastructures: aquaria and museums; and (6) Others: networks, communities of volunteers and NGOs. This sectoral classification enabled a detailed examination of the specific areas of focus within the education landscape. The data was then subjected to qualitative analyses to provide deeper insights into the nature and impact of the initiatives.

To provide a comprehensive understanding of the blue education landscape in Europe, both publications and initiatives on blue education were included in a unified graphic representation. This integrated approach allowed for a holistic view, including both the academic and practical initiatives in blue education. By plotting publications alongside projects, we aim at illustrating potential synergies between scientific research and its practical applications.

2.3.3. Targeted interviews

Initially, the interviews were recorded and transcribed prior to analysis. Following transcription, content analysis was conducted to identify recurring themes. Content analysis of interviews involved systematically examining the text of interview responses to identify patterns and themes. The process started by coding, meaning that key phrases, words, or concepts from the interview transcripts were labelled or categorized. These codes were then grouped into broader categories or themes that capture the main ideas or topics discussed by the interviewees. By analysing the frequency and context of these themes, one can uncover common trends, providing insights into the participants' perspectives and experiences. These themes were reviewed and refined to ensure they accurately represented the experts' perspectives. The insights gained from the interviews will serve a dual purpose: first, they will provide a deeper understanding of the experts' views on the current educational landscape, and second, they will be used to validate the preliminary results obtained from scientific mapping. By cross-referencing the themes from the interviews with the findings from the scientific mapping, we aim to corroborate and enhance the validity of our initial results, thus ensuring comprehensive and well-supported state of play.

The information obtained from the semi-structured interviews contributed to develop a detailed assessment that have been institutionalised to support blue education in selected experimentation countries (Sweden, Greece, Spain, Portugal, Ireland and France) with the aim at capturing the (1) the history and chronology of the development of an instrument; (2) factors that have helped supporting, or constraining, the development of the instrument over time; and (3) how challenges were overcome and been translated into impacts, as summarised in **Table 1**.

Table 1. BlueLightS semi-structured interviews on key instruments in experimentation countries

Country	Key instrument
Sweden	Marine Network for Water Education and Network for Limnic Pedagogy
Greece	Framework for Terrestrial and Marine Education
Portugal	Escola Azul and Educar para uma Geração Azul program
Spain	Green Schools in Catalonia
Ireland	Explorers Educational Program
France	Educational Marine and Terrestrial Areas

Data have been analysed based on the information gathered from the semi-structured interviews, focus groups and participation of external partners and a follow-up has been made with all countries in August. Even though all experimentation countries (9) participated in the semi-structured interviews, the present report only focus on instruments from selected countries due to recent establishment or a lack of a specific program, initiative or framework. For more information on data analysis, see **Annex 8.2**. Due to the complexity of the blue education landscape and the national instruments, there may be gaps in capturing the complete overview. For this reason, the instruments present in **Annex 8.2** should be considered according to the historical perspective for its development and be used as a source of inspiration and guidance to support the development of blue education in Europe.

2.3.4. Data disclaimer

The database of blue education initiatives was meticulously compiled by the BlueLightS partnership, with thorough checks conducted across EU countries. However, it is important to note that some initiatives may not be included in our dataset due to language barriers or limitations in the scope of our data collection efforts. While every effort was made to ensure comprehensive coverage, the data may not fully capture all existing initiatives in the region.

3. Current State of Blue Education in Europe

3.1. Key policies and strategies supporting Blue Education in Europe

In recent years, the importance of the marine and freshwater environments has gained recognition across Europe, with numerous countries developing comprehensive strategies to ensure their sustainable management. The interconnectedness of marine and freshwater systems with societal well-being, economic development, and environmental sustainability has led to the integration of these themes into national policies.

The European Union has comprehensive maritime and marine policies and strategies which often guide the national policies of its member states. Ocean literacy and blue education are increasingly recognized as components of EU policies and strategies related to the marine and maritime environment, according to a first review of ocean literacy in European Maritime Policies (French et al., 2015). Today, ocean literacy, although not mentioned by name, is a strategic objective of the EU's Mission Restore our Ocean and Waters under its Green Deal.

3.1.1. Blue education in EU policies and strategies

Ocean literacy and blue education are integral components across several key EU policies and strategies, though the emphasis and terminology may vary. While few documents explicitly use the term "ocean literacy," the underlying principles of educating and engaging the public, promoting sustainable practices, and fostering an understanding of marine and water-related issues are consistently highlighted. **The Mission Ocean, European Strategy for a Sustainable Blue Economy, and EU Marine Strategy Framework Directive** are particularly notable for their direct focus on public engagement, education, and the development of blue skills.

Here we present the findings of how these concepts are integrated into some of the key EU frameworks:

- **Integrated Maritime Policy (IMP)** aims to foster the sustainable development of seas and oceans while coordinating all maritime affairs across sectors and borders. It supports initiatives (e.g. education and outreach programs) that enhance knowledge about the marine environment and understanding of maritime issues. It also promotes the "European Maritime Day" to raise awareness about the maritime sector.
- **Common Fisheries Policy (CFP)** regulates fishing activities within the EU to ensure sustainable fish stocks and protect the marine environment. It includes provisions for increasing public awareness of sustainable fishing practices and the importance of marine resources conservation. Education and training programs are also encouraged to ensure that those involved in the fisheries sector understand sustainable practices and the ecological impacts of fishing.
- **EU Green Deal and its Mission Ocean, Seas and Waters** aim to transform the EU into a resource-efficient and competitive economy, including components related to the blue economy. As part of the Horizon Europe framework, its mission aims to protect and restore the health of oceans, seas, and inland waters by 2030 by increasing ocean literacy and public engagement, particularly younger generations. Educational programs such

as the blue schools and citizen science projects are key components for this purpose. It also supports the development of green and blue skills for sustainable economy.

- **European Water Framework Directive (WFD)** is the EU's primary legislation for protecting inland surface waters, groundwater, and coastal waters. Education on water management and the importance of protecting water resources is encouraged to ensure public understanding and involvement in water conservation efforts.
- **European Strategy for a Sustainable Blue Economy** aims to promote a sustainable blue economy across the EU, balancing economic growth with the health of marine ecosystems. It highlights the importance of developing blue skills and enhancing ocean literacy as part of its goals. It promotes education and training in blue economy sectors, such as marine renewable energy, sustainable fisheries and aquaculture, and maritime transport.
- **EU Marine Strategy Framework Directive (MSFD)** is designed to protect the marine environment across Europe by achieving good environmental status (GES) of the EU's marine waters. It encourages member states to implement programs that educate the public about marine environmental issues, engage citizens and stakeholders in the protection of marine environments.
- **OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic: North-East Atlantic Environment Strategy (NEAES)** is responsible for the protection of the marine environment of the North-East Atlantic. OSPAR's focus on public engagement and the dissemination of information aligns with the broader goals of ocean literacy and blue education, contributing to a better-informed public that is equipped to support marine environmental protection efforts.
- **EU Maritime Spatial Planning (MSP) Directive** aims to promote sustainable growth of maritime economies, sustainable development of marine areas, and sustainable use of marine resources. It encourages member states to integrate maritime spatial planning into educational and vocational training programs to build expertise in managing marine and coastal areas.
- **Atlantic Strategy and Action Plan 2.0 (2020-2025)** aims to enhance marine and maritime knowledge, improve ocean governance, and foster innovation and economic growth while protecting the marine environment. It emphasizes the need to develop skills and promote ocean literacy to ensure a knowledgeable and skilled workforce for the blue economy, while increasing public awareness and engagement.
- **The European Commission's Council** Recommendation COM/2022/11 on learning for the green transition and sustainable development sets out how sustainability can be integrated into all aspects of education and training while published the European competence framework on sustainability ('GreenComp') in January 2022.

3.1.2. Blue education in national strategies and policies

Across Europe, countries have adopted various strategies that reflect their unique geographical, cultural, and ecological contexts. Each country has tailored its approach to address national priorities while aligning with broader European and global sustainability goals. These strategies not only focus on environmental protection but also integrate educational initiatives aimed at raising awareness and promoting sustainable practices.

Blue education, which encompasses the teaching and learning about marine and freshwater ecosystems, sustainable practices, and the maritime economy, is increasingly seen as essential for fostering a society that values and protects aquatic environments. This is mostly indirectly embedded in national strategies, reflecting each country's commitment to equipping citizens, especially younger generations, with the knowledge and skills necessary to engage in sustainable practices and protection of the environment and resources.

Overall Key Themes in National Strategies

- **Marine and Coastal Strategies**: address the protection and sustainable use of marine resources. These strategies often include specific mentions public awareness and education initiatives aimed at fostering a deeper connection between citizens, communities and marine environments.
- **Water Management and Freshwater Strategies**: National Water Strategies often include components on public education and awareness, highlighting the importance of freshwater conservation and sustainable water management. These strategies emphasize the role of education in achieving sustainable water use and protecting aquatic ecosystems.
- **Education for Sustainable Development (ESD):** The ESD frameworks are often already embedded in the school curricula or educational programs. These strategies focus on equipping citizens with the knowledge and skills to make informed decisions that contribute to sustainable development goals, including the conservation of marine and freshwater environments (referring to SDG 14).
- **Biodiversity Strategies and Climate Plans:** both emphasize education and awareness about the importance of biodiversity and climate change in marine and freshwater environments.
- **Marine Research Strategies:** While they focus mostly on advancing marine research and innovation, they often highlight the need for specialized education and training programs.

These national strategies reveal a country's commitment to embedding marine and freshwater education within formal and non-formal learning environments, including curriculum development, public outreach programs, and professional training initiatives designed to build capacity in marine and freshwater management.

Furthermore, and based on the semi-structured interviews from selected experimentation countries (see **Annex 8.1**), national policies, strategies and/or initiatives related to blue education were identified for Spain, Ireland, France, Portugal, Sweden, and Greece that can be further used for the design, development and implementation of their experimentation plans (**Table 2**). Blue education in national policies and strategies in France is also analysed below (see also **Table 3**).

Table 2. Key instruments of blue education in experimentation countries

Instrument, country	Starting year	What it does	Main topics	Extend	Challenges encountered
"Escoles Verdes" program (Catalonia)	1998	Offering an initial training course in Education for Sustainability to schools Networking, experience sharing between schools	Sustainability, eco-social education	>1500 schools; 25% of Catalonian schools	Marginal status of outdoor education, difficulty to access nature Lack of teacher training
Explorers Program (Ireland)	2000	Delivering marine modules for the classroom and outdoor education, providing official teacher training, and developing accessible online resources	Ocean Literacy principles and SDGs	12000 children annually	Time for cross-curricular integration and translating resources into Irish. Convincing policymakers and educators of the social and economic benefits of ocean literacy
Educational Marine Areas (France)	2016	Giving a small natural territory to be managed in a participatory manner by the pupils of a school, supervised by their teachers and an environmental education organisation	eco-citizenship, sustainable development, dialogue	>1100 EMA/ETA; 75000 childrens reached	An entry cost for the teachers to learn the method, rely on their willingness. Rapidly growing policy, in need for long term funding and strong regional governance
The Escola Azul program (Portugal)	2017	Providing a supportive framework for schools, offering resources, networking opportunities, and professional development	understanding of the ocean's significance, human interconnectedness	470 schools in the network	Limited financial support for schools, mostly relying on calls for funding, fluctuation fundings from the Ministry of the Sea. Low awareness of the program, difficulty to meet in person
Educar para uma Geracao Azul program (Portugal)	2018	Training primary school teachers, providing educational resources and support throughout the school year from the 1st to the 4th grade of primary school through an interdisciplinary approach	teachers as main vectors to foster ocean literacy among children	278 schools, 1349 teachers and over 24700 students	
Regional Marine Network for Water Education; National Network for Limnic Pedagogy (Sweden)	2018	Supporting information sharing between partners and members; Informing each member of the ongoing opportunities, such as trainings, workshops, new projects; Representing the Swedish Blue Education context in international discussions about ocean and water literacy	Water and ocean literacy	(coming up by end of 2024: a survey is ongoing)	Visibility, empowering teachers. Information is not yet spread easily regarding the on-going activities and the steps of how to become a blue school are still unclear for many teachers
Framework for Environmental Education (Greece)	2023	Supporting the integration of « blue » into the school programmes Supporting the 52 Centers of Environmental Education that support non-formal education through local field trips	the student's relationship to the natural and social environment and how to tackle the problems connected to it	around 5 % of the Greek schools (mostly coastal schools) implement blue projects	Visibility among school directors and teachers Lack of guidance and collaboration opportunities under the network Financial issues, accessibility to marine ecosystems

Case study: Blue education in national policies and strategies in France

France has the world's second-largest maritime territory, surpassed only by the United States. This space gives France a strong responsibility at the international level in terms of protecting marine biodiversity. The maritime sector contributes significantly to the French culture, and economy, accounting for 14% of the nation's GDP. With an annual value of €270 billion, this sector surpasses the automotive and aeronautical industries in economic importance. But this heritage and its potential are not widely recognized within the country. There is a notable lack of attention to marine issues in public discourse, environmental and economic policy, despite France's rich maritime history, strategic geographic position, and substantial economic opportunities in this field.

However, **in its marine and maritime related strategies** (National Strategy for the Sea and Coast, French action plan 2024-2030, National Biodiversity Strategy and French ESD Strategy), **France shows a strong commitment to integrating marine and freshwater education into both formal and informal learning settings**, encompassing curriculum development and public outreach initiatives.

The country has the largest number of blue education initiatives (see **Table 3** and **Annex 8.1**), including a well-established blue school program called “Aires Marines Educatives” (Educational Marine Areas), launched since 2016 by the French biodiversity agency. The network, composed of both educational marine and terrestrial areas, is supported by government funding of 4 million euro/annually to maintain a network of more than 1000 schools managing in a participatory manner an area close to their school. Currently, there are 327 educational marine areas, working specifically on marine or coastal ecosystems. This is the largest blue education network in Europe. The

integration of blue education and sustainable development into French national strategies reflects a growing recognition of the importance of these issues.

Figure 2. Photo of activity of Educational Marine Areas in Calanques @OFB

Table 3. Example of how blue education is linked to several French national strategies

	Maritime Strategy	Biodiversity	Climate	Education for Sustainable Development ESD	Water Strategy
France	**National Strategy for the Sea and Coast** French Ministry for the Ecological Transition Refers to the importance of *sensibilisation* (awareness-raising) and *éducation à la mer* (education about the sea). Promotes integration of marine sciences and conservation into education curricula, vocational training in marine sectors, public awareness campaigns,	**National Biodiversity Strategy** French Ministry for the Ecological Transition Promotes awareness and education about biodiversity, including marine and freshwater ecosystems, in particular by setting a target of 18,000 educational areas by 2030. Integration of biodiversity education into formal and non-formal education systems.	**National Climate Change Adaptation Plan** French Ministry for the Ecological Transition Includes educational components to raise awareness about climate change impacts on marine and freshwater environments.	**French ESD Strategy** Ministry of National Education and Youth Mentions the sea and ocean in several contexts, primarily focusing on integrating marine topics into educational curricula, promoting ocean literacy, and fostering public awareness about marine conservation. **Schools as the first place to commit to the ecological transition - 20**	**National Water Strategy of France (Stratégie Nationale pour l'Eau)** French Ministry for the Ecological Transition Fosters a culture of water stewardship Supports the integration of sustainable water use into ESD programs

	cultural heritage and citizen science. Highlights the role of Marine Protected Areas in both conservation and education, suggesting that MPAs can serve as platforms for educational activities and public engagement. **French action plan 2024-2030 (marine strategy framework directive)** Specific mention of formal blue education via the objective of developing educational marine areas.			**measures for the ecological transition at school** Set the goal of establishing 18 000 educational marine or terrestrial areas (which can focus on both marine or freshwater) by 2030, representing one third of French pupils	

More information on national strategies and policies in the EU are included in sub-chapters of "Focus areas in Blue Education" and "Initiatives or other programs" of the Deliverable 3.1 A report on proposed blue education experimentation in selected countries.

3.2. Financing for blue education

Financing for blue education is gaining traction as organizations and governments recognize the need to educate people about the ocean's role in our planet's health, human well-being and our economy. Several initiatives and funding mechanisms are emerging to support this effort, primarily through grant programs, public-private partnerships and philanthropic foundations. The European Union allocates significant resources through programs like Horizon Europe for marine research and education, the application processes can be complex, and many smaller projects struggle to meet the requirements.

However, a significant part of the funding for blue education comes from the European Union who has placed ocean literacy and blue education in its strategies and policies. The following grants are found in:

- **EU4Ocean Coalition:** Funded by the European Commission's DG MARE and CINEA, this initiative unites organizations, projects, and individuals involved in ocean literacy efforts. It promotes collaboration among stakeholders from education, research, civil society, and the private sector via calls for collective action on their Challenge of the year.
- **ProBleu Project:** Funded by Horizon Europe, ProBleu aims to enhance water literacy in European schools. It provides financial support to schools developing educational projects focused on protecting oceans and freshwater ecosystems. In its first funding call, the program granted over €87,000 to 11 projects from various European countries.
- **SHORE** (Sustainable Horizons for Ocean Resilience and Engagement): This project emphasizes building resilience for coastal and ocean communities through collaborative education, policy development, and public

engagement. SHORE focuses on promoting sustainable practices in coastal regions, addressing issues such as biodiversity loss, coastal erosion, and the impacts of climate change on ocean ecosystems. SHORE provides grants to schools up to 10.000 euro per project.

- **BlueLightS:** This project is geared toward developing a comprehensive, transnational framework for education and awareness related to sustainable ocean and water practices. It connects schools, universities, and local communities to promote ocean literacy and sustainability. BlueLightS provides grants to schools up to 3.000 euro per project.
- **Erasmus+:** is a key European Union program that provides funding and opportunities for educational exchanges, training, and partnerships across Europe. For schools, Erasmus+ offers significant support to improve teaching and learning through mobility, collaboration, and innovation. Erasmus+ is a powerful tool for schools and marine educational institutes to engage in collaborative educational projects on the ocean.

While there are funding opportunities for blue education from various sources, the overall availability is often limited. Here's a breakdown of the current landscape regarding funding from government bodies, municipalities, foundations, and companies:

- **National government funding:** National governments play a critical role in financing education initiatives related to ocean literacy and sustainability. However, in many countries, such funding remains insufficient and often comes with strict guidelines and limited allocations. The funding is mostly linked to research budgets which allocate a small amount for dissemination and education. Large marine research institutes such as the Marine Institute (IE), IFremer (FR), HCMR (GR), CNR (IT) or the Flanders Marine Institute (BE) have an education program for schools on marine science.
- **Municipal Funding:** Local governments can provide grants or funding for community-level ocean literacy programs. However, these funds are frequently tied to specific local initiatives or projects and may not be consistently available. Budget constraints in municipalities often result in prioritizing other sectors over environmental education, leaving limited resources for blue education initiatives. Municipality funding like in Gdynia (PO) and Den Helder (NL) were essential to develop a local blue school community.
- **Foundations and NGOs:** While several foundations focus on environmental issues, their funding for blue education is often competitive and project specific. Organizations may need to align closely with the foundation's mission to secure funding, which can be a barrier for many potential applicants. Additionally, many foundations offer only short-term grants, making it challenging to sustain ongoing educational efforts. A few foundations such as the Oceano Azul Foundation (PT) and Voice of the Ocean (SE) have blue education in their overall strategy.
- **Corporate Sponsorships:** The private sector has begun to engage more in funding blue education initiatives. However, such sponsorships are typically focused on specific projects that align with corporate social responsibility goals, such as the Sailing Team Maliza. As a result, while funding from the private sector is growing, it is often not enough to support comprehensive educational programs or long-term initiatives. But there are exceptions of companies that support in blue education such as the Mallorca-based SeaTeach, who created a blue school community of more than 100 schools and initiate projects on blue careers.

Despite the growing availability of funding through programs like Erasmus+, Horizon Europe, and national initiatives, the lack of sufficient funding remains a key obstacle to implementing blue education effectively. Although funds are available, they often fall short in reaching all schools and organizations that could benefit from them. Additionally, the complexity of applying for these funds, coupled with competition for limited resources, limits the scope and impact of blue education projects.

3.3. Research on blue education

3.3.1. Scientific mapping of publications on blue education

3.3.1.1. Marine domain

In total, 79 publications on marine education were identified suitable for further analysis including 61 articles (77.2%), 16 proceedings papers (20.3%) and 2 reviews (2.5%). The development of marine education between 2003 and 2023 is shown in **Figure 3**. The number of publications has fluctuated over the years, growing by 18% on average per year. It is important to note that this is an average, and the actual growth in any given year may vary. Some years, the growth may be higher than 18%, while in others, it may be lower or even negative. Generalized Additive Models (GAM) fitting of the data revealed an increase in the number of publications as from 2017, soon after 'ocean literacy' was formally adopted in Europe (2012).

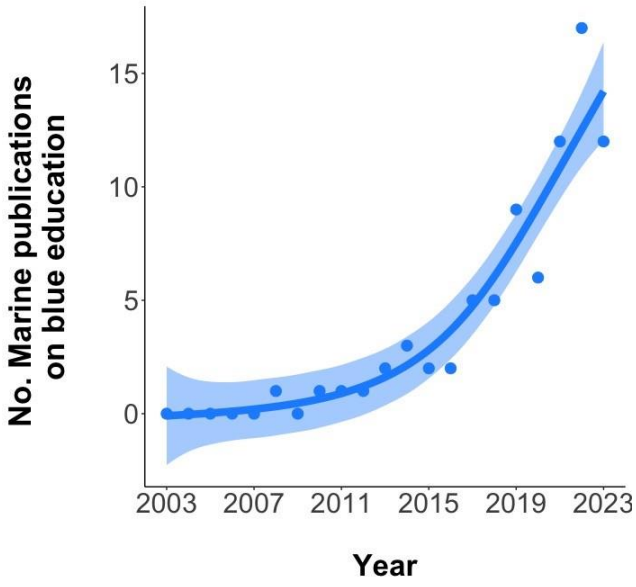

Figure 3. Number of publications on marine education in Europe (2003-2023)

A steep noticeable rise in the number of publications was observed in 2022 (n = 17). A total of 344 authors affiliated to 171 institutions have published on marine education. A. Mogias was identified as the most prolific author with 8 publications (10%), followed by T. Boubonari (8.9%), other authors included G. Fauville, N. Grotjohann, T. Kevrekidis, M. Mokos and T. Schmaeing with 5 publications each. The most prolific institutions publishing on marine education were led by Democritus University of Thrace (26.6%), followed by University of Lisbon (13.9%) and University of Bielefeld (12.7%). In overall, 43 publishing outlets were identified. The most popular journal for publishing on marine education was Mediterranean Marine Science (8 publications), followed closely by Frontiers in Marine Science with 7 publications, Environmental Education Research, and Sustainability with 6 publications each (**Annex 8.3**). Proceedings papers were published mostly in several editions of the Proceedings of the International Conference of Education, Research and Innovation (ICERI) (**Annex 8.3**).

Our findings reveal key insights into the leading countries contributing to marine education. The results indicate that Greece (16.5%), Portugal (12.7%) and Spain (11.4%) are the top contributors, collectively accounting for a significant portion of the total publications (**Figure 4**). These countries have shown a strong commitment to advancing blue education, reflected in their robust research output. This trend highlights the pivotal role these nations play in shaping the discourse and development of marine education across Europe.

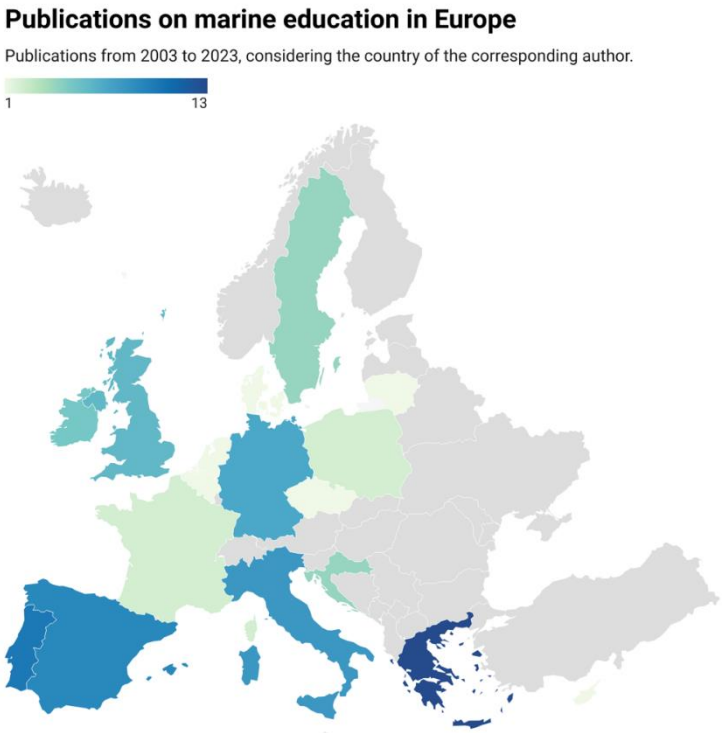

Figure 4. Publications on marine education in Europe (2003-2023) considering the country of the corresponding author (colour gradient is proportional to the number of publications)

3.3.1.2. Freshwater domain

In total, 26 publications on freshwater education were identified including 20 articles (77%) and 6 proceedings papers (23%). The number of publications has fluctuated over the years, growing by 6.7% on average per year. It is important to note that in some years the growth may be higher than 6.7%, while in others, it may be lower or even negative. A noticeable rise in the number of publications was observed in 2019 (n = 5). GAM fitting was not conducted due to the insufficient quantity of data available.

A total of 81 authors affiliated to 35 institutions have published on freshwater education. G. Martinez-Borreguero was identified as the most prolific author with 3 publications. The most prolific institution publishing on freshwater education were University of Extremadura (30.8%), followed by University of Granada (23.1%). In overall, 20 publishing outlets were identified. The most popular journal for publishing on freshwater education was Sustainability, with 6 publications (**Annex 8.4**).

3.3.1.3. Marine and Freshwater domains

In total, 102 publications on blue education were identified, including 78 articles (76.5%), 22 proceedings papers (21.5%) and 2 reviews (2%). It is important to note that after merging the databases from the marine and freshwater domains, three duplicates were found. In addition, since most publications were from the marine domain, the overall results are expected to closely mirror those derived from the marine subset. The development of blue education publications between 2003 and 2023 is shown in **Figure 5**. The number of publications has fluctuated over the years, growing by 18% on average per year. It is important to note that this is an average, and the actual growth in any given year may vary. Some years, the growth may be higher than 18%, while in others, it may be lower or even negative. GAM fitting of the data revealed an increase in the number of publications as from 2017, a few years after 'ocean literacy' was formally adopted in Europe (2012), similar than the one reported for marine publications. A steep noticeable rise in the number of publications was observed in 2022 (n = 20). A total of 401 authors affiliated to 208 institutions have published on blue education. A. Mogias was identified as the most prolific author with 8 publications, followed by T. Boubonari with 7 publications, other authors included G. Fauville, N. Grotjohann, T. Kevrekidis, M. Mokos and T. Schmaeing with 5 publications each. The most prolific institutions publishing on blue education were led by Democritus University of Thrace (26.6%), followed by University of Lisbon (13.9%) and University of Bielefeld (12.7%). In overall, 54 publishing outlets were identified. The most popular journal for publishing on blue education was Sustainability (11 publications), followed by Mediterranean Marine Science (8 publications), Frontiers in Marine Science and Environmental Education Research with 7 publications each (**Annex 8.3**). Proceedings papers were published mostly in several editions of the Proceedings of the International Conference of Education, Research and Innovation (ICERI).

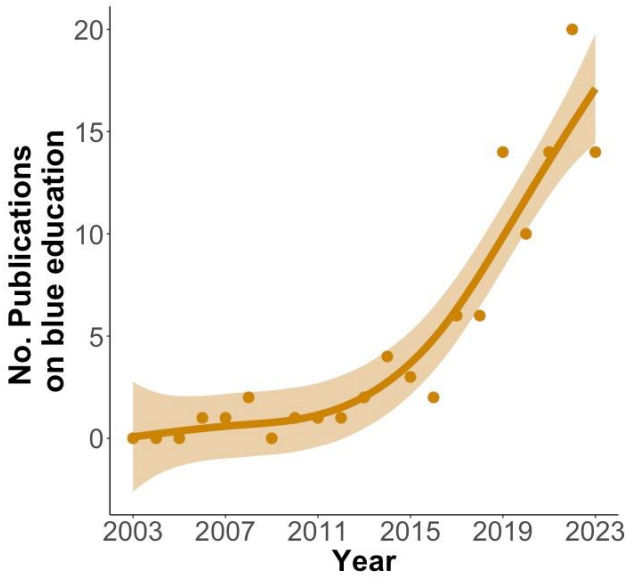

Figure 5. Number of publications on blue education in Europe (2003-2023)

The significant increase in the number of publications in 2022 (n=20) is probably attributed to the special issue published by the Mediterranean Marine Science journal. The analysis of publications revealed that the leading countries publishing in marine and freshwater education are Spain (18.6%), Greece (15.7%) and Portugal (10.8%) (**Figure 6**). These countries show active engagement and investment in advancing knowledge in blue education,

indicating strong research infrastructures and robust academic networks. The results highlight the contributions of these nations in shaping the discourse and driving innovation, positioning them as key players in the global research landscape on blue education.

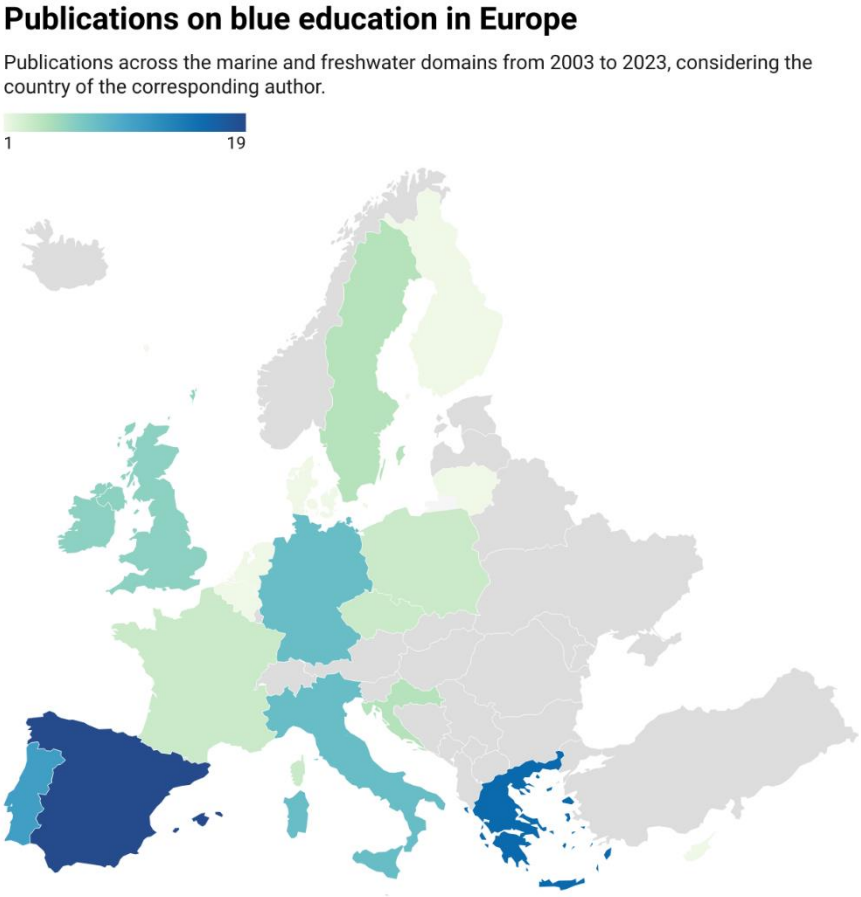

Figure 6. European countries leading in blue education publications (2003-2023) considering the country of the corresponding author

3.3.1.4. Thematic areas on blue education

In the present study, we applied a combination of bibliometric analysis and science mapping to a dataset of scientific publications on ocean literacy between 2003 and 2023, obtained from Web of Science and Scopus databases.

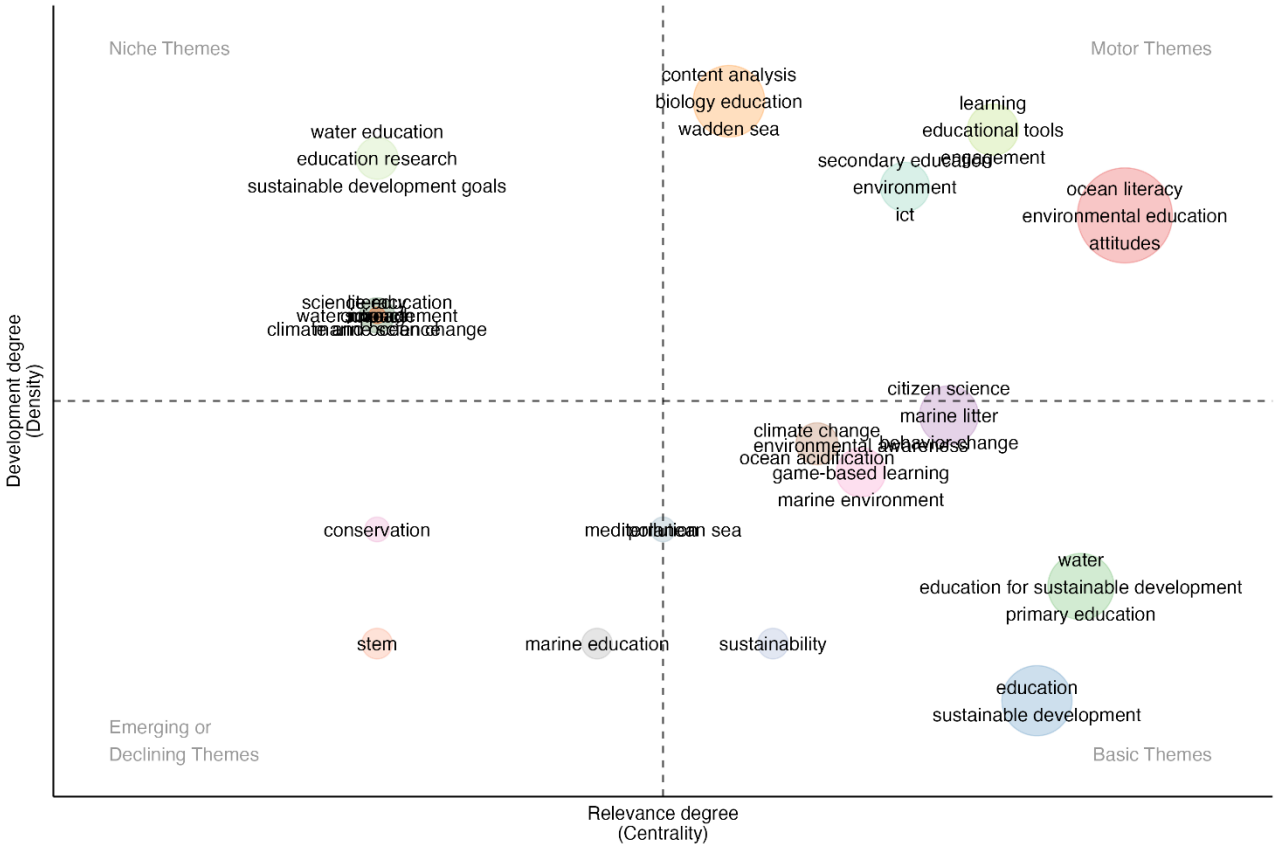

Figure 7. Thematic areas on blue education (niche, motor, emerging/declining, basic themes)

Publications collected for referential purposes together with the ones on blue education (n=694) were categorized into the following thematic areas following a rigorous content analysis of their titles, keywords, and abstracts:

- Ocean Literacy
- (Fresh)water literacy
- ESD in practice and initiatives
- Research on ESD
- Environmental education
- Citizenship education
- Inclusive education
- Pedagogy and teaching methods
- Curricula analysis

- STEM/STEAM education
- Outdoor education
- Impacts
- Sustainable use of resources and eco-schools
- Climate education
- Cultural and social dimensions
- Digital learning and innovative technologies
- Project-based, hands-on, transformative and experiential learning
- Teacher's knowledge and training
- Policy development & strategies
- Non-formal education

This approach ensured that each publication was accurately assigned to relevant thematic areas based on the following core concepts for different educational frameworks and their components:

- Environmental education
- Education for Sustainable Development (ESD)
- Climate education
- STEM/STEAM education
- Ocean and (fresh)water Literacy
- Non-formal education (including outdoor education)
- Curricula analysis
- Pedagogy and teaching methods (including project-based, hands-on, transformative and experiential learning)
- Digital learning and innovative technologies
- teachers' knowledge and training
- Cultural and social dimensions (including citizenship and inclusive education)
- Impacts

- Policy development & strategies

The thematic area **environmental education** has been continuously found in 40 publications (2006-2024). However, only 6 of them are related to marine (5) and freshwater (1) domains (2018-2023), for both primary and secondary level students, with leading organizations from Portugal (e.g., Universities of Porto, Lisbon and Aveiro) followed by Germany (e.g., University of Bielefeld) and focusing on topics-themes included into the following categories: **aquatic science topics:** migratory fishing species, marine litter, microplastics; **blue-related education:** environmental education, chemistry education, biology education, ocean and estuarine literacy; **non-formal education:** outreach project; **cultural and social dimensions:** nature connectedness, environmental awareness, environmental attitudes, plastic waste recycling; **digital learning, innovative technologies and other tools:** educational tools, 3D printing, storybook reading; **geographical areas:** Minho River Estuary, Wadden Sea; **policy development & strategies:** sustainability.

In addition**, sustainable use of resources and eco-schools** have been found as a main thematic area in 31 publications (2007-2023) which seem to be related both to environmental education and ESD as well as sustainable schools. However, none of them is referring to marine or freshwater environments.

As far as **Education for Sustainable Development (ESD)** is concerned**,** 201 publications have been found to represent this important thematic area mostly of them referring to research (172) and less to practices and initiatives (29) between 2005 and 2024. Despite the large number of publications appeared in ESD, only one scientific article (2020) from a leading organization of Spain was found to be related to aquatic domain including topics-themes such as: waste, water, energy; primary education; curriculum; competences for sustainability. Despite the above-mentioned, there are a few publications including the topic of ESD in their research (see topics below).

Surprisingly, the core concepts of **aquatic and marine education** were not found as main thematic areas. One more article, included in ESD thematic area, was found to refer to the term **aquatic education** (2017) from a leading organization of Germany regarding topics-themes such as swimming, educational objectives, adolescent development, health behaviour. The term **marine education** appeared in 12 publications (2017-2024) and included mostly in the thematic area of “Ocean Literacy” but also in areas such as digital learning and innovative technologies, pedagogy and teaching methods (including project-based, hands-on, transformative and experiential learning), teachers’ knowledge and training, citizenship education. The above-mentioned publications target both primary and secondary level students as well as teachers and educators regarding categories and topics-themes such as: **aquatic science topics:** ocean acidification, **climate change,** marine conservation, whaling tradition; **blue-related education:** formal education, environmental education, marine education, Ocean Literacy, ocean sciences education, science education; **cultural and social dimensions:** environmental awareness, awe, psychological distance, emotions, attitudes, awareness, engagement, public perception, nature blindness, collective intelligence, argumentation, participatory research, science outreach, motivation; **digital learning and innovative technologies:** virtual reality games, technology uses in education, virtual dive, underwater ROV, gamification, educational technologies; **curricula analysis:** science curriculum, textbooks, content analysis; **geographical areas:** Adriatic Sea; **policy strategies:** sustainability, SDG 14: Life below water; **teaching methods:** cognitive learning. Leading organizations of these publications are from Croatia (e.g., Croatian Institute of Oceanography & Fisheries, University of Zagreb), Sweden (e.g., University of Gothenburg) and Ireland (e.g., Ollscoil na Gaillimhe-University of Galway, Dublin City University).

Climate education appeared in 14 publications as a main thematic area (2012-2023). However, only one of these articles (2019) was related to marine domain for primary level students with a leading organization from Canada (e.g., Laval University) but in collaboration with France (e.g., CNRS) regarding topics such as Arctic, education,

interactive, multimedia, outreach. Nevertheless, the term **climate change** is included in the topics of a few publications of aquatic domain of this mapping (see topics below).

STEAM/STEM education have been found in 21 articles for the last ten years (2013-2023) as a main thematic area though it seems to have been introduced earlier than 2003. Only two articles seem to be related to aquatic environment mostly for secondary level students with leading organizations from Italy in 2022 (e.g., Consiglio Nazionale delle Ricerche) and Spain in 2014 (e.g., EL Chaparil High School). These articles are dealing with categories such as **aquatic science topics:** water quality; **geographical area:** Adriatic Sea; **blue-related education:** art education; **cultural and social dimensions:** ocean citizenship, equality, cultural diversity, communication plan; **policy strategies:** wastewater management, sustainability.

Of the 17 articles having as a main thematic area **curricula analysis** (2011-2023), only one (2020) seems to be related to freshwater domain regarding secondary level students and topics such as water, **education for sustainable development,** secondary education, and curriculum by Universidad de Extremadura (Spain).

Non-formal education (including mostly outdoor education) includes 19 articles published (2006-2023), while only 5 articles are related to marine environments (2020-2024) targeting primary/secondary students and teachers/educators with one leading organization from Germany (University of Bielefeld) and two more from Croatia and France (University of Zadar, Université de Bretagne Occidentale). These articles focus on categories and topics-themes such as blue-related education: education, ocean literacy, marine science education, environmental education, biology education, didactics of Biology; non-formal education: sea class, Educational Marine Area, outdoor activity, out-of-school learning, environmental knowledge, misconceptions; cultural and social dimensions: nature connectedness; environmental attitudes; teaching methods: pedagogy; policy strategies: SDG14; UNESCO World Heritage Site; geographical areas: Wadden Sea.

Digital learning and innovative technologies seem to be an important thematic area found in 41 publications (2006-2024), while only 6 of them are related to marine domain (2010-2024) regarding primary/secondary students and teachers/educators and focusing on categories-topics such as **blue-related education:** marine education, STEM education, Ocean Literacy, Education, ICT, environmental education; **aquatic science topics:** ocean acidification, **climate change,** oceans; **cultural and social dimensions:** environmental awareness, awe, psychological distance, emotions, affect, outreach; **policy strategies:** environmental protection, SDG 14: Life below water; **digital learning, innovative technologies and other tools:** virtual reality games, educational robotics, robotic fish, robotic toolkit, virtual laboratory, technology uses in education, underwater virtual reality, virtual dive, marine robotics, robotics education, writing, electronic learning, distance learning; **teaching methods:** scientific method. These articles were published by different leading universities (Breda University of Applied Sciences, Marche Polytechnic University, Stanford University, University of Gothenburg, University of Zagreb, University of Aegean).

Citizenship and inclusive education included in the thematic area of **cultural and social dimensions** were found in 20 publications (2013-2024) of which only 4 articles are referred to the marine domain (2019-2024) targeting primary and secondary level students by different leading universities (University of Lisbon, University of Bielefeld, University of Oviedo, University of Plymouth). These articles focus on **blue-related education:** ocean literacy, education, basic education, biology education, didactics of biology**; cultural and social dimensions:** behavioral science, effectiveness, attitudes, intended behavior, awareness, engagement, public perception, ocean citizenship; **policy strategies:** marine conservation, sustainable development; **aquatic science topics:** whaling tradition; mudflat hiking tour; tides; **curricula analysis:** quantitative content analysis; **teaching methods:** pedagogical model; **geographical areas:** Wadden Sea.

After ESD, the most important thematic area seems to be **teachers' knowledge and training** as it was found in 146 publications (2009-2024). However, only 8 of these articles are referring both to freshwater (5) and marine (3) domains (2013-2023) targeting mostly primary level students by different leading universities (University of Helsinki, Universitat de Girona, Democritus University of Thrace, Dublin City University, University of Lyon, University of Granada, Charles University of Prague). The articles focus on **blue-related education:** Mathematics teacher education, **Education for Sustainable Development,** Mathematics Teacher Education for Sustainability, Mathematics teacher professional development, Ocean Literacy, environmental education; **cultural and social dimensions:** environmental responsibility, environmental citizenship, individualization, private-sphere environmentalism, collective action, attitudes, background factors, behavior, knowledge, nature blindness, marine literacy, water education, science process skills; **policy strategies:** sustainability, sustainable development, sustainable development goals; **other educational tools:** case-study, information sources, Internet, fieldwork.

Another important thematic area seems to be **pedagogy and teaching methods (including project-based, hands-on, transformative and experiential learning)** included in 45 articles (2008-2024). Among them, ten are referring to marine and one to freshwater domains during the last years (2017-2024) targeting on primary and secondary level students by different leading universities (University of Porto, University of Exeter, University of Almeria, University of Bremen, University of Zagreb, Loughborough University, University of Granada, University of Ostrava, University of Oviedo, Universita degli Studi di Bari Aldo Moro). These articles focus on **blue-related education:** STEAM, Ocean Literacy, environmental education, compulsory education, marine education, science education, water literacy, water education, education for sustainable consumption, education, STEM; **aquatic science topics:** constructed wetlands, contamination of aquatic environments, plastics, climate change; ice melting; oceans; **cultural and social dimensions:** motivation; engagement; science outreach; eco-social transition; **policy strategies:** environmental sustainability, marine sustainability; sustainable development sustainable fisheries; ecolabels; **digital learning, innovative technologies and other tools:** educational kits; underwater ROV; educational technologies; educational tools; mobile applications; games; robots; multimedia systems; **teaching methods:** creative pedagogies; digital pedagogies; game-based learning; gamification; cognitive learning; flipped learning; project-based learning.

Though the thematic area of **impacts** is referring to a few articles (15 in total) during the last ten years (2015-2024), none of them is related to aquatic domain. Only in one article of freshwater domain is referring as theme and in a few publications having as a main thematic area "Ocean Literacy" (see below).

As far as **policy development & strategies** is concerned, a few articles are included (18 in total) during the last ten years (2012-2023) while two of them are related to the marine domain (2020-2022) by different leading universities from France and Spain (University of PSL, University of Basque Country) focusing on topics such as **education for sustainable development;** sustainable development goals; quality education; Agenda 2030; education challenges.

Ocean literacy is one of the main thematic areas of this scientific mapping found in 50 articles (2008-2024) targeting on primary and secondary level students. For this area, leading organizations are not only **numerous universities but also marine/freshwater research centres** from Italy (e.g. Consiglio Nazionale delle Ricerche, University of Camerino), Greece (e.g. Hellenic Centre for Marine Research, Democritus University of Thrace), Spain (e.g. University of Oviedo, University of Valencia), Portugal (e.g. Universidade do Algarve, Universidade da Madeira, Universidade do Porto, Istituto Nazionale Geofisica e Vulcanologia, Universidade de Vigo, Universidade de Lisboa) Lithuania (Kaunas University of Technology, Klaipeda University), Ireland (e.g. Trinity College Dublin, Ollscoil na Gaillimhe-University of Galway, University of Limerick), Croatia (e.g. University of Zadar, Croatian Institute of Oceanography & Fisheries, University of Zagreb), Sweden (e.g. University of Gothenburg), UK (e.g. University of Plymouth, University of Exeter), Germany (e.g. University of Bielefeld), Denmark (e.g. University of Southern Denmark), Poland (Polish Academy of Sciences).These articles focus on **blue-related education:** Ocean Literacy,

education for environment and sustainable development, science literacy, environmental education, education, ESD, Mediterranean Sea Literacy, ICT & education, scientific literacy, ocean sciences education, marine education, formal education; science education, STEM, marine science education, biology education, didactics of biology, climate and ocean literacy; **non-formal education:** citizen science, knowledge, content knowledge, non-formal learning, educational program, outdoor learning, EMSEA, ocean misconceptions; **curricula analysis:** content analysis science curriculum, textbooks, science textbooks; **aquatic science topics:** freshwater, seafood, plastic, human impact, marine litter, micro-plastics, pollution, marine angiosperms, seagrass loss, blue carbon, coastal ecosystems, **climate change,** rocky shores, plastic pollution, beach sampling, biological invasions, sea turtles, *Caretta caretta*, ecological problems, coastal areas, ocean health, coastal lagoons, anthropogenic marine debris, ocean acidification, sharks and rays, artificial reefs, climate adaptation and mitigation, environmental data and observations; **teaching methods:** experiential activity, game-based learning, teaching-learning process, interdisciplinary learning, science learning, project-based learning, participatory action research, teaching sciences, participatory design, teaching strategies, grounded theory; **digital learning, innovative technologies and other tools:** Information and Communication Technologies (ICT), educational game, board game, learning tool, learning objects, artificial intelligence, aquarium missions, education technology, information sources, iBook, educational app, mobile learning, online learning; **cultural and social dimensions:** seagrass value, environmental awareness, skills development, behavior change, perceptions, integrated intervention, well-being, pro-environmental behavior attitudes, collective intelligence, argumentation, participatory research, oceanography outreach, social marketing, scientific career global citizenship, interdisciplinary skills, public attitude, science communication; **policy strategies:** conservation (seagrass, marine environment, shark, ocean), sustainable development, SDGs, sustainable seafood, marine heritage, sustainability; Decade of ocean science, stakeholder engagement, international cooperation, Blue School, 2030 Agenda, sustainable fish consumption, **SDG 13: Climate action,** EU4Ocean coalition, protected areas; **geographical areas:** Mediterranean Sea, Zakynthos, Adriatic Sea, Europe, Wadden Sea, national park, UNESCO World Heritage Site; **impacts:** evaluation, measure development, assessment, impact, Collective Impact Assessment; prior-knowledge self-assessment.

(Fresh)water literacy is one of the less frequent themes of this scientific mapping found in 17 articles (2006-2023) targeting on mostly primary level students with different leading organizations (e.g. University of Warsaw, Universidade de Lisboa, Kaunas University of Technology, University of Seville, University of Coimbra, Universite de Montpellier, University of La Rioja, University of Extremadura, University of Athens, Leuphana University Luneburg, University of Malaga, University of Karlova, Centre for Freshwater and Environmental Studies, University of Aegean, Eastern Macedonia & Thrace Institute of Technology) and focusing on different topics such as **blue-related education:** education, ocean literacy, environmental education, education for sustainability; **non-formal education:** knowledge, citizen science, myths; policy strategies: water conservation, nature conservation, sustainable river management, SDGs, sustainable development, sustainable future, water management; **aquatic science topics:** river, water, fish farm, physical& chemical properties of water, pollution, purification, environmental changes; **cultural and social dimensions:** attitudes, environmental perception, gender, shaping competency, behaviour change, water therapy, water is life, water inspires arts, value of river; **curricula analysis:** student-centred curriculum, curriculum; impact; **teaching methods:** project-based education, intergenerational learning, concept map, lesson plan.

In conclusion, thematic areas on blue education are categorized in 4 groups: niche, motor, emerging/declining and basic themes (**Figure 7**). Niche themes include **ocean literacy**, education, water, **citizen science, content analysis**, **environmental awareness**, secondary education, learning and **water education**, while emerging/declining themes include **STEM and marine education** as well as conservation. Some of the motor themes are also ocean literacy, content analysis, learning as well as environmental education, educational tools, biology education. The most important basic theme seems to be **education for sustainable development** and in general sustainability as well

as **climate change** and particularly **ocean acidification** along with marine and water environment, **game-based learning** and environmental awareness.

3.3.2. Mapping initiatives and projects on blue education

In total, 137 European initiatives on blue education were used for analysis (**Annex 8.4**). The data analysis of European initiatives in blue education reveals key insights into the region's efforts to deepen the connection between individuals and aquatic environments by increasing awareness, understanding, and appreciation of the importance of marine and freshwater ecosystems. The findings indicate a growing trend in the number of initiatives (**Figure 8**), with a significant concentration in countries such as Portugal (24.1%), France (12.4%), Sweden (10.2%), Ireland and the UK (8% each) (**Figure 9**). These countries are at the forefront of implementing blue education initiatives, showcasing a strong commitment to integrating marine and freshwater components into their educational frameworks.

Additionally, the analysis highlights a diverse range of approaches, including formal education programs, school-community outreach, and professional development courses for teachers, all aimed at fostering a deeper understanding of marine and freshwater issues. These results underscore the increasing importance placed on blue education across Europe and suggest a coordinated effort to address marine and freshwater issues through education.

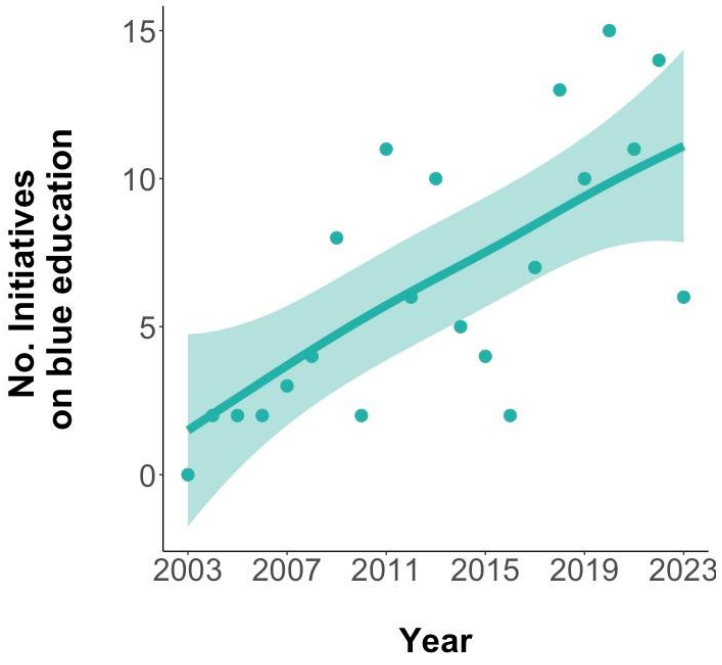

Figure 8. Number of European blue education initiatives (2003-2023)

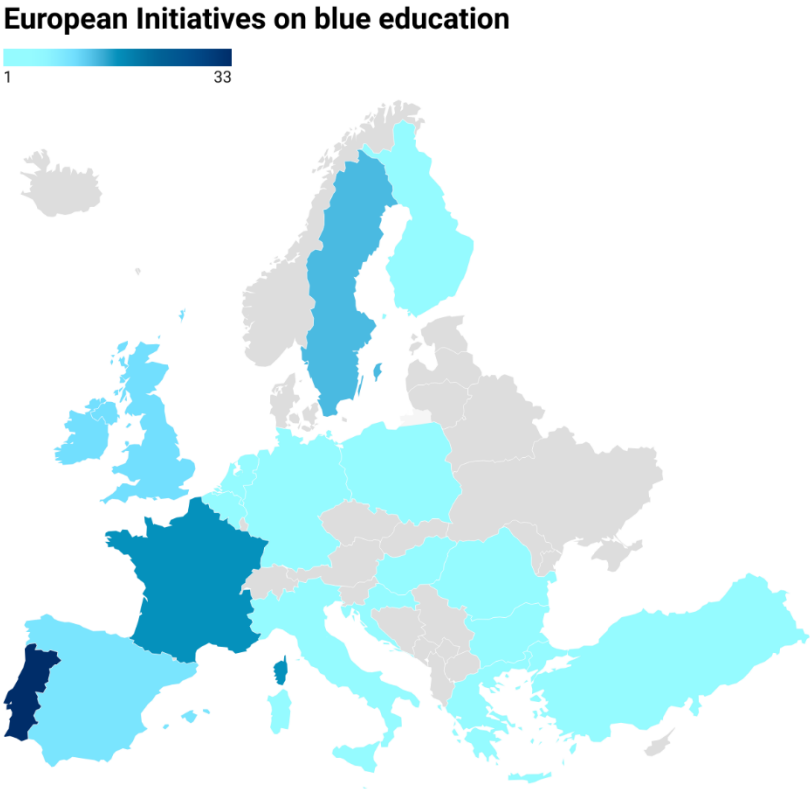

Figure 9. European initiatives on blue education (2003-2023) considering the country of the coordinating organization (colour gradient is proportional to the number of initiatives)

Our results provide some insights in the types of organizations involved in implementing blue education initiatives in Europe (**Figure 10**). **Academia** emerges as a leading contributor (23%), driving a significant portion of the initiatives, particularly by facilitating knowledge transfer and developing research-based courses, providing teacher training, and creating educational resources. Through partnerships with schools and educational authorities, academia has the potential to align blue education with broader educational goals, fostering a culture of sustainability at all school levels. The **public sector**, including **government agencies and public institutions** (18%), plays a crucial role in policymaking and funding support, facilitating broader access and participation as well as regulatory compliance. The **private sector** is also actively engaged (18%), especially in areas such as **industry partnerships** and **practical training programs** for the blue economy sectors, aiming to bridge the gap between theoretical knowledge and real-world application. **Research organizations** (17%) also play an important role by developing science-based resources and teaching methodologies. Their expertise ensures that educational content is scientifically accurate, relevant, and aligned with current environmental challenges. By collaborating with schools, these organizations help integrate ocean and freshwater literacies into formal and non-formal education, fostering early awareness and understanding of marine issues among students. This foundational knowledge equips the next generation to engage in sustainable practices and address future challenges related to marine and freshwater ecosystems.

Aquaria and museums (7%) play a pivotal role by providing immersive, hands-on learning experiences that bring marine- and freshwater-related topics to life, making abstract concepts tangible for students. By offering interactive exhibits, educational programs, workshops, and courses for teachers, aquaria and museums help foster a deeper

understanding of aquatic ecosystems. Their collaboration with schools ensures that blue education is not only accessible but also engaging, inspiring the next generation to value and protect the marine and freshwater ecosystems.

Networks and associations (7%) also play a crucial role by providing a platform for collaboration, communication, resource and experiences sharing, enabling educators and practitioners to identify the most effectives ways to integrate blue education into the curricula. These networks help standardize educational approaches, promote best practices, and advocate for the inclusion of marine and freshwater topics in national and regional education policies. By connecting educators across Europe, they amplify the impact of blue education, ensuring long lasting results not only at the individual but also at the community level.

This diverse involvement underscores the collaborative nature of blue education efforts across Europe, highlighting the complementary roles of different sectors in advancing sustainable practices.

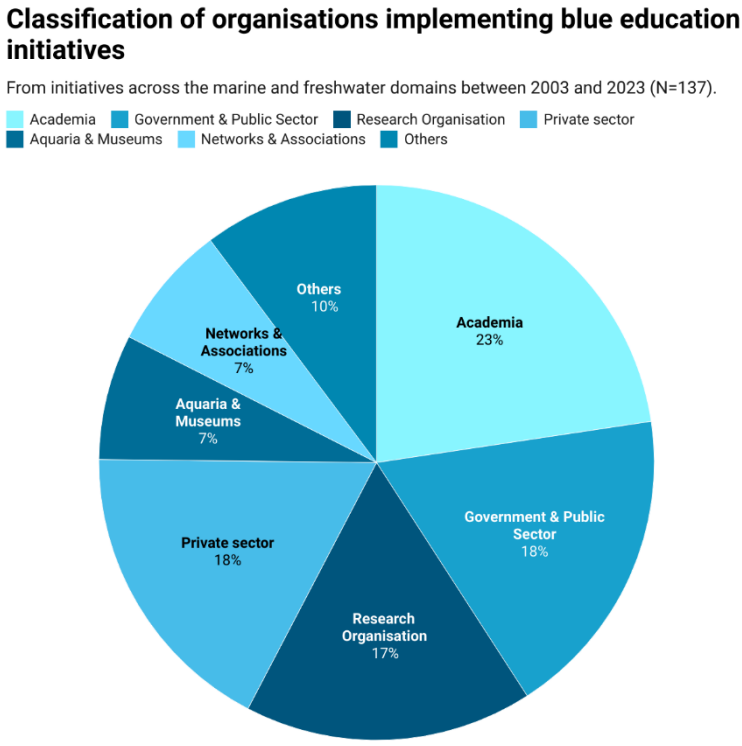

Figure 10. Type of organisations implementing blue education initiatives in Europe

Our findings reveal distinct patterns in the primary audiences targeted by these initiatives (**Figure 11**), indicating that a significant proportion of initiatives are directed towards schools (64%). A notable number of initiatives are designed specifically for teachers (14%), providing them with resources and training to integrate blue education into their lessons.

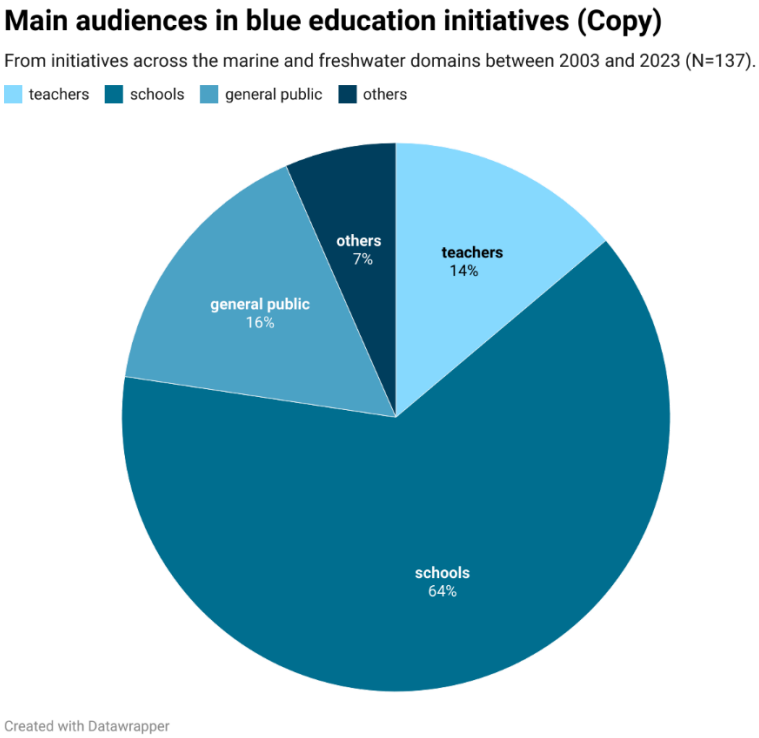

Figure 11. Main audiences of blue education initiatives in Europe

Figure 12 illustrates the development of both scientific publications and initiatives related to blue education. This figure showcases how academic work informs and supports on-the-ground initiatives. This dual inclusion not only highlights the interconnections and mutual reinforcement between research and implementation but also offers a more nuanced depiction of the blue educational landscape, enabling a better identification of gaps, overlaps, and opportunities for further development and collaboration across Europe. We hypothesize that a major enabler was the political will of the European Commission through DG MARE's initiative Marine knowledge 2020. A series of workshops held in 2013 and 2015 aimed at raising the profile of ocean literacy among policymakers, scientists, educators and practitioners. These workshops led to the inclusion of ocean literacy in the Atlantic Strategy, which led to the implementation of the All-Atlantic Blue Schools and Blue Schools Global Network. The analysis suggests a critical turning point in 2016, marking a significant shift in the trajectory of blue education. This shift is marked by a sudden surge in research activity and the emergence of new initiatives. It may be attributed to the launch of the first EU projects on ocean literacy, specifically SeaChange and ResponSEAble, in 2015.

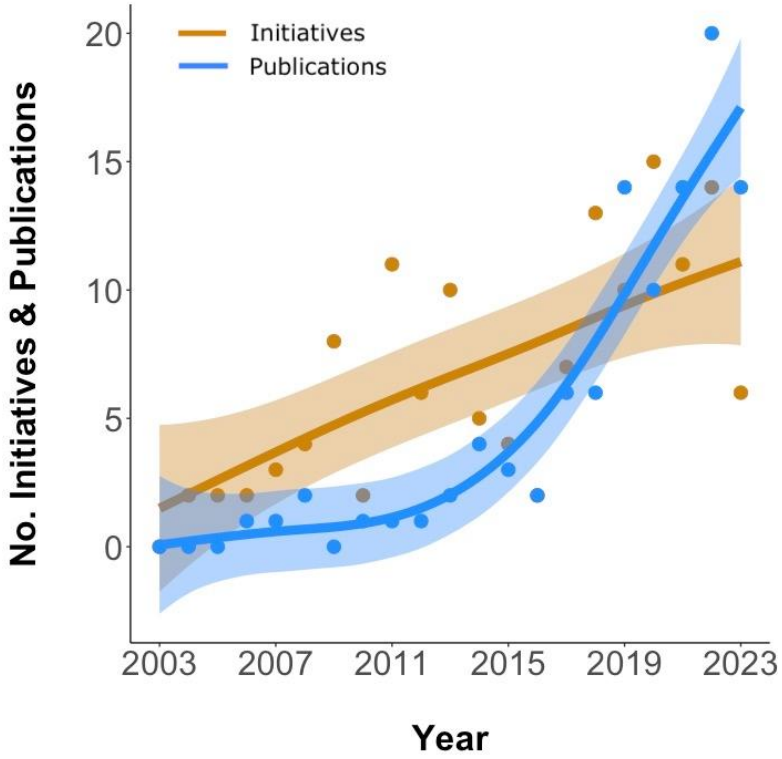

Figure 12. Development of blue education (publications in blue, initiatives in orange) in Europe (2003-2023)

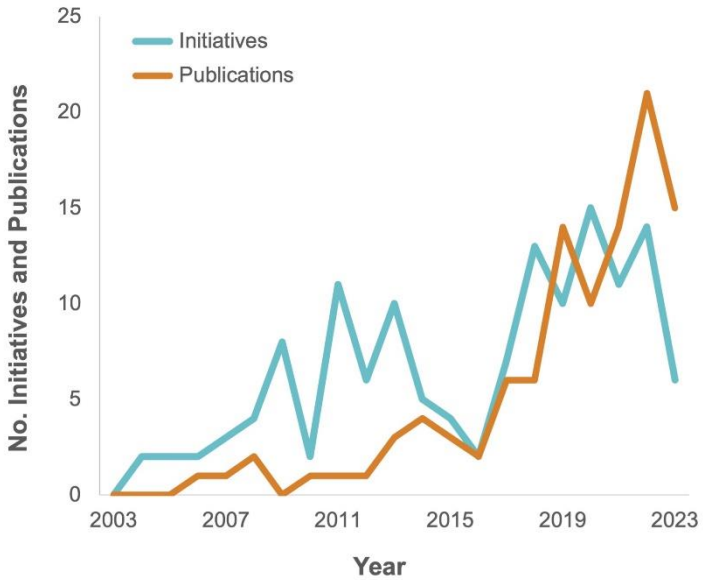

Figure 13. Temporal distribution of European blue education initiatives and publications (2003-2023)

Although the GAM fitting may vary across scientific publications and initiatives, the overall trend remains consistently positive (**Figure 13**). Meaning that there has been a consistent increase in the number of publications and initiatives related to blue education over time. This could indicate growing interest, increased research activity, and greater

recognition of the importance of blue education. Despite variations in the gam fitting, the general direction in the following years is one of progress and development.

3.4. What is taught in schools

3.4.1. Finding the blue in national curricula

The curriculum plays a pivotal role in shaping what is taught in schools, adhering to national or regional educational standards. For this report, we define "curriculum" as the minimum knowledge and skills that students are expected to acquire on a national level. Given the large diversity of curricula across EU Member States, extensive research is necessary to assess how marine and freshwater topics are integrated into educational frameworks. Several studies have already begun to explore this "blue" aspect of education.

Although environmental education, citizenship education and education for sustainable development are receiving a lot of attention in European school curricula, ocean literacy has not yet achieved comparably widespread diffusion (Mokos et al., 2020). **Several studies indicate a scarcity of ocean-related topics, which often overlook the ocean's significance for biodiversity, climate, and human well-being** (Copejans & De Doncker, 2007; Fauville et al., 2018; Mogias et al., 2019; Realdon et al., 2019; Barracosa et al., 2019). As a result, they rarely appear in school materials, textbooks, assessments or training (Donert et al., 2015).

In 2020, the European Commission's Ocean Literacy coalition EU4Ocean conducted a comprehensive analysis of curricula from nine countries, including Belgium (Flanders), Croatia, Finland, France, Germany, Greece, Portugal, Romania, and the United Kingdom (Pocze et al., 2020). This report indicated that OL is identified in various topics in primary education. The analysis of the curricula aimed at highlighting blue entry points already existing within each national system. In primary education, most topics linked to ocean literacy emerged in the natural sciences. This subject mentions environmental education, and it includes elements like nature and plants, material processes and states of matter, space and time, and animals and humans. Some curricula specifically mentioned natural heritage, different ecosystems, ocean, and marine food webs. However, what emerged most prominently across countries is the general attention towards sustainable future, livelihoods and anthropogenic impact on Earth.

In secondary education, most observed countries take a more subject-based teaching structure. As a result, the subjects of physics, chemistry, geography and biology provide most entry points to relevant ocean topics. Provided that education becomes more nuanced and in-depth, the link to the ocean is more specific and specialized in secondary schooling. Specifically, topics addressed comprise the ocean and seas, oceanic currents, plate tectonics, coastal geomorphology, and habitats. However, the emphasis is placed also on the ecosystem services provided by the ocean and the environmental problems threatening it, such as ocean acidification, plastic pollution, oil spills and overexploitation of marine resources. Hence, secondary education curricula look at both strictly scientific and more socio-economic aspects of ocean education.

Teachers who participated in Network of European Blue School's professional development activities also pointed out that OL is absent from the curriculum, and **professional development in this area remains largely driven by personal initiative.** Consequently, textbooks, which are mainly curriculum-based, **focus predominantly on terrestrial topics** (Copejans, 2014). A review of Croatian elementary textbooks identified gaps in the integration of ocean literacy principles (Ezgeta-Balić & Balić, 2024), while a similar analysis of Greek secondary textbooks found minimal content on ocean science (Mogias et al., 2021).

On a side note, at the time of the analysis, in countries like Belgium (Flanders), Greece, the United Kingdom and Romania, the curricula were undergoing changes. These updates have opened new possibilities for addressing ocean literacy and marine topics in education such as in Flanders (Belgium).

Case Study: Towards Integrating the Ocean into the Flemish Curriculum

In Flanders, blue education kickstarted almost 2 decades ago. The Flemish government had given a mandate and funding to the Flanders Marine Institute (VLIZ, Ostend) to provide ocean education programs in 2007. Prior to this, VLIZ has supported 2 thesis students who concluded that the ocean was missing in the school curricula of Biology and of Geography (Eggermont, 2007; Copejans & De Doncker, 2007). That same year, VLIZ, in partnership with the Geography Teachers Association and the marine research community, organized a groundbreaking multi-day conference to educate teachers on diverse aspects of ocean science. In 2012, VLIZ took the lead in organizing the First Conference on Ocean Literacy in Europe in Bruges, advocating making ocean literacy a priority in the EU's research strategy and funding programs. VLIZ also co-founded the European Marine Science Educators Association and played a key role in the European ocean literacy project 'Sea Change (2015–2018). Since 2017, advancing ocean literacy had been officially recognized as a strategic goal of the institute.

This focus on ocean literacy and blue education made it possible to build a wide network of education stakeholders in Flanders, including teachers, preservice teacher trainers, handbook writers, book authors, curriculum writers and education authorities, all of whom gained greater awareness of ocean science. Over 15 years, VLIZ successfully advanced ocean literacy in the region, paving the way for an ideal environment for curriculum reform.

In 2021 the Flemish education system started its modernization process, and so the process of changing the curricula, starting with the oldest age group. The entire process of curriculum change is ongoing and expected to finish no earlier than 2027. At secondary education level, the integration of system thinking in geography education of the Katholiek Onderwijs Koepel created the first opportunities to include more ocean topics, such as the ecosystem services of the ocean (ocean-human), coastal processes (ocean – land) and climate-ocean interaction (ocean-atmosphere), recognizing as one of the first countries in the world the role and value of the ocean.

However, as the initial phase of the curriculum reform had led to an overloaded schedule for the teachers, the learning objectives had to be reconsidered and scaled back a bit. As a result, in 2023 some new ocean-related topics became optional objectives, left to the discretion of teachers who are motivated to incorporate them into their lessons.

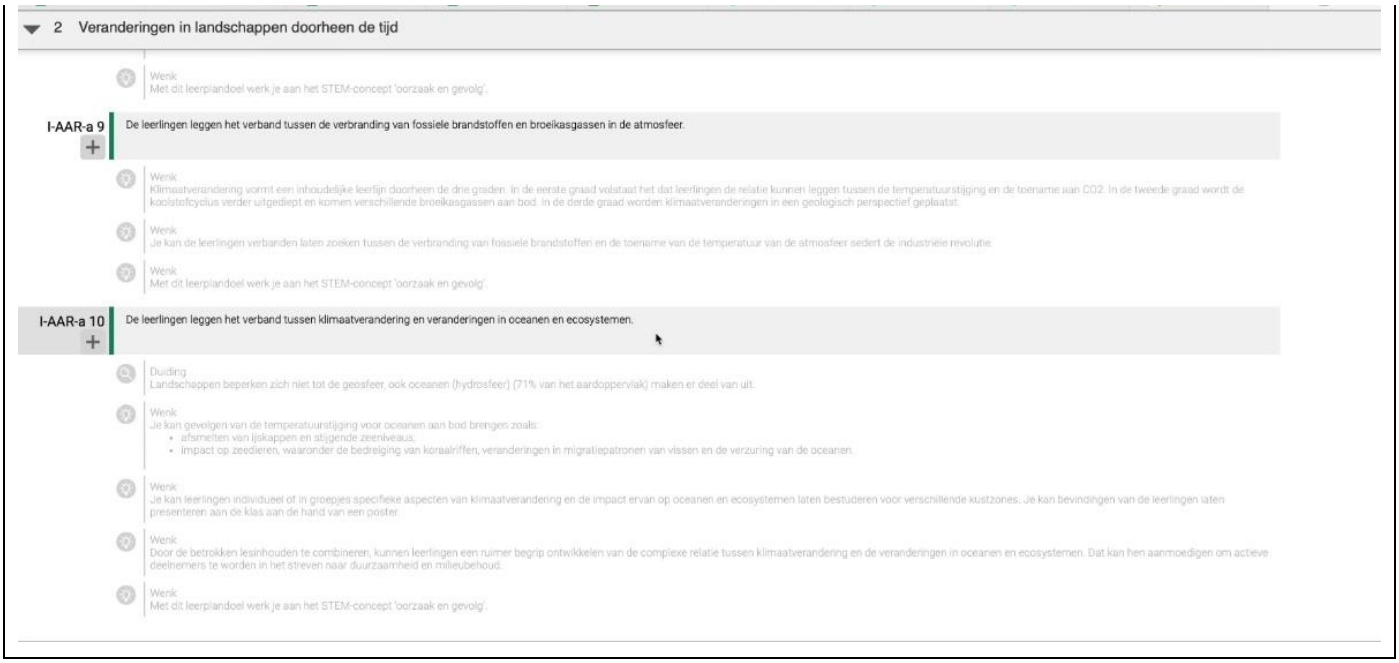

Figure 14. Extract from the curriculum Geography, secondary education, 1nd grade 2024 illustrating the optional learning objectives on the effects of climate change on the ocean and its ecosystems

After introducing the topic of ecosystem services of the ocean, it was noticeable that teachers in Flanders were not familiar with introducing a multidisciplinary topic such as the ocean into the classroom. The teachers needed a didactic framework to tackle this topic, and to fully grasp its potential. So professional development sessions on these topics were organised all over Flanders over the course of a year by the education authorities. Additionally, some textbooks provided teachers with both content and exercises. As the majority of the teachers in Flanders use textbooks from educational publishers as a basis of their classes, the role of textbooks is almost as significant as the role of the curricula in Flanders. Learning contexts in textbooks are now not solely land based.

Some teachers and schools in Flanders have been pioneers in developing ocean related classes. The Sint Lodewijkscollege from Bruges has been incorporating ocean classes on a regular basis in both secondary and primary school level for more than 10 years. Another EU Blue School in Flanders, Sint Paulus school in Avelgem, took up the challenge to give one hour a week during a full year on ocean science and ocean literacy (2024-2025) to test the potential of such an interdisciplinary science course. The teacher, a former coordinator of an international master course on marine ecology at the University of Ghent, is testing the feasibility of such a blue curriculum in Flanders.

Although ocean literacy in Flanders is well recognised, there is still ample opportunity to further strengthen blue education and integrate it more fully into mainstream formal education. With the ongoing curriculum reform in primary education, Flanders is uniquely positioned to take a pioneering role in this effort.

Recommendations for a blue curriculum – IOC UNESCO

Without a structured didactic framework —encompassing learning objectives, teacher training, and textbook content— teachers are unable to effectively introduce ocean topics in the classroom. Recognizing this gap, UNESCO has emphasized with their Blue Curriculum initiative (UNESCO, 2022) the need to integrate Ocean Literacy into national educational frameworks by 2025 as part of the broader Sustainable Development agenda.

UNESCO's 2022 publication titled "A New Blue Curriculum: A Toolkit for Policy-Makers" provides a comprehensive framework for integrating ocean and freshwater education into formal curricula. The document emphasizes several key dimensions essential for Blue Education:

Ocean Literacy: Understanding the ocean's influence on us and our influence on the ocean. This includes knowledge about marine ecosystems, the importance of the ocean in climate regulation, and sustainable use of marine resources.

Freshwater Literacy: Recognizing the importance of freshwater systems, such as rivers, lakes, and groundwater, in supporting ecosystems, human communities, and economies. This dimension focuses on sustainable management and conservation of freshwater resources.

Interdisciplinary Approach: Blue Education encourages a multidisciplinary approach, integrating sciences, social studies, geography, and environmental education to provide a holistic understanding of water-related issues.

Active Citizenship: Promoting active engagement and stewardship among students, encouraging them to participate in conservation efforts and policy discussions related to water resources.

Cultural and Social Dimensions: Recognizing the cultural, historical, and social connections people have with water bodies. This includes indigenous knowledge and practices related to water conservation and management.

Technological and Innovation Aspects: Leveraging new technologies and innovative methods to study and solve water-related challenges, such as using remote sensing for water quality monitoring or developing new sustainable fishing practices.

The toolkit also provides practical guidelines for policymakers and educators on how to implement these dimensions in school curricula, emphasizing collaboration between educational institutions, local communities, and governments (UNESDOC) (UNESDOC) (UNESCO Document Repository).

In the effort to advance ocean literacy across Europe, it is essential to reshape how we perceive the ocean, seas, and water. This requires the **development of new narratives** and inspiration around these vital ecosystems. Currently, there is a notable imbalance in the incorporation of "blue" content across European countries—some have integrated it deeply into their educational systems, while others lag behind. To address this, harmonizing the level of knowledge and awareness about the ocean is crucial across all European nations. However, the diversity of national curricula and school systems presents significant challenges to implementing unified changes at a European level. Instead, adjustments to individual national curricula will be needed to ensure consistent ocean literacy.

Cultural identity also plays a role in how ocean-related content is presented in curricula. For example, maritime nations like Portugal might naturally emphasize ocean topics, whereas landlocked or Balkan countries may not. To overcome these discrepancies, effective communication with schools and teachers about curriculum changes is essential. Schools require integrated work models that allow for a multidisciplinary approach to learning about the

ocean, where subjects like mathematics, English, and geography are interwoven with ocean-related content. Teacher training should focus on guiding educators on how to merge these subjects effectively and offer a holistic approach to learning.

Environmental education is also fragmented across various disciplines, from science to social studies, ethics, and citizenship. A more cohesive integration of sustainability and environmental topics is needed to increase visibility and impact within school systems. Rather than overhauling the entire curriculum, schools could introduce joint classes where different teachers (e.g., geography and biology) collaborate to deliver ocean-related content, amplifying its significance.

For instance, a curriculum review in Portugal revealed that terms like "ocean" or "sea" were not explicitly included. However, ocean themes do appear in subjects like language, history, and geography. This highlights the tendency for the ocean to be treated as an "off-topic," often sidelined for project-based learning activities instead of being a core component of the curriculum.

Key elements of a comprehensive blue education curriculum should include a forward-looking approach, integrating knowledge about marine ecosystems, human impacts, conservation strategies, and sustainability. Climate education, social sciences, and citizenship should be emphasized at all school levels to incorporate blue education. Engaging both veteran teachers with their experience and younger teachers with their innovative ideas is essential. In addition, engaging school principals, who oversee curriculum planning across departments, is critical for successful implementation.

Supporting teachers with clear goals and providing resources for teaching ocean-related content is equally vital. National bottom-up initiatives with strong local partners familiar with their country's curriculum can aid in tailoring blue education to local contexts. Moreover, the use of outdoor schooling, technology like AR/VR, and gamification as an assessment tool can enhance student engagement.

The integration of blue education into existing curricula requires a harmonized approach across Europe, with guidance materials for countries on how to include ocean literacy in their education systems. Project-based learning, fostering citizen engagement, and the promotion of critical thinking are fundamental strategies for this integration. In addition, the blue principles must be reflected in 21st-century education frameworks, with initiatives like Blue Schools playing a pivotal role.

In response to the ongoing environmental crisis, the United Nations has recommended the integration of education for sustainable development—encompassing both climate and ocean literacy—into national curricula (United Nations, 2024). The recent report from the UN High-Level Panel on the Teaching Profession, presented in South Africa, echoes this call by emphasizing the importance of cross-cutting ocean literacy within school curricula. It also stresses the need for robust teacher training and access to materials.

While the EU lacks the authority to enforce educational reforms, it can provide recommendations and support curriculum development through EU programs and funding. A European-wide project, such as the Blue Schools initiative, would be an ambitious yet crucial step towards embedding ocean literacy in curricula across Europe.

3.4.2. Training and capacity building for teachers

3.4.2.1. Ocean Topics in Pre-service Teacher Training

Ocean literacy and blue education are noticeably absent from most standard teacher training curricula (Seachange project). Instead, the focus tends to be on subjects that align with national education priorities, often marginalizing critical topics like ocean sciences, marine ecosystems, and sustainability.

As a result, new teachers often feel unprepared to introduce these themes in their classrooms. Integrating ocean literacy into pre-service teacher education is essential to prepare future educators to teach about the ocean's role in climate regulation, biodiversity, and the global economy.

Some institutions, such as the University of Gothenburg and the University of Zadar, have begun offering modules on ocean education for pre-service teachers, setting an important example of how this gap can be addressed.

3.4.2.2. Teacher Professional Development (In-Service Training)

For teachers already in the profession, ongoing professional development is crucial to build their capacity to teach blue education. This training should go beyond introductory concepts, offering a deep dive into marine science, the effects of human activities on the ocean, and sustainable practices.

Workshops, webinars, and field experiences can help deepen teachers' understanding of ocean-related topics. Providing hands-on experiences in local marine environments and opportunities to collaborate with marine scientists helps bridge knowledge gaps and connect educators with real-world expertise.

Professional development programs also offer innovative teaching methods, such as project-based learning, experiential education, and the use of digital resources and data, making ocean literacy more engaging for students.

Several extensive online courses, such as BlueMinds4Teachers, OTGA Ocean Literacy for Teachers, and the MOOC Blue Schools, provide excellent resources. There are also numerous short courses, lasting 1 to 4 hours, offered by various ocean education stakeholders.

3.4.2.3. The Role of Teacher Networks in Knowledge Sharing

Teacher networks play a pivotal role in spreading blue education. These networks foster collaboration, allowing educators to exchange best practices and share valuable teaching resources. Platforms like those supported by European Blue Schools (European School Education Platform group) and other similar organizations help teachers stay updated on the latest research and innovative approaches.

However, ocean topics are often missing from leading formal education networks and events, limiting their visibility and integration into mainstream teaching. By promoting the inclusion of ocean literacy in these spaces, we can help ensure that it becomes a more central part of the educational dialogue.

In addition to sharing resources, teacher networks promote peer mentoring, creating a ripple effect where teachers inspire and influence their colleagues both within their schools and across education systems.

Participation in both local and global ocean literacy networks empowers educators, offering collective problem-solving opportunities and fostering advocacy for ocean literacy in schools.

These teacher networks are integral to the growth of blue education programs.

3.5. Impacts of Blue Education

Brennan et al. (2019) and McKinley et al. (2023) expanded the original education-based framing of OL, proposing several other dimensions of it: a) awareness, b) knowledge, c) attitude, d) communication, e) behaviour, f) activism, g) emotional connections, h) access and experience, i) adaptive capacity, j) trust and transparency. These dimensions should also be accounted for when designing OL initiatives and interventions, ensuring that knowledge development is not the sole focus of initiatives. Stoll-Kleemann (2019) also highlighted key internal (e.g., emotions and values) and external factors (e.g., socio-cultural and politico-economic), as well as the internal (e.g., social norms and moral involvement) and external drivers (e.g., economic incentives) that impact behaviour change and can therefore increase the effectiveness of ocean literacy.

So far, no one can reliably evaluate the progress that has been achieved in OL over the last couple of decades as little research effort has been carried out as revealed by the scientific mapping and especially in relation to common measurement tools which have to take into consideration not only the knowledge factor, but also other dimensions of OL and the multi-perspective approach proposed by the IOC-UNESCO. In any case, important baseline studies to portray some of these perspectives have been made so far on a global scale (Stoll-Kleemann, 2019 and references therein; Paredes Coral et al., 2021), while good practices of EU-regional collaborations have also emerged (e.g., Mogias et al., 2015; 2019; Realdon et al., 2019; Cheimonopoulou et al., 2022; Mokos et al., 2020; 2021; Koulouri et al., 2022).

Furthermore, the **Escola Azul** (Blue School) programme of the Portuguese Ministry of Economy and Maritime Affairs distinguishes and guides the schools that work on OL, creating a community that brings together schools, the sea sector, municipalities, industry, NGO's and other entities (e.g., 330 schools, 60,000 students, 17 municipalities, 110 stakeholders). Throughout the 2020/21 school year, the Escola Azul programme was the subject of an impact study, to assess its relevance and usefulness for the promotion of more responsible and participative generations, which contribute to the Ocean sustainability (https://escolaazul.pt/en/escola-azul/estudo-de-impacto). Teachers, students, municipalities and partners participated in surveys, interviews and focus groups. A high percentage of students participating in the impact study have declared that they: a) talk with their families and friends about the Ocean and how to protect it; b) don't use plastic straws; c) intend to volunteer in actions related to the Ocean; d) pick up litter found on the beach and on the school ground; e) look up for more information about the Ocean. Their teachers referred that a large percentage of their students but also themselves: a) are more interested in ocean issues; b) reflect more about the effects of human behaviour on the ocean; c) understanding better of the ocean and the impact of our actions; d) developed some sort of change in their daily lives (recycling, reusable materials, etc.). Results of this impact study revealed that: a) the Blue School has effectively contributed to raise the significance and status of the ocean and OL within the school community; b) the stable evolution and growth of the Blue School programme evidences the effectivity of its methodology; c) the Blue School community recognizes the programme's importance and relevance, and d) the Blue School has also contributed significantly to create effective synergies between school communities, local communities and ocean stakeholders.

A Collective Impact Assessment of the **Explorers Education Programme** in Ireland identifies the impact of the programme to grow further. In 2022, the Explorers Education Programme had the largest number of participating children, reaching 15,237. In 2023, the programme won the "Best Education Outreach Award" category of the Education Awards in Ireland. In addition, the Explorers Education Programme conducts annual evaluations, using the **Explorers Ocean Literacy Knowledge Questionnaires for Teachers – Evaluating Your Knowledge about the Ocean** and the **International Ocean Literacy Survey**. Annual questionnaires evaluate student's marine literacy knowledge and are led by teachers. Service providers conduct concept mapping, questioning and class discussions to review the children's project work. Service providers also collect quantitative and qualitative data from the teachers via pre- and post-participation surveys and observation schedules, which reflect their knowledge and interest in teaching children about the ocean. Qualitative data gathered from teachers provides information about their personal experience in taking part in the programme, success factors, challenges incurred and general feedback on the programme. Furthermore, teacher's feedback on future marine-themes projects informs the Explorers Education Programme on potential modules, activities, lesson plans and resources that need to be developed to sustain interest and empower teachers to keep marine literacy in their teaching curriculum and schools.The ability to collectively reflect and assess impact moves beyond an intervention, allowing for more meaningful behavioural, social and system changes for the collective good, inspiring the next generation of marine leaders and ocean champions. Other impact measures captured annually are those of the programme's social media campaigns.

In France, more than 1,200 **Educational Marine Areas** (EMAs) have been established supported by an institutional structure with the resources to do so (OFB) and in collaboration with the Ministry of education, the Ministry of environment, and the Ministry of overseas territories. The goal is the establishment of 18,000 EMAs in 2030 within the framework of National biodiversity strategy with the Ministry of Education in charge of implementing the objective, while 4 million € are put in a call this year (see **Chapter 3.1.2**).

Erasmus+ project **We are blue schools!** in Spain has been awarded as the best WESTMED project. It also won the prize as best initiative for the development of blue skills and circularity. Within the framework of the project, a survey was carried out with 143 teachers responding, while 98 schools have become members of the EU Blue Schools network. The specific objectives of the project were to: a) successfully implement as a pilot project an inclusive and comprehensive EU Blue School Network in the confined regional area of Mallorca over the short term of one school year by creating a true grass-roots approach that includes teachers, schools and local environmental actors; b) document this approach in a BluePrint that enables other EU regions to follow this example and successfully recruit a large Network of European Blue Schools. The main idea of the BluePrint Guide is to provide concise information about the implementation of the We are Blue Schools project through the experience gained in the project countries, by presenting challenges and solutions as well as best practices and advice on how other organizations can set up a network of Blue Schools from a bottom-up approach.

The Erasmus+ project entitled "Supporting the development of socially inclusive blue challenges in schools in the Mediterranean Sea basin (**BlueSchoolsMed**) aimed to support the design, implementation, and evaluation of sea-related projects at school by bringing together scientists, teachers, educators, pupils, and key stakeholders from four Mediterranean countries (Greece, France, Italy, and Malta). In total 230 pupils, aged between 9 and 19 years old, participated in the project's survey from 18 primary and secondary schools, situated in 14 cities in Greece, France, Italy, and Malta. The pupils reported that after the end of the project they had learned many new things in relation to different marine issues and that their pro-environmental attitudes and responsible behaviour towards the marine environment had been raised. They also learned to collaborate with peers from other schools and countries. They mainly felt peaceful and calm as well as happy and joyful, when thinking of the ocean. While working on the project, happiness and joyfulness, along with fun and excitement, were the highest stated factors. Twenty-two teachers participating in the project reported that their joint effort with the pupils highly achieved the pre-determined project

principles, such as being sustainable, interactive and proactive, inclusive and democratic. Most teachers preferred multidisciplinary approaches, identifying challenges related to the sea, and organising fieldwork activities; in terms of the impact of their "blue" projects, they highly ranked the increase of pupils' knowledge and awareness of sea-related issues, their satisfaction with the projects' results, the development of a sense of community within the classroom, and of responsible attitudes. All projects faced several challenges, with the COVID-19 restrictions being the most important ones. Regarding the elements that worked well, the positive feedback of teachers, the originality of ideas and activities that came into light, and the achieved multi-disciplinarity were the most important. Noteworthy outcomes from surveys in which the students and teachers participated addressed diverse facets of human development encompassing cognitive, emotional and psychokinetic dimensions.

BlueMinds4Teachers: The EU4Ocean project aimed at strengthening the skills of teachers and other educators in OL issues through the collaboration of marine and freshwater scientists, experts from education and social sciences, teachers experienced in development and implementation of blue projects and young ocean ambassadors. Among others, a survey was prepared to evaluate the course and its performance, and help the partners improve themselves, the course and its content. Out of the ~70 attendees, 42 of them responded to the survey. According to this survey, teachers and other educators declared that they increased their knowledge in relation to the issues of all the three sessions. In addition, they are convinced to design and implement ocean-related issues in their classroom/non-formal education setting by using modern participatory methods, applying interdisciplinary and/or multidisciplinary approaches and collaborating with experts, stakeholders and the local community. Finally they surely feel more self-confident about developing a blue project after this course.

Impacts of blue education activities are measured mostly through relevant interventions by blue initiatives and projects integrated with education systems regarding number of participants/users (e.g., Croatia), number of schools awarded with blue-related labels (e.g., E3D label for engagement of schools in an ecological transition in France, EU blue schools network certificates), annul surveys for students and teachers (e.g., Portugal, Ireland) and metrics from social media (e.g., Ireland).

Based on the targeted interviews carried out during this task, it is worth mentioning the following:

- In Portugal, the "letter challenge" is a tool for measuring the impacts of environmental education as not only students but also teachers and student's family members write letters to industry companies asking for more sustainable packaging.
- In Norway, the impact is "measured" by being a good citizen as they have a youth parliament in each municipality and this way young people have voice to bring issues for voting.
- In Belgium, "behavioural scientists conduct gigantic studies across generations".

During the survey carried out within the T3.1. of WP3 of the project, 17 out of the 64 respondents referred to the "lack of evaluation framework for Blue education activities" among other constraints.

Based on the semi-structured interviews in selected experimentation countries, the following should be noted:

- **Croatia:** There is a lack of data on the effectiveness of Eco-Schools in measuring and promoting environmental education. The program requires annual impact assessments but it's unclear if all schools comply or if the data is accessible. Similarly, non-formal environmental education providers like NGOs and universities may assess their own programs but don't typically share this information publicly. Consequently, determining the overall state of environmental education and the potential of Eco-Schools to integrate blue education is challenging due to limited data.

- **Greece:** Measuring the impact of Blue Education is hindered by a lack of standardized assessment. While non-formal actors, such as the HCMR and DUTH, demonstrate effective blue education programs, formal education lacks consistent evaluation methods. Teachers often do not assess the impact of their blue education activities, and there's no mandatory framework for doing so. Although the recent introduction of a broader environmental education framework might offer opportunities for improvement, specific guidelines for impact assessment are still absent.
- **Sweden:** The impact of a Swedish network focused on ocean education has been primarily assessed through self-reported surveys from its members. While the network has demonstrated value and influenced public awareness of ocean threats, the specific impact on blue schools remains unmeasured.
- **Portugal:** The impact assessment of blue initiatives, such as Escola Azul and Educar para uma Geracao Azul, is challenging due to a lack of standardized assessment methods. Both initiatives have different approaches, for instance EGA performs a full assessment annually, while Escola Azul may perform every two years (not continuous). While some data collection exists, such as surveys for Escola Azul, a comprehensive evaluation system is missing.
- **Spain:** Impact measurement in the Escoles Verdes program is inconsistent in the Catalonian region. While schools undergo self-evaluations annually, with more in-depth assessments every four years, there's no standardized approach to measuring program impact. Some schools may conduct additional surveys, but overall, data collection and analysis lack uniformity.

To conclude, **evaluation is integral in the development of blue education programs and initiatives** which strive to reach common goals of responsible ocean citizenship and sustainable use of the water world. Based on partners' experience, indicators of knowledge-awareness, attitudes/values, behaviour change, actions, emoceans should be assessed through a pre- and post-survey design, to evaluate blue education activities that will be carried out in experimentation countries.

3.6. Key Enablers

Due to the absence of a unified education policy across the EU, each member state retains full responsibility for its education system and curriculum. The EU's role, as outlined in Article 165 of the Treaty on the Functioning of the European Union, is limited to supporting member states in providing high-quality education and training. As a result, both ocean literacy and blue education in Europe are largely implemented through bottom-up initiatives that assist teachers and education providers. In this context, partnerships with knowledgeable enablers who are committed to transferring expertise and supporting educators are crucial for the advancement and widespread adoption of blue education across Europe. Our analysis identified several stakeholder groups that play a pivotal role as key enablers in the promotion and the implementation of blue education (**Figure 15**).

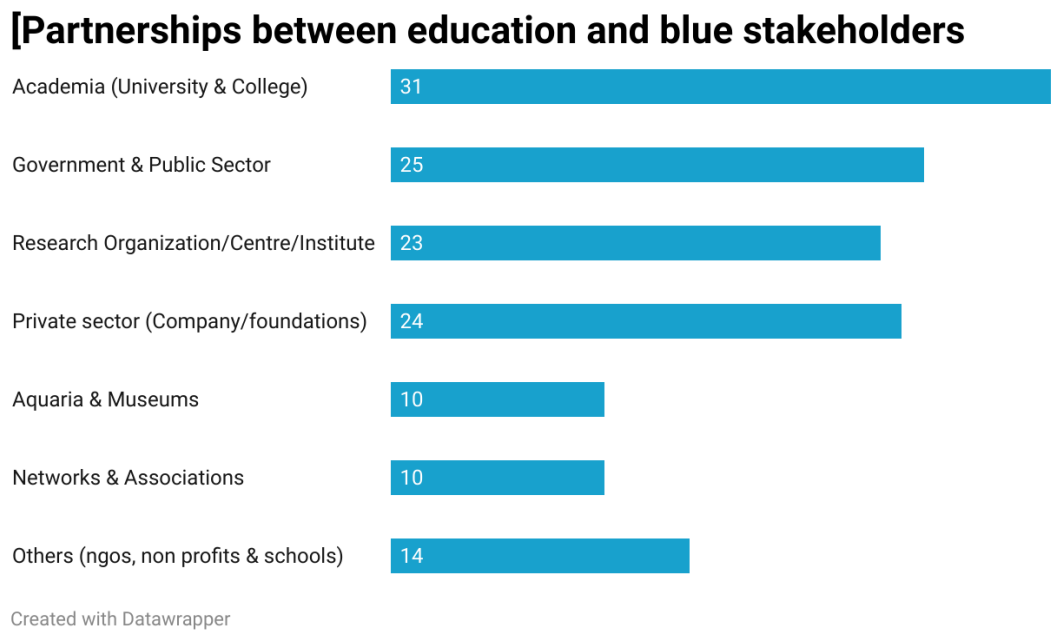

Figure 15. Partnerships between education and blue stakeholders

3.6.1. Key Enablers identified in the Database of initiatives and projects

The analysis of the database revealed four major stakeholder groups that facilitate the implementation of blue education across Europe: academia (universities and colleges), government and the public sector, research organizations/centres/institutes, and the private sector.

Academia (Universities & Colleges) emerged as the primary enabler, with 31 initiatives documented in the database. The role of academia is to generate and disseminate knowledge within society, addressing socio-economic needs by equipping the younger generation with the necessary skills and by shaping and training their minds. Higher education institutions in this category play a pivotal role in knowledge transfer, developing research-based courses, providing teacher training, and creating educational resources, thereby advancing the integration of blue education into various educational levels and settings. Through partnerships with schools and educational authorities, academic institutions have the potential to align blue education with broader educational objectives, fostering a culture of sustainability across all levels of schooling. The leading institutions identified in the database include the University of Gothenburg, Newcastle University, University of Southampton, University of Aveiro, Faculty of Engineering University of Porto, Universidade de Coimbra, Centro de Ciências do Mar e do Ambiente, University of Algarve, Swedish University of Agricultural Sciences, Stockholm University.

Research institutions, akin to academia, contribute to the creation and dissemination of knowledge within society, while also transforming this knowledge into technology, methodologies, and skills for societal benefit. Research organizations such as The Marine Biological Association, Task Group for the Extension of the Continental Shelf, The Marine Institute, The Future Ocean Cluster of Excellence, Flanders Marine Institute, Interdisciplinary Centre for Marine and Environmental Research, Laboratoire d'Océanographie de Villefranche/Observatoire Océanologique de Villefranche, Institute of Marine Sciences, Obra social “la Caixa”, European Institute for Marine Studies, LabexMer consortium, International Ocean Institute, International Centre for Black Sea Studies, Swedish Institute for the Marine

Environment, by leading collaboration with schools help integrate ocean and freshwater literacies into formal and non-formal education, fostering early awareness and understanding of marine issues among students. In addition, research projects funded by public (EU or national) grants often require the dissemination of knowledge through educational and outreach programs. As a result, research institutions are key enablers of blue education across Europe, with at least 23 institutions actively engaged in these activities and listed in the database.

Government and public institutions at all levels — European, national, regional, and local — can play a crucial role in the implementation of blue education across Europe. Through policymaking and financial support, these institutions can facilitate broader access and participation, as well as ensure regulatory compliance. These mechanisms significantly shape the educational environment on various scales. Although the European Union cannot directly influence national educational systems, policymaking and recommendations at the European level are instrumental in advancing blue education across member states.

A prime example of such support is the EU4Ocean Coalition, funded and supported by the European Commission. This initiative demonstrates how political and administrative backing for bottom-up efforts can help introduce blue education in schools. By establishing a centralized secretariat, the coalition works directly with local stakeholders in EU countries, aiding in the introduction of blue education projects in schools and providing support to youth initiatives, thereby fostering a stronger connection to blue education across Europe.

Among 25 government **agencies and public institutions** in the database the following were identified as most engaged in blue education facilitation: Science Foundation Ireland, Local Government Management Agency Libraries Development, National Water forum, The Heritage Council, The Arc Programme, Finnish National Agency for Education material bank, Direction Régionale et interdépartementale de l'environnement, de l'aménagement et des transports, OFB, Mobiliteit en Openbare Werken, Ciencia Viva, Confederacion hidrografica del mino-sil,

The private sector is typically defined as the part of the national economy that operates independently of direct state control. Traditionally, this includes for-profit companies, but in some cases, non-profit organizations, such as foundations, are also included, as they are run without government oversight. For the purpose of this report, a combined for-profit and non-profit approach was used in the database analysis, as organizations engaged in blue education often share similar profiles and frequently collaborate to further facilitate the implementation of blue education in Europe.

The analysis identified 24 stakeholders actively involved in various types of educational and training programs, resource development, youth engagement, and support, as well as industry partnerships and practical training programs for blue economy sectors (see also *Blue Skills Initiatives* below). These initiatives aim to bridge the gap between theoretical knowledge and real-world application.

Among the most recognizable and involved private sector stakeholders are **foundations** such as: SAHFOS, Ecomar Fundacíon, Surfrider foundation, Oceano Azul Foundation, Fondation Tara ocean, Foundation for the promotion of partnership and development of civil society, Classes Enjeux Maritimes, Foudation for Environmental Education and other **private companies** such as: Digital Explorer CIC, Seateach, ACTeon environment, OpenTEA, Geonardo Ltd, Greenspace Education, Curiocean, Vattenverkstaden.

3.6.2. Networks & Associations

Networks can take various forms, ranging from informal collaborations to more structured organizations. For example, the Network of European Blue Schools (NEBS), while not a legal entity, functions as a collaborative platform for

schools and teachers, with its secretariat managed by the European Marine Science Educators Association (EMSEA) — a registered NGO bringing together ocean literacy professionals. For the purposes of this report, **networks and associations** are considered a distinct group based on their collaborative roles, rather than their legal status. These networks and associations play a crucial role in disseminating blue education, as they bring together stakeholders with shared interests, fostering the exchange of knowledge, best practices, experiences, and mutual support.

EMSEA has been instrumental in introducing the concept of ocean literacy to Europe. Since 2012, the EMSEA Annual Conference has been a key event for the European ocean literacy community, uniting marine scientists, educators, policymakers, and curriculum developers from across Europe and beyond. The conference facilitates the exchange of knowledge and best practices in ocean literacy and blue education. This expertise enables EMSEA to effectively manage the NEBS as a successful network of schools that integrate blue projects into their educational programs.

Another significant pan-European network is the European Schoolnet, a consortium of over 30 European Ministries of Education based in Brussels. As a not-for-profit organization, European Schoolnet focuses on promoting innovation in teaching and learning among its key stakeholders, including Ministries of Education, schools, teachers, researchers, and industry partners. Additionally, the network is a member of the EU4Ocean Coalition and has contributed by providing the Massive Open Online Course (MOOC) titled *Bring the Ocean into Your School*. This MOOC aims to raise awareness of ocean literacy and equip educators with the tools and knowledge necessary to inspire the next generation of ocean stewards. The course also guides participants in designing their unique "Find the Blue" projects and introduces them to the Network of European Blue Schools. Using the MOOC Learning Scenario Template, teachers are encouraged to initiate their own blue projects and adapt these activities to their classrooms.

The Charter for Blue Education further highlights a commitment to collaboration and strategic alignment between European education networks and sustainability initiatives. It reinforces the engagement to strengthen blue education and support societal transformation across Europe.

In addition to these pan-European networks, various national and local networks play critical roles in supporting the implementation of blue education programs and partnerships within individual EU member states.

- **Portugal:** Environmental Education Network for Ecosystem Services (REASE), a project that aimed to start consolidating some of the essential human and material resources in the Algarve to guarantee its sustainability, to train teachers and other environmental education technicians and to raise awareness among children, young people and the public of the importance of ecosystems as service providers for the planet and humanity. Blue wave, a project that aims to promote Ocean literacy in a school context through educational sessions in Portuguese secondary schools integrated in the Escola Azul network and teacher training sessions. Upon participation in each activity, each student receives a **BlueWave passport stamp**.
- **Sweden:** Swedish Network for water education, two networks for water education - one for the sea and one for freshwater. The Swedish Institute for the Marine Environment runs the network for marine pedagogy and the Swedish Centre for Nature Guidance runs the network for limnic pedagogy. The work is carried out on behalf of the Swedish Agency for Marine and Water Management.
- **Finland:** LUMA Centre Finland, a science education network of Finnish universities. The aim is to inspire and motivate children and youth into mathematics, science and technology (STEM) by developing new methods and activities of science and technology education based on research. Furthermore, they support the life-long learning of teachers working on all levels of education from early childhood to universities and strengthen the development of research-based teaching. The Lukema network is a community coordinated within two national

development projects funded by the ministry of education and culture and they have been awarded for seven years since 2018. The development projects enable them to produce, among other things, different events and material to support education in the common 'Lukema' network.

- **France:** Partenariats Education Nationale is the Navy's vocational baccalaureate* partnerships with the French Ministry of Education representing a network of 51 secondary schools and 1,300 students keen to discover the Navy, its unique environment, its facilities and the diversity of its professions, while following a specialized secondary course. These partnerships offer a maritime dimension to the curriculum.
- **Romania:** Black Sea Universities Network including in its activities the establishment of a first laboratory on Blue Economy in the kindergarten, high level courses for graduate students, contest organized for students to develop paintings, art crafts or online art works with solutions to minimize or reduce pollution of sea waters, marine litter and coastal-based solutions, organization of visits with high-level experts in remote areas for explaining the benefits of Blue Growth, organization of hackathons involving students from universities and high schools to address different aspect on Blue Growth Contest of innovation ideas for start-ups on aquaculture and fisheries.

Several other networks & associations have been developed that contribute to blue education with activities and resources, such as the Portuguese Wildlife Association, European Network Science Centres & Museums, Sportfiskarna, The Finnish Nature Association, Association Ocean Academy, Associação Almargem, Marine Stewardship Council, The Swedish Society for Nature Conservation, Associação natureza Portugal, Rede Cantabra de Desarrollo rural, The Rivers Trust, Irish Ocean Literacy Network.

3.6.3. Aquaria & Museums

Depending on local laws, policies, and other legal factors, **aquaria and museums** may fall into various categories, such as public sector (state-owned), private sector, or even non-profit organizations. However, for the purpose of this report, they are considered a distinct category, irrespective of their legal status, due to their role as facilities that collect and display specimens for public viewing. This gives them significant potential to influence the public. According to Britannica, a museum is an institution dedicated to preserving and interpreting tangible evidence of humankind and the environment. Museums are established for various purposes: to serve as recreational venues, scholarly centers, educational resources, or as contributors to the quality of life in their regions. They also attract tourism, promote civic pride or nationalism, and may even serve ideological aims. Given their inherently educational nature, museums can reach wide audiences and play a pivotal role in fostering understanding of the world, including in the promotion of blue education.

Similarly, aquaria provide the public with opportunities to learn about animals and the natural world. While some of these facilities operate commercially, many are dedicated not only to sales but also to education and raising awareness. For example, the European Association of Zoos and Aquaria (EAZA) brings together zoos and aquaria that maintain the highest standards of care and population management for the species under their stewardship. EAZA Members are committed to developing education and outreach programs that are as impactful as possible for their visitors and local communities, making aquaria associated with EAZA platforms for blue education.

The analysis of the database identified 10 stakeholders from this group who contribute to the implementation of blue education in Europe, three of whom run major long-term initiatives.

- **Oceanário de Lisboa,** EAZA member with initiatives such as: the 'Portugal is Sea' map presenting the Portuguese territorial reality, accounting not only for its land area, but also for its maritime territory and exploring

a range of educational materials which are related to the map and are adapted to the specificities of the Portuguese education system; the Voxmar which aims to create a new image of the Portuguese Sea depicting nine thematic conversations with more than 30 speakers who share inspiring stories; a wide range of educational programmes focused on ocean literacy, including subjects such as earth, life and natural sciences, literature, mathematics and nature conservation suited to different education levels of schools, with a view to complementing curricular programmes; training sessions aimed at teachers and educators of all education levels, with a view to providing them with tools and innovative, dynamic activities that can be easily incorporated into their classes. The Directorate-General for Employment and Labour has accredited since 2009 the Oceanário de Lisboa as a training entity, officially recognising its ability to organise professional training sessions; the Oceanário Shuttle which travels across the country to accomplish its mission by offering educational experiences for all ages and spreading the good news: we can all help conserve nature.

- **Nausicaá - Centre National de la Mer,** EAZA member, is a scientific and cultural center exclusively dedicated to the marine world. Its mission is to promote knowledge about the world's oceans and raise public awareness of the importance of effective ocean management. Nausicaá offers two primary forms of education: programs designed for schools and those aimed at the public. One of the key resources available to the public is the Document Resource Centre, which processes and manages a vast array of information—monitoring, analysis, drafting, dissemination, and archiving. This information is available to Nausicaá's diverse audience, including children, students, teachers, the public, professionals, and researchers. For schools, Nausicaá offers extensive educational resources and support for developing ocean-focused educational projects. Schools can book classes, activities, or customized visits to enhance learning about the ocean. Whether as part of an excursion or a broader educational project, Nausicaá provides a rich, interactive learning environment, offering students an engaging and educational adventure full of surprises.
- **Muséum national d'histoire naturelle** with the initiative "Plages Vivantes" (Living Beaches) programme which is a participatory observatory of the biodiversity of the upper reaches of beaches, with the aim of better understanding and predicting the effects of global and local changes.
- **Gdynia Aquarium,** part of the National Marine Fisheries Research Institute, is classified as a zoo under Polish law — an institution dedicated to breeding and housing various species of animals for **educational**, scientific, recreational, and wildlife conservation purposes. The aquarium features a dedicated Education Center that serves approximately 40,000 students annually, offering classes on topics such as the Baltic Sea, coral reefs, fish anatomy, water chemistry, marine geology, etc. In addition, the aquarium runs the Polish Ocean Literacy Portal and organizes numerous educational and outreach events throughout the year, including "Baltic Sea Protection Day" and "Shark Week." As an institutional member of EMSEA, Gdynia Aquarium plays a leading role in promoting ocean literacy in Poland, actively disseminating the latest initiatives and participating in efforts at various scales.

3.6.4. Enabling Initiatives

Aside from the entities identified as key enablers in the implementation and dissemination of blue education, it is important to highlight various initiatives and projects that contribute to the spread of blue education. These initiatives may not always be linked to direct partnerships or activities between specific entities, but they play a significant role by creating resources, providing indirect support, and fostering a broader awareness of blue education.

Noteworthy in this realm are **Blue skills** projects that are emerging to meet the needs of the Blue Economy by creating a skilled, modern workforce aware of the necessity for the sustainable use of marine resources. Led by Sea-

Teach, the Blue Generation project (2018-2023) aims to inspire and engage young people aged 15 to 29 to pursue sustainable careers in Blue Economy sectors. Similarly, the NextBlueGeneration project focuses on improving the age balance within the Blue Economy workforce and reducing youth unemployment by equipping teachers in secondary, vocational, and tertiary education with the appropriate tools and data.

The FLORES project encourages kids and young people to choose **Offshore Renewable Energies** careers by raising awareness on Ocean Literacy and offshore renewable sector. It gives access to a full range of training materials in several languages for all ages, including youngsters, teenagers or current workers from industry to boost their career and future in the Offshore Renewable Energies sector.

The She4Sea project aims to equip unemployed women with the adequate skillset to enter three maritime sectors, equip women that are already active in the maritime industry with skills for pursuing actual managerial and leadership roles. It also provides VET trainers with training tools and methodologies tailored to women's soft skills development.

The project Skills Beyond the Seas provides seafarers and those who want to become seafarers with information and guidance for their career planning. Finally, there are several maritime schools around Europe training middle and high school levels students preparing them for a (blue) career in maritime or, in other words, blue economy sector.

Although the initiatives and projects analyzed primarily focus on the EU, it is important to mention several **global initiatives** closely connected to EU blue educational activities. One such initiative is the, initiated by IOC UNESCO, OceanTeacher Global Academy, a web-based training system launched in 2005. It supports classroom training, blended learning, online tutoring, and self-paced learning. Another global initiative with a strong EU connection was the Contest Teaching resources about the ocean, organized by the Flemish UNESCO Commission during the 2018-2019 academic year. The competition aimed to raise awareness about the importance of the oceans by encouraging the development of educational packages focused on marine themes. The UNESCO Ocean Literacy Portal launched in 2017, serves as a valuable platform not only for the public but also for educators and researchers.

The I Live by the Sea international project, launched in 2017, is a global contest that invites young people up to the age of 21 to submit photos or films telling the story of "their sea." Through this creative expression, participants from diverse natural and cultural backgrounds share their perspectives on marine issues. A panel of international judges reviews the submissions, with the best entries being showcased at various events dedicated to the ocean worldwide.

The AORA Ocean Literacy Working Group works to foster alignment and collaboration among strategic partners in Canada, the United States, and the European Union. This initiative supports the implementation of Transatlantic Ocean Literacy, as outlined in the Galway Statement.

National Geographic's Ocean Initiative, launched in 2008, offers a comprehensive collection of resources, including footage, photos, information, games, activities for children, teacher resources, blogs, maps, newsletters, and travel tips related to the ocean. Lastly, the EuroGOOS Ocean Literacy Working Group, established in 2019, provides a resource library that can serve as a general blue literacy tool, offering a wide range of educational materials focused on the ocean.

More information on initiatives and other programs in the EU and especially for the experimentation countries are included in sub-chapters of "Focus areas in Blue Education" and "Initiatives or other programs" of the Deliverable 3.1 A report on proposed blue education experimentation in selected countries.

4. The EU Blue School program

4.1. Short history of blue schools

4.1.1. Introduction

Although environmental education and education for sustainable development are gaining increasing attention in European school curricula, ocean literacy has yet to achieve comparably widespread diffusion. Formal education is considered “ocean blind,” even in countries with direct access to the ocean or sea. As there is little to no information shared via the curricula, handbooks and teacher training (see **Chapter 3**), Europe is finding more creative ways to bring the ocean into the classrooms. One of them is the concept of a blue school. The label of a blue school is granted to schools that are dedicated to bringing the ocean into the classrooms.

The idea of a blue school took shape in 2015 as part of an EU-funded project to increase OL in Europe called the Sea Change Project. Here, the theoretical concept of Blue Schools was developed by consultation rounds in eight European countries. The research revealed how difficult it is to engage teachers to address ocean topics in classrooms, while these are hardly part of the curricula. Besides the lack of financial and political support, the existence of well-established environmental education programs and the large cultural and educational diversity were also main obstacles to setting up such a large pan-European or national blue school initiative. Regardless of the prospective difficulties, in 2017, the Portuguese Ministry of the Sea established the first blue school programme.

Following the example of a success story in Portugal, in 2020, the European Commission’s DG MARE (The Directorate-General for Maritime Affairs and Fisheries) established the European Coalition for Ocean Literacy (EU4Ocean), which includes besides a community of blue schools (Network of European Blue Schools - NEBS), also a community of young ocean advocates (Youth4Ocean Forum) and organisations and individuals involved in ocean literacy initiatives (EU4Ocean Platform).

The main goals of the NEBS are to:

- Create a more ocean-literate society where schools become agents for change and sustainability.
- Build bridges between ocean professionals and schools.
- Set up a network where teachers can share experiences and collaborate with other schools, nationally and internationally.

In the meantime, the All-Atlantic Blue School was set up in 2021 (All-Atlantic Blue Schools Network (2023)). The All-Atlantic Blue Schools Network (AA-BSN) is a network implemented under the All-Atlantic Ocean Research and Innovation Alliance, which is multilateral agreement on research between the countries bordering the Atlantic Ocean. By connecting schools from 16 Atlantic countries to raise and promote ocean literacy and society awareness, AA-BSN is contributing to European, national and international strategies. As the Atlantic Blue School initiative ended, the coordinators collaborated with UNESCO to initiate a Global Blue Schools Network to continue the work and expand the blue school program globally.

4.1.2. Creating the Network of European Blue Schools

The community of EU Blue School was set up in 2020 based on a survey targeting teachers, school managers, staff from ministries of education, and professionals in marine science education to understand the gaps and needs in teaching ocean topics.

300 respondents from 17 EU countries (and 3 from the United Kingdom, 1 from Turkey and 3 outside Europe – not specified) answered the questionnaire. Most respondents declared that they lived in a coastal town (<20 km from the sea; 76%). Respondents were primarily teachers (67%; Secondary Education > Primary Education > Higher Education > Kindergarten), followed by marine educators (14%) and marine researchers (9%).

97.8% of the respondents declared they include ocean/aquatic topics in their teaching practice. Notwithstanding, respondents also shared that the main reasons not to address ocean topics (at all or at higher frequency) are the "little visibility of the ocean in educational resources" (66.7%), followed by "insufficient time/planning in the curriculum" (63.33%) and "lack of opportunities for students to interact with the marine environment" (50%). Despite the difficulties in intertwining ocean topics with school curricula, respondents reported relating ocean teaching practice to a total of 35 school subjects, mainly science related such as "Biology" (52.81%)," Natural Sciences" (39.33%) and "Geography" (31.46%). "Ocean pollution" was the most addressed topic (71,6%), followed by Ocean and Climate (56,1%), Marine Ecology (56,5%), Marine Biology, and Marine Conservation (both 50,6%).

Respondents revealed they mainly teach about the ocean through "Lectures and reading" (74.6%), "Films and documentaries" (67.9%), and "Outdoor activities" (48.9%). Other approaches included "Laboratory experiments," "Inviting a speaker to the classroom," participating in "Citizen science" and developing "Artistic projects"/

To involve stakeholders in the co-creation process for the NEBS, a series of 8 virtual focus group meetings were held in Portugal, France, Ireland, and Romania and at the scale of the different sea basins (Mediterranean Sea, Atlantic, North, and Baltic Seas) throughout May and June 2020. These meetings typically gathered 8 to 12 stakeholders (teachers, education professionals, marine experts), lasting between 2 to 3 hours, with a total of 76 individuals participating. The goal was to gather existing ocean school projects and capture opinions on good practices, challenges, certification processes, handbook content, and conditions for a successful Network.

The focus group analysis revealed the following preconditions:

- There is a strong interest in the NEBS;
- Developing ocean-related projects is challenging due to curricular constraints;
- The handbook should provide guidance on joining the Network;
- The certification criteria should not be too prescriptive, with the possibility to adapt to local context;
- A simple and non-bureaucratic process could foster the NEBS growth.

4.2. The NEBS foundations

The survey and focus groups, as well as the Portuguese Blue School program, helped to define the NEBS foundations. In a European Blue School, teachers actively engage students to bring the ocean into the classroom

through project-based learning and open schooling. By incorporating project education, students can explore ocean-related topics that are not in the curricula. This approach encourages developing skills such as critical thinking and problem-solving as students collaborate on real-world challenges and connect their learning to their local communities. Open schooling further extends learning beyond the classroom, fostering partnerships with local organizations, marine scientists, NGO's and maritime companies, which provide students with direct experiences and insights into ocean stewardship or ocean careers. Through these methods, European Blue Schools could cultivate a sense of responsibility and awareness about the importance of the ocean in sustaining life on Earth.

The educational model of NEBS is based on ten key criteria (**Figure 16**). These can be considered guidelines for developing a project and criteria for self-evaluating the application to become a European Blue School. Five criteria are compulsory, while the others are optional and will help strengthen a project.

The compulsory criteria ensure that 1) students gain more in-depth knowledge and skills by working for an extended period to explore and investigate an ocean topic, 2) students are encouraged to be active and productive learners, 3) projects have an active and student-centred pedagogy where students develop secondary skills (social skills, solution-oriented thinking, creative thinking, 4) a connection is built to local ocean stakeholders and 5) wide dissemination of the project is done.

The five optional criteria encourage teachers to develop more complex project ideas, increase authentic and outdoor learning experiences, and collaborate with teachers from different disciplines, diverse age groups, and geographies.

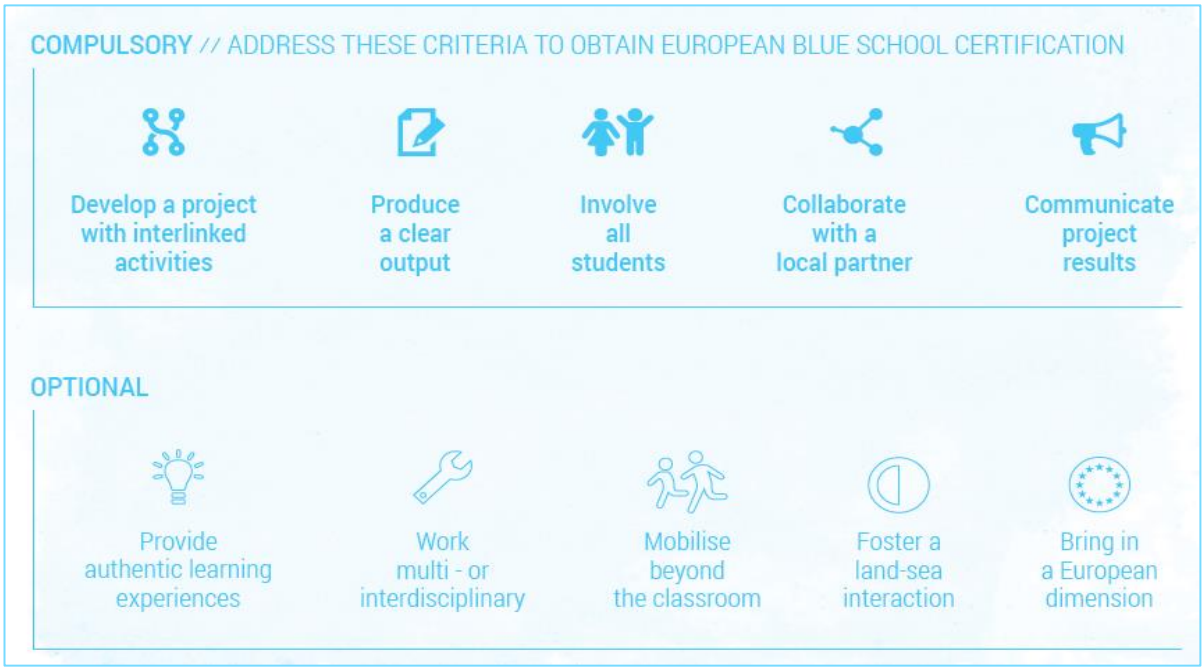

Figure 16. The 5 compulsory and 5 optional criteria to become a European Blue School

4.3. Support to teachers

Direct communication and contact among teachers and various forms of networking have been central to the NEBS since the beginning of this initiative. A primary benefit of the NEBS is its European cultural dimension, where teachers share experiences, practices, tools, and methods, across the borders.

As a way to facilitate networking, the NEBS organise online networking sessions. Additionally, the NEBS launched its official group on the European School Education Platform (ESEP), intending to transfer their Facebook group there gradually. ESEP (funded by the European Commission) is the largest collaboration platform for school staff, researchers, and policymakers to engage and share news, publications, and resources, and find partners for Erasmus+ funded projects and, therefore, a strategic place for the NEBS to engage. The ESEP/eTwinning can also be used to let students interact and help teachers find collaborations for bringing the ocean into their classroom.

This group's goal is to be teacher-led. Educators have the opportunity to influence its direction, content, and activities. This approach ensures that the platform evolves in alignment with its users' real-world needs and interests, facilitating adequate support and engagement within the school education community. This initiative aims to encourage direct engagement and promote synergies between the NEBS and the ESEP platform, enhancing the reach and impact of Blue Schools.

Another effort undertaken to get teachers involved in the NEBS is equipping them with the knowledge and tools to develop impactful blue projects and draw inspiration from existing initiatives.

In 2022 and 2024 a series of Science Projects Online Workshops (SPOWs) on various ocean topics were conducted in collaboration with European Schoolnet and Scientix. These three-week interactive online workshops provided personal training with content knowledge, teaching guidelines and class resources to a limited number of educators new in the field of blue schools. A more extensive course on becoming a blue school was launched in 2024 by the European Schoolnet Academy, which attracted over 1100 teachers. The “Bring the Ocean into School” MOOC has been successful in motivating teachers to initiate projects. According to a post-course survey, 97% of participants said they would apply the ideas and examples from the course in their daily teaching, noting increased confidence in incorporating ocean-related topics at their schools. Subsequent evaluations of NEBS applications in Spring 2024 revealed that teachers implemented projects conceived during the MOOC and successfully applied to NEBS. The course materials remain available at the European Schoolnet Academy.

In April 2024, an additional online course, BlueMinds4Teachers, funded by EU4Ocean, was offered to teachers on OL. The project aimed to enhance the skills of teachers and educators in OL through the collaboration of marine and freshwater scientists, experts from educational and social sciences, experienced teachers implementing ocean-related projects, and young ocean ambassadors. The course was attended by 70-90 participants. According to the post-course survey, participants felt more confident in developing ocean-related projects, with a mean rating of 4.24 on a scale from 1 (totally disagree) to 5 (totally agree).

4.4. Certification of a blue school

Any public or private school, coastal or inland, can become a European Blue School if it has conducted or is currently undertaking a project connected to the ocean that aligns with the NEBS criteria (see **4.2**). The process of becoming a European Blue School and accessing its benefits is completed online. Teachers fill out the application form on the

Maritime Forum Blue Schools Community website, providing project details and contact information and meeting the specified criteria. In addition, the application form collects information, such as the sea basin the project is connected to, the school's geographic coordinates, the number of participating students, connection to the curriculum, and other related initiatives. The data presented in this section is derived from the application forms.

The application periods are open twice yearly—from September to December and January to May. The applications are reviewed by the NEBS Secretariat. During the evaluation process, teachers may be contacted for further details, and once the results are finished, they will receive them via email. If approved, the European Blue School Certificate is issued for the current school year; if declined, the project can be modified to meet the requirements and resubmitted.

After a project finishes, schools stay in the Network. This approach allows for ongoing communication and collaboration with teachers beyond their project timelines to provide ongoing support, facilitate networking opportunities, and promote the exchange of best practices, effectively advancing the quality of ocean education in Europe.

The growing interest in the NEBS increases the importance of adapting the program to better align with the current landscape of blue education and address the evolving challenges and opportunities in this field. Therefore, after careful analysis and evaluation, in the summer of 2023, three types of European Blue Schools were recognised:

- European Blue School - Schools that meet the criteria and are located in one of the EU countries
- Associated Blue School - Schools that meet the criteria and are located in countries associated with Horizon Europe
- Partner Blue School - Educational institutions such as maritime VET schools, teacher training centres, non-formal education centres, etc.,

While the NEBS criteria emphasize the importance of project-based learning and open schooling, there are no requirements regarding engagement in terms of project duration or a whole school approach. This flexibility is intentional, as it encourages schools to embrace ocean literacy at their own pace and in a manner that best suits their educational objectives. However, it is essential to recognize and appreciate varying levels of engagement among schools and teachers within the Network. Some may demonstrate a high level of dedication and sustained involvement over extended periods, while others may engage more sporadically or on a smaller scale.

To acknowledge and celebrate this diversity, the NEBS introduced diversified certificates or levels of European Blue Schools - 1. Blue School (Entry Level), 2. Aquamarine Blue School (Intermediate Level) and 3. Ultramarine Blue School (Advanced Level). These differentiated certificates will serve as a means of recognizing and rewarding schools and teachers who exhibit exceptional commitment and dedication to the European Blue Schools initiative. By extending project durations, submitting repeated applications with evolving projects, and demonstrating ongoing engagement with ocean literacy principles, schools can progress through different levels of certification. In addition to honouring those who are deeply engaged with NEBS, diversifying certificates will serve as a powerful motivator for others to increase their involvement and advocacy for ocean literacy.

4.5. NEBS Composition

The schools in the NEBS are not evenly distributed across locations and certification types. The majority (79%, 406 schools) are within the EU, - in 22 of the 27-member states. 21% (107 schools) of NEBS members are located in EU-associated countries, with the majority in Turkey (**Figure 17**). A large part of the blue schools are located in the Mediterranean Sea basin (60% EU, 38% non-EU) and Black Sea region (15% in EU, 52% non-EU), with Spain, Greece, Italy, Turkey and Romania as the leading countries.

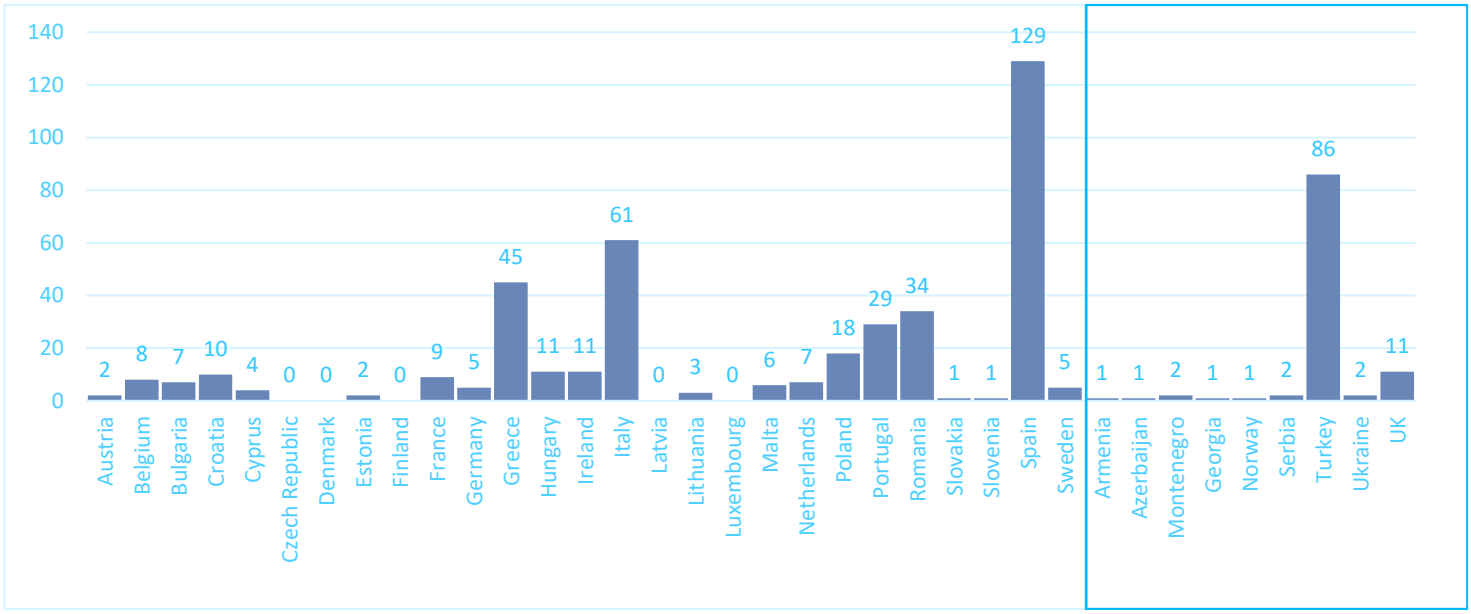

Figure 17. Number of certified European Blue Schools per country (2024)

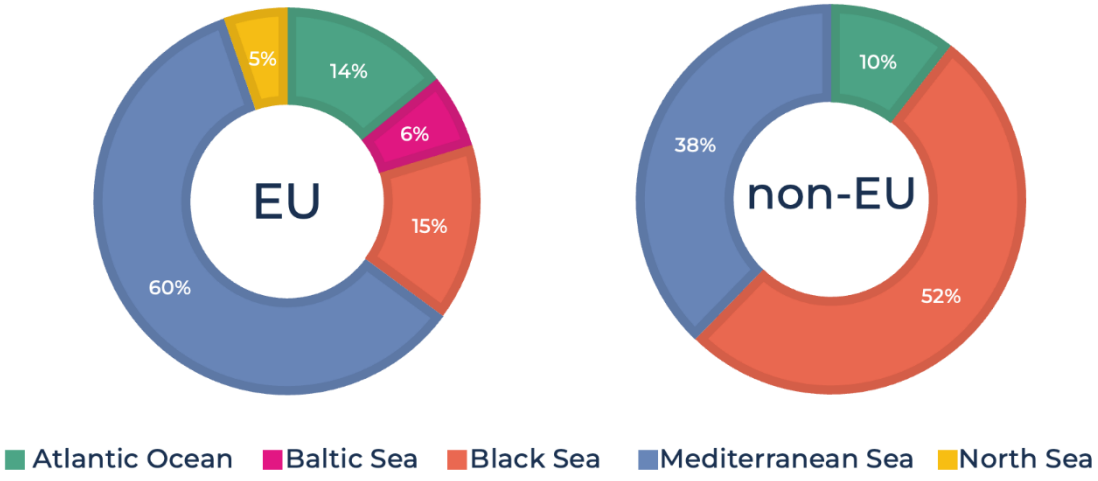

Figure 18. Distribution of blue school projects by sea basin (2024)

Projects developed with primary to junior high school students (ages 7-15) are prevalent in both EU and non-EU countries, accounting for 60% and 59%, respectively. Secondary schools comprise 32% of EU projects and 38% of non-EU projects (**Figure 19**). The NEBS composition concerning school levels is best analysed concerning age groups, because of the diversity of educational systems – 3-6 yo (preschool), 7-15 yo (primary, middle, and junior high school), and 16-18 yo (high school, vocational, and technical schools).

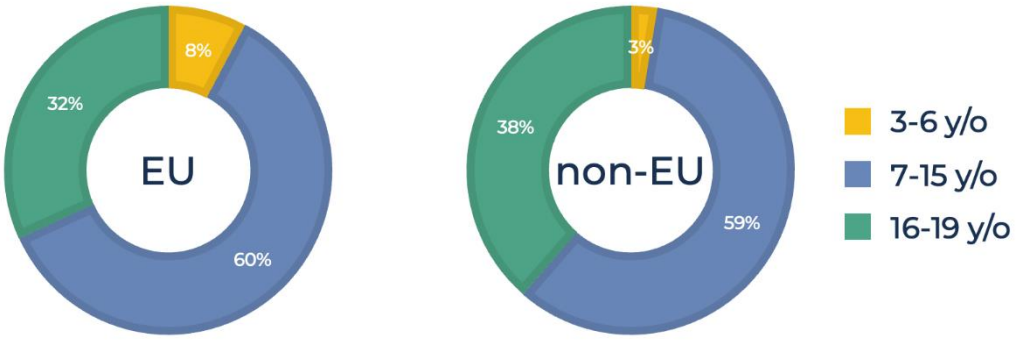

Figure 19. Network composition by student aged (2024)

4.6. Local and Regional NEBS support

The NEBS has certified 585 (2024) blue projects since school year 2020-2021 (**Figure 20**). It has been growing steadily since its inception, and the growth gained momentum in the school year 2023-2024, evidenced by the increasing number of schools joining the network and the rising number of submitted applications since 2020 In 2024, three new EU-funded projects were set up to support the growth of the NEBS. These projects—ProBleu, SHORE, and BluelightS—aim to foster environmental awareness and promote water and ocean literacy via blue schools in Europe.

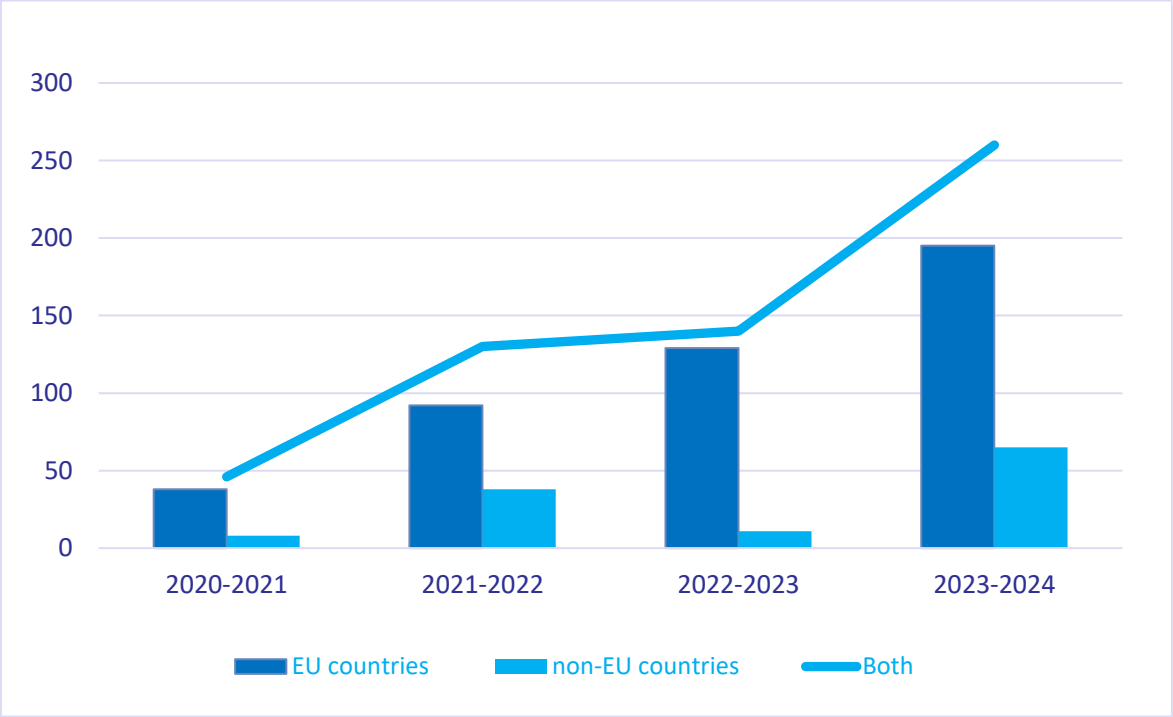

Figure 20. Increase in issued certificates per school year (2024)

Local, regional or national support plays a crucial role in engaging new schools in the NEBS. The two countries with the highest number of schools, Spain and Turkey (**Figure 17**), are directly connected to local support. In Spain, 92 out of 129 schools are located in the Balearic Islands, predominantly in Mallorca, and were supported by the Erasmus+ funded Some Escoles Blaves project (see **3.5**). The large number of Turkish schools is linked to the support of the SHORE project and the Turkish Ministry of Education, causing a significant increase in applications from Turkey during the 2023-2024 school year (400 applications).

Another example of a country where schools received additional support about joining the NEBS is Poland (18 schools, **Figure 17**). The Gdynia Aquarium of the National Marine Fisheries Institute, supported by funding from the Gdynia City Hall, developed a program for local schools. The program supported the teachers throughout the project development, implementation, and application process, which resulted in 11 schools joining the NEBS in the 2021-2022 school year. This support is reflected in NEBS composition, with Poland currently having the most schools among all Baltic countries and ranking 6th among EU countries (**Figure 17**).

The growth of NEBS seems to be also influenced by funding. According to a survey conducted in June 2024 (see **4.1.2**), 45% of teachers identified the lack of funding as a significant obstacle (**Figure 22**). A significant increase in applications and subsequent network growth was observed in relation to the funding for school opportunities from SHORE, ProBleu, and BlueLightS. These funding schemes are targeted towards already certified blue schools or requires them to be in the process of getting certified before completing the funded project. The first ProBleu funding call opened on November 17th, 2023, and March 1st, 2024, followed by SHORE on January 17th, 2024. BlueLightS will launch its first call in September 2024.

However, funding availability is not the only factor contributing to the rise in applications from these projects. Each project also offers webinars and information sessions on funding calls, during which NEBS is presented through both online and in-person events. The significant increase in applications also coincided with the organisation of the MOOC and other online courses that attracted new schools.

4.7. Impact and challenges

In June 2024, an EU-scale survey was conducted to learn more about the impact and value of NEBS to its members, highlighting the significant role of the Blue School projects in advancing OL. The survey aimed to identify the main obstacles and challenges encountered and provide a platform for further improvement and development for teachers and students and the wider community.

This online survey was sent to all NEBS members, excluding the schools in Mallorca (Som Escoles Blaves), as this region was the subject of a separate research approach. A total of 80 participants from 14 countries answered the survey. 66% of the responses came from southern European nations (Italy, Spain, Greece, and Turkey), aligning with the highest concentration of Blue Schools in the network. 70% of schools are from urban areas and coastal communities, 10% are from Island schools, and the remaining responses are from schools in suburban and rural areas.

The respondents considered the improvement in awareness about the ocean and the improvement of OL in local communities as the principal outcomes of being a Blue School. Nevertheless, the teachers recognized all outcomes as very important, ranking between 77% and 92% (**Figure 22**).

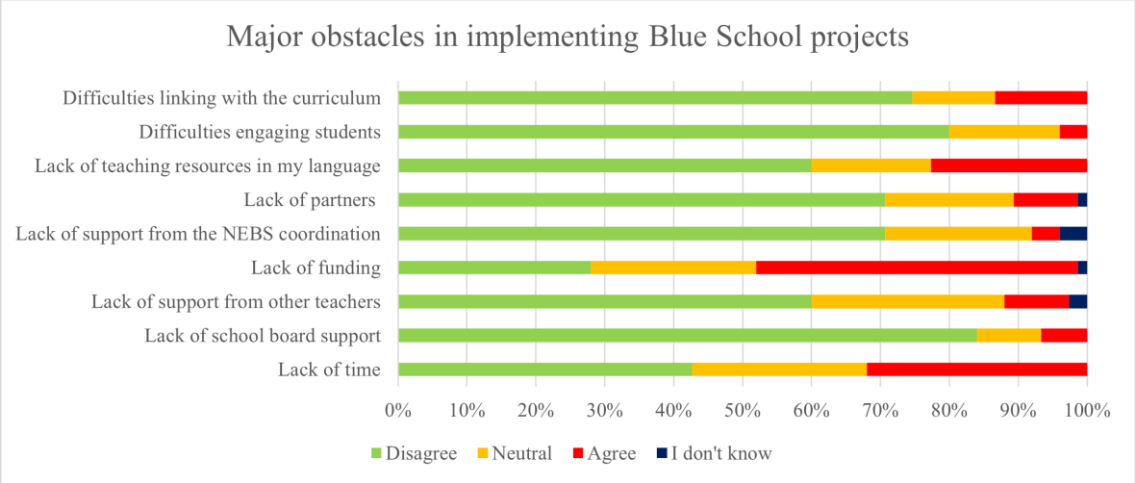

Figure 21. Assessment of the obstacles to implementing OL in European Blue Schools

When asked about the obstacles experienced when implementing the Blue School project, 45% of teachers identified the lack of funding as a significant obstacle, followed by the lack of time identified by more than 33% of teachers (**Figure 21**). Conversely, 83% of teachers did not experience any struggle in having school board support when implementing OL projects, 80% had no difficulty engaging their students, and 75% could link their projects with the curriculum easily. The latter is consistent with the results of the 2020 initial survey and with the data from the

application form, according to which 93% in EU and 89% in non-EU countries declare that the project was developed in connection to school curricula (**Figure 23**).

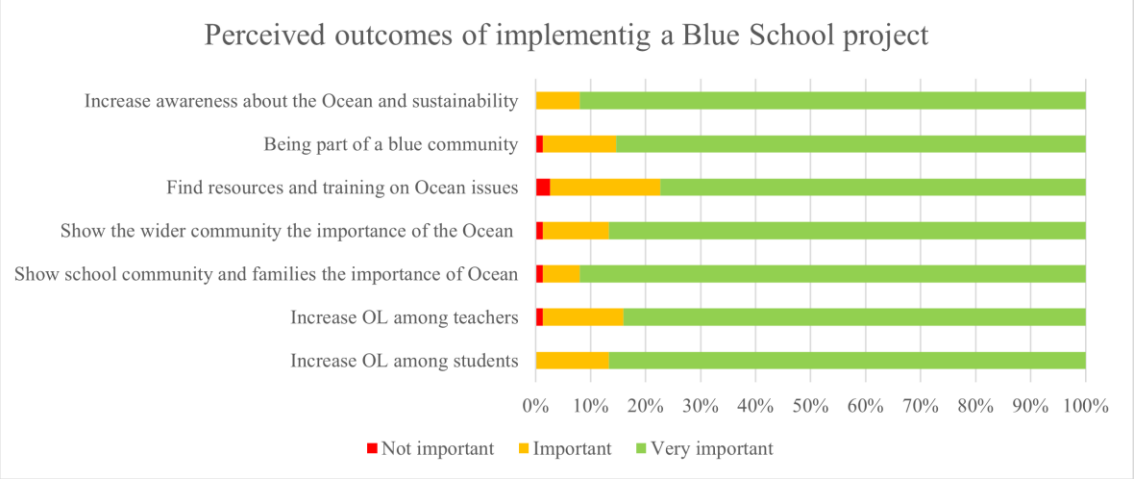

Figure 22. Evaluation of the primary outcomes of the schools' project implementation

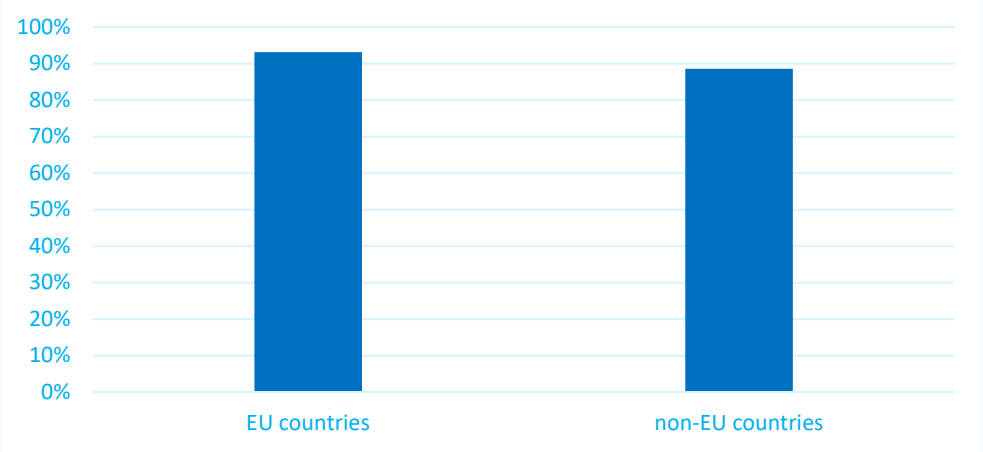

Figure 23. The percentage of projects connected to school curricula

The data from this survey corresponds to a limited sample of European Blue Schools, which does not allow us to draw definitive conclusions. However, it still provides valuable insights and considerations that can help improve and adapt the pedagogical model of the European Blue Schools.

Table 4. Barriers to implement Blue School program (Seachange 2016, Atlantic Blue Schools 2023, Network of European Blue Schools-NEBS 2024)

Barrier to implement blue schools	Sweden	Denmark	Belgium	UK	Greece	Ireland	Spain	AA-BSN	NEBS
Lack of funds for the implementation of actions or transport	x	x		X	x		x	X	X
Lack of time to develop the project	x	x					x	X	X
Difficulty in involving teachers/schools in the program/project (no incentive)	x		x	X	x			X	
Lack of support from school management	x		x		x			X	
Lack of support from decision-making bodies – Ministry of Education or similar					x			X	
Lack of curricular flexibility (which allows articulating initiatives with curricular programs)			x				x	X	
Lack of confidence and training to teach about the ocean		x		x	x	x		X	
Physical distance to the ocean		x	X		X (some regions)			X	
Lack of interest in working on the ocean theme			X		X (lack of interest in environmental education)			X	
Lack of interest on the part of students in studying and exploring the ocean theme									
Lack of support from the Blue School coordination									
Competition with another well-established program			X (Eco-schools)	x	x	X (Green schools)		/	/
Lack of teaching resources in own language									x

5. Challenges and opportunities

5.1. Challenges to implementing Blue Education in schools

Blue education, centred on enhancing ocean literacy, faces numerous challenges across Europe. These challenges stem from a variety of structural, financial, and policy-based issues that hinder its adoption and integration into national education systems. From the publications, interviews with experts and the survey of the experimentation countries several challenges were derived.

5.1.1. Barriers of the experimentation countries

The survey[2] carried out within the T3.1. of the WP3 identified several barriers on implementing blue education. Most of the 64 stakeholders of the experimentation countries (Croatia, Romania, Greece, Spain, Finland, Sweden, Portugal, France, Ireland) in BlueLightS found that **lack of funding** to support dedicated blue education activities seems to be the most important barrier to develop blue across their national educational systems. **Interest from teachers** but also their **training** and **available educational resources** on blue challenges and issues also seem to be inefficient, along with **curricula constraints** and **absence of blue in the general framework of environmental education (Figure 24).** More detailed information regarding the specific barriers faced by each of the experimentation countries, including graphs displaying the frequency of responses in the form of five horizontal bar charts based on the survey results, is provided in **Annex 8.5.**

Figure 24. Barriers to develop blue across national educational systems of experimentation countries

5.1.2. Comparison of barrier research

The barriers identified in the BlueLightS survey align closely with the research findings from Fauville et al. (2018), which mapped 657 interconnected barriers to teaching ocean literacy to students aged 12–19 across several

[2] D3.1-A report on proposed blue education experimentation in selected countries

European countries. They used the application of **Collective Intelligence** from some of our experimentation countries (Sweden, Ireland, Portugal, Spain, Greece; see **Annex 8.6**) along with Belgium, UK, and Denmark (257 stakeholders) within the framework of Seachange project (2016). We compare the results from this analysis with the results of the survey done under WP3.

Meta-analysis revealed 657 interconnected barriers to teaching about the ocean influencing one another in a European Influence Map. The influence map shows 8 themes: Awareness and Perceived knowledge; Policies and Strategies; Engagement, formal education sector; the Ocean itself; Collaboration; Connections between humans and the ocean and the Blue Economy, having the greatest influence and impact on marine education, with their average influence score decreasing from the first to the last, i.e. the first theme significantly aggravates (makes worse) the following themes and so on.

Regarding barriers to teaching 12–19 years old about the ocean according to Fauville et al.:

1. *Awareness and perceived knowledge: Ocean Literacy=lack of awareness of the concept of ocean literacy or its relevance for our society, Ocean knowledge=lack of or partial knowledge about the ocean as reported also by several studies on the public's awareness of the ocean*

   Apart from lack of teachers' knowledge, awareness and knowledge about the ocean issues were not mentioned most probably because several other dimensions of OL such as attitude, communication, behaviour, activism, emotional connections, access and experience, adaptive capacity, trust and transparency (Brennan et al., 2019; McKinley et al.,2023) have been proposed to be equally important.

2. *Policies and strategies: funding=lack of money for resources and funds to experience the marine environment, Governance= lack of support from local and national authorities to incorporate ocean issues in the school curriculum*

   Similar barriers for development of blue education to the ones included in policies and strategies and additional ones (see below) selected by our stakeholders of WP3 survey seem to persist: Lack of funding to support dedicated blue education activities as well as curricula constraints and insufficient attention paid to blue in the general framework of environmental education (no blue in environmental education) remain as crucial barriers for the development of blue education across the experimentation countries. Policies and strategies from WP3 survey also include bureaucracy and the absence of "blue" (no continuous blue programme support) in general and in the evaluation framework (no evaluation frameworks) in particular.

3. *Engagement: Interest=a lack of interest of ocean topics by teachers and students, Distractions=interferences coming from the social environment that distract students from the marine environment and affect their engagement toward it, Communication= difficulty to reaching out to the targeted audience in their own language and through the right channel, and Hands-on= lack of hands-on activity available to student.*

   As far as engagement is concerned, lack of interest from teachers but also parents and appetite for blue education activities along with insufficient support for students' academic, social and emotional needs were also selected as barriers across the experimentation countries. However, communication and hands-on activities were not mentioned among challenges in the survey.

4. *Formal education sector: Teaching=inadequate teaching methods used to teach about the ocean, the shortage of teacher training courses and the lack of motivation and knowledge about the marine environment among teachers, Field trip=concerns and difficulties experienced by teachers and students during field trips,*

Interdisciplinary=the lack of interdisciplinary work among teachers, Equipment=lack of adequate equipment in school, School Culture=obstacles originated from the school management, Curriculum=curricula are restricted and do not include ocean topics, Time=scarcity of time available in the curricula to include ocean subjects, and Teaching material=there is not enough teaching material and the material existing should be improved.

Most of the barriers seem to be found in the school system also from our WP3 survey such as lack of time, lack of general knowledge by teachers on ocean and freshwater-related topics and issues areas (lack of teacher knowledge), lack of teacher training on blue challenges and issues, lack of educational resources that can help supporting the development of blue education activities, insufficient integration of innovation (e.g. project-based teaching, outdoor schooling) and technology in teaching methods and learning processes (poor innovative teaching, little tech integration). Policy and institutional barriers, bureaucracy and curricula constraints could also be included in the obstacles of formal education sector.

5. *The ocean itself: Access= physical location along with socio-economic components influences one's possibility to reach the ocean, Ocean complexity= highlight the complexity of the ocean and how this inherent complexity challenges people's ability to get an overview of the ocean system*

   Difficult access to water/marine (outside) environments (difficult access to water) was also voted by our stakeholders as an obstacle. Ocean complexity was not mentioned among challenges of our WP3 survey.

6. *Collaboration: External programmes= abundance and lack of external programmes offering marine education, Informal education= lack of marine activities offered in informal education and marine teaching centres and Partnerships= lack of connection between schools and scientific institutions.*

   Considering the lack of role recognition of marine/freshwater researchers, lack of appropriate “blue” partners/stakeholders and in general lack of human resources (lack of people) remains a question.

7. *Connection between humans and the ocean: Personal Experience=lack of personal experience with the ocean, Culture= citizens’ inability to understand the cultural and societal importance of the ocean and Everyday life= people limited ability to understand the importance of the ocean in their everyday life*

   Limited interest and involvement of local communities (little community interest) was found as an obstacle closer to connection between humans and the ocean.

8. *Blue Economy: Marine Careers= lack of awareness of the different potential career linked to the ocean such as marine educators, Industry= competing interests in the ocean environment*

   Projects related to blue careers have already emerged to meet relevant requirements most probably explaining the absence of this barrier from our WP3 survey.

When comparing with the barrier research of the EU Blue Schools Network (see **Chapter 4**), we see many similarities, but also differences. The challenges of establishing national blue school programs vary significantly across countries due to differences in education systems and local contexts. Here are some examples of how these barriers manifest in different nations:

- **Sweden:** The primary obstacles identified include a lack of funds, limited time, difficulties in engaging teachers, and insufficient support from school management.

- **Ireland:** The main challenges involve a lack of teacher confidence and training to effectively teach ocean topics, as well as strong competition from other well-established programs, such as Green Schools.
- **Spain:** Key barriers include a shortage of funds, limited time, and a lack of curricular flexibility that hinders the integration of ocean education into existing programs.
- **Greece:** The barriers are more varied and include a lack of funds, difficulties in involving teachers, insufficient support from both school management and decision-making bodies like the Ministry of Education, a lack of teacher training and confidence, physical distance from the ocean in some regions, low interest in environmental education, and competition with other well-established programs.

Blue schools are project education, which can be a barrier with regards to time, training and funding resources (developing a project), and that curriculum constraints are, as predicted by the NEBS, less significant. Understanding and addressing these barriers is crucial for the long-term success of the EU Blue Schools initiative, as they hinder the ability of schools to fully embrace ocean literacy and prepare students to engage with the vital issues surrounding the marine environment.

5.1.3. Main challenges of blue education

After comparing the survey, research papers and interviews with experts, we conclude that the implementation of blue education across Europe faces numerous challenges, deeply rooted in policy gaps, financial constraints, fragmented curricula, and limited teacher training. These barriers are further compounded by the diverse educational landscapes across countries, which influence how ocean literacy is prioritized and integrated into school systems.

Policies and strategies

A significant obstacle to blue education is the **lack of consistent policy support and awareness among educational policymakers**. Ocean literacy often remains marginalized in national agendas, lacking the recognition and resources necessary to gain traction within formal education systems. Many countries face challenges in aligning blue education with their national priorities due to bureaucratic hurdles and short-term political agendas that impede long-term commitment.
The **absence of a cohesive policy framework for blue education** across Europe contributes to fragmented implementation efforts. In some regions, governance structures fail to provide the support needed to incorporate ocean topics into school curricula effectively. Without clear guidelines and national strategies, integrating blue education into the broader educational landscape becomes an uphill battle, especially where local and national authorities do not prioritize marine issues.

Financial constraints

Financial limitations pose one of the most substantial barriers to the adoption of blue education. Schools and smaller organizations often struggle to secure funding to support marine education initiatives due to the complex nature of grant application processes and limited financial resources. Many educational institutions lack the administrative capacity to navigate these processes, resulting in only a small number of schools successfully accessing available funds.
Furthermore, most existing **funding opportunities are short-term and project-based**, such as those from Erasmus+ or Horizon Europe, which limits the sustainability of blue education initiatives. Even when schools receive initial funding, maintaining these programs over the long term remains a significant challenge. Expanding localized

projects to a broader regional or national scale requires substantial financial investment that is frequently unavailable, underscoring the need for more sustainable and long-term funding solutions.

Teacher training

Teachers are at the heart of blue education, yet they often **feel underprepared to tackle ocean literacy topi**cs due to a **lack of adequate training**. Pre-service teacher education rarely includes a focus on marine science or ocean-related subjects, which leaves new educators lacking the confidence and knowledge required to introduce these concepts to their students.
In-service professional development also falls short, with **limited opportunities for teachers** to deepen their understanding of ocean literacy and innovative teaching methods. Many educators report that they lack the tools, resources, and support needed to teach ocean topics effectively. This gap is exacerbated by the absence of ocean-related themes in major formal education networks and events, which limits opportunities for professional growth and collaborative learning among teachers.

Curriculum challenges

Fragmentation within the curriculum itself poses a significant hurdle to integrating blue education. Environmental education is often dispersed across subjects like science, social studies, ethics, and citizenship, without a cohesive framework to link these areas into a comprehensive narrative on ocean literacy. Even science education misses a multidisciplinary approach. This disjointed approach makes it difficult for educators to deliver a unified message about the importance of the ocean in our ecosystems and society.
The **lack of curricular flexibility** further compounds these issues. Many schools have rigid curricula that do not allow for the integration of new topics, limiting the ability of educators to introduce ocean-related content. Efforts to standardize a blue curriculum across Europe are also complicated by significant variations in educational systems, languages, and cultural priorities between countries. Some nations naturally incorporate more marine education due to their coastal geography, while others lag, highlighting the need for a more harmonized approach to ocean literacy across Europe.

Engagement and the formal education sector

Engagement with blue education is another challenge, both for teachers and students. **Low interest levels and competing educational priorities** often divert attention away from marine topics. For instance, in some countries, well-established programs like Eco-Schools take precedence, making it harder to introduce or prioritize ocean literacy.
Moreover, the formal education sector often **lacks the infrastructure to support hands-on, experiential learning** activities that are crucial for engaging students with marine topics. Barriers such as limited time, inadequate teaching methods, and insufficient resources for field trips prevent educators from fully immersing students in the complexities of the ocean. Without the tools and institutional backing, fostering a deep connection between students and the marine environment remains a struggle.

Collaboration and partnerships

Collaboration between schools, scientific institutions, and marine education centres is vital to the success of blue education, yet these **partnerships are often lacking**. Many schools do not have strong connections with marine professionals or non-formal education centres that could provide valuable resources and expertise. The absence of

structured collaboration reduces the impact of blue education initiatives and limits the reach of marine literacy programs.
To bridge this gap, **more robust networks and partnerships are needed** to link schools with the scientific community and other blue education stakeholders. By fostering these connections, educational institutions can gain access to a wealth of knowledge, tools, and innovative teaching strategies that can help make ocean literacy a more integral part of the learning experience.

Connection with the sea

The relationship between humans and the ocean is another area where understanding is limited. Many people **lack personal experiences with the sea**, which can make it difficult for them to grasp its significance in their everyday lives. Cultural and societal perceptions also play a role, with some regions placing less emphasis on the ocean's importance to their local identity and economy.
Building a stronger connection between individuals and the ocean is essential to overcoming these barriers. By fostering emotional and cultural ties to the marine environment, educators can help students and communities develop a deeper sense of stewardship and responsibility for the ocean's health.

Blue economy and career awareness

Awareness of the blue economy and ocean-related career opportunities remains low. Many students are unaware of the diverse range of professions available in marine science, conservation, and sustainable blue industries. Addressing this gap requires more targeted educational efforts that showcase the career pathways linked to the ocean and its resources, inspiring the next generation to pursue opportunities within the blue economy.

5.2. Opportunities to implementing Blue Education in schools

The following recommendations for addressing barriers to ocean education are based on insights gathered from the interviews, surveys, research papers, and reports. This comprehensive approach ensures that the strategies reflect a diverse range of perspectives and experiences in the field.

Policies and Strategies

- **Increase Policy Support and Awareness**: Advocate for greater recognition of ocean literacy within national education strategies by engaging policymakers and raising awareness of the importance of blue education. Developing policy briefs and organizing high-level forums with decision-makers can help align ocean literacy goals with broader national and European educational priorities.
- **Promote a Balanced Top-Down and Bottom-Up Approach**: Effective blue education implementation requires a combination of top-down policy initiatives and grassroots, bottom-up efforts. While top-down initiatives can introduce blue education quickly, they must be balanced with local ownership and grassroots engagement to ensure sustainability. This approach aligns blue education with national priorities while also addressing regional needs and capacities.

- **Engage Decision-Makers and Empower Teachers**: Engage and educate decision-makers at the highest political levels to put blue education on the national agenda. Simultaneously, empower teachers as key stakeholders through targeted training, resources, and support, recognizing that their involvement is crucial for the long-term integration of blue education into school curricula.
- **Foster Partnerships Beyond the Ocean Literacy Community**: Encourage collaboration not only with ocean literacy advocates but also with stakeholders from the education sector, including ministries of education, key teachers, universities, businesses, and NGOs. Building official connections between formal and non-formal education entities can strengthen blue education initiatives.

Financing

- **Develop Sustainable Funding Mechanisms**: Advocate for long-term, dedicated funding streams to support ocean literacy and blue education initiatives. Ensure that funding mechanisms are straightforward, with clear guidelines and expectations for teachers and schools involved in these projects.
- **Facilitate Access to Funding**: Simplify the funding application process to make it more accessible to schools and educators. Provide support through toolkits or guides that outline how to apply for grants, as well as transparent criteria for project funding to reduce bureaucratic obstacles.
- **Leverage Multi-Stakeholder Collaboration for Financial Support**: Build a community platform that enables multi-stakeholder partnerships, bringing together educators, scientists, policymakers, and funders to pool resources and support blue education. Collaboration is key to scaling these initiatives, ensuring the financial and material resources required for long-term sustainability.

Teacher Training

- **Integrate Ocean Literacy into Pre-service Teacher Education**: Include dedicated modules on marine science and sustainability in teacher training programs to ensure new educators are well-prepared to teach these topics. This should also involve hands-on experiences and the development of e-learning resources to support online teaching formats.
- **Empower Teachers as Key Stakeholders**: Focus on bottom-up initiatives that empower teachers through training and development. Equip them with the necessary resources, support, and practical tools to integrate blue education into their lessons without adding to their workload. Recognize their pivotal role in driving the success of blue education initiatives.
- **Create a Comprehensive Blue Education Toolkit**: Provide teachers with a practical "blue toolkit" that includes planning resources, materials, and implementation models for blue education. This toolkit should be designed to integrate ocean literacy seamlessly into the existing curriculum rather than adding to teachers' already extensive workload.

Curriculum Development

- **Adopt a Cross-Curricular Approach**: Integrate Ocean Literacy into multiple subjects to provide a holistic understanding of marine topics. A cross-curricular strategy allows students to explore ocean-related themes within science, social studies, mathematics, language arts, and more, making it easier for teachers to weave these topics into their daily teaching.

- **Emphasize Flexibility and Teacher Autonomy**: Allow educators more freedom to adapt ocean education content to fit the needs of their students. Provide schools with the flexibility to integrate blue topics in ways that align with their local contexts and educational goals.
- **Engage School Principals in Implementation**: Recognize the crucial role of school principals in motivating teachers and driving curriculum changes. Encourage their active involvement in promoting and integrating blue education into their schools.

Engagement and the Formal Education Sector

- **Ensure Student-Centered Learning**: Design blue education projects that put students at the center of the learning process by tapping into their interests, such as digital technology, gaming, and local issues. Empower students to take ownership of their learning and encourage their active participation in citizen science projects.
- **Promote Open Schooling and Critical Thinking**: Encourage schools to adopt open schooling methods that promote flexibility, personalization, innovation, and lifelong learning. Active participation and experiential learning can help students develop critical thinking and problem-solving skills related to ocean literacy.
- **Support Continuous Evaluation**: Implement regular assessments of blue education programs to monitor their impact and identify areas for improvement. This data-driven approach will guide enhancements in program quality, ensuring that the initiatives remain relevant, effective, and aligned with educational goals.

Collaboration and Partnerships

- **Build a Centralized Platform for Collaboration**: Develop a digital platform where stakeholders from various sectors, including schools, educators, scientists, and organizations, can connect and share resources. This platform should categorize activities by student age, region, and project focus, making it easy for teachers to find relevant contacts and tools.
- **Promote Citizen Science and Community Involvement**: Encourage the involvement of local communities, families, and students in ocean literacy initiatives. Participatory science projects that address local marine issues can inspire students and foster a sense of belonging and responsibility.
- **Combine Top-Down and Bottom-Up Efforts for Synergy**: Use a multi-stakeholder approach that leverages both top-down support from policymakers and grassroots-level initiatives from educators and communities. This balanced strategy can amplify the impact of blue education, ensuring that it is both widespread and sustainable.

Raising Awareness of the Blue Economy and Career Pathways

- **Highlight Career Opportunities**: Introduce students to the variety of career paths related to the blue economy and ocean industries through curriculum content and career exploration activities. This can be further supported by partnerships with local businesses, universities, and marine organizations.
- **Inspire Sustainable Thinking**: Emphasize the importance of sustainable living, resource conservation, and positive environmental action within the blue education curriculum. Inspire students to think critically about their impact on the environment and encourage behaviors that contribute to a sustainable future.

Addressing Cultural and Regional Differences

- **Adapt Content to Local Contexts**: Tailor blue education initiatives to align with the specific cultural and regional contexts of each country. Recognize that maritime nations might emphasize ocean-related topics more heavily, while inland regions might require different approaches to engage with these concepts.

- **Develop Integrated Learning Models**: Encourage schools to adopt integrated work models where ocean-related topics are linked with other subjects like geography, mathematics, and language arts. Provide guidance to teachers on how to merge these subjects effectively for a more cohesive learning experience.

Student Engagement and Learning

- **Focus on Hands-On and Experiential Learning**: Engage students through fieldwork, outdoor schooling, and experiential activities that bring marine topics to life. Building connections with nature helps deepen students' understanding of environmental processes and fosters a lasting commitment to ocean conservation.
- **Encourage Local Community Participation**: Strengthen students' ties to their communities by involving them in locally focused projects that address regional marine issues. This connection to local efforts will promote eco-citizenship and a sense of responsibility toward sustainable ocean management.
- **Overcome Language Barriers Through Creative Methods**: Utilize interactive games, arts, and digital activities to bridge language gaps among students from different regions. Integrate these activities into multilingual learning environments to enhance communication and understanding.

Communication

- **Reframing the narrative:** To effectively promote blue education, it is crucial to move beyond traditional narratives that focus solely on marine conservation, ecological challenges and ocean literacy. A reframed approach should emphasize the interconnectedness between the ocean, society, and culture, highlighting the ocean's role in shaping our economy, health, heritage, and identity.

6. Conclusions

Blue education focuses on increasing awareness and understanding of the importance of marine and freshwater ecosystems, promoting the need for addressing environmental challenges (e.g. climate change, pollution), responsibly protecting aquatic environments, sustainable management of their resources and development. It includes both formal and non-formal programs that promote ocean literacy, conservation, sustainability, while nurturing responsible citizens and a skilled workforce for the growing blue economy. Blue education complements green education by emphasising the interconnectedness of land and water ecosystems, providing a more comprehensive approach to sustainability.

This **report aims** to provide an overview of blue education in Europe so far by examining current research, initiatives and policies while highlighting the gaps, progress, challenges, and opportunities. The goal is to further develop a framework to strengthen blue education in Europe, which will be tested and validated in nine countries (Spain, Sweden, Finland, Greece, Portugal, Ireland, France, Croatia and Romania) to guide future policy recommendations.

The modern Environmental Education movement, which gained momentum in the late 1960s and 1970s, brought increased attention to the aquatic environment. Over time, Marine and Aquatic Education emerged, but by the mid-1990s, ocean-related subjects were marginalized in US school curricula. This led to workshops and initiatives aimed at establishing the **Ocean Literacy** (OL) framework developed to educate students and citizens about the ocean's importance. Since then, it evolved from a knowledge concept to a multi-perspective approach including different dimensions such as awareness, knowledge, attitude, communication, behaviour, activism, emotional connections, access and experience, adaptive capacity, trust and transparency promoted by different networks all over the world.

In Europe, significant efforts have been made through the Galway and Belem Statements to align ocean research and education efforts across the Atlantic while OL has been promoted by the European Marine Science Educators Association. The European Commission supported large OL projects such as SeaChange and ResponSEAble, empowering citizens to understand the human-ocean relationship. OL gained further prominence through the United Nations Decade of Ocean Science for Sustainable Development (2021-2030), which aims to foster sustainable ocean stewardship. The EU's 2020 establishment of the **European Ocean Coalition (EU4Ocean) further advanced OL**, connecting stakeholders, promoting youth engagement, and integrating ocean knowledge into education through the Network of European Blue Schools. The Charter for Blue Education further highlights a commitment to collaboration and strategic alignment between European education networks and sustainability initiatives. It reinforces the engagement to strengthen blue education and support societal transformation across Europe.

Ocean literacy and blue education are integral components across several **key EU policies and strategies**. The Mission Ocean and European Strategy for a Sustainable Blue Economy are particularly notable for their direct focus on public engagement, education, and the development of blue skills while the European competence framework on sustainability "GreenComp" published in 2022 was the outcome of the European Commission's Council Recommendation COM/2022/11 on learning for the green transition and sustainable development.

Across Europe, countries have adopted various **strategies** focusing not only on environmental protection but also integration of educational initiatives aimed at raising awareness and promoting sustainable practices. These strategies address national priorities while aligning with broader European and global sustainability goals and at the same time reflect their unique geographical, cultural, and ecological contexts. For instance, France shows a strong

commitment to integrating marine and freshwater education into both formal and informal learning settings, encompassing curriculum development and public outreach initiatives through its marine and maritime related strategies (National Strategy for the Sea and Coast, French action plan 2024-2030, National Biodiversity Strategy and French ESD Strategy).

Regarding blue education, **national strategies** such the “Escoles Verdes” program in Spain, the Explorers program in Ireland, the Educational Marine Areas concept in France, the Escola Azul and Educar para uma Geracao Azul programs in Portugal, the Regional Marine Network for Water Education and the National Network for Limnic Pedagogy in Sweden, and the Framework for Environmental Education in Greece reveal experimentation countries’ commitment to embedding marine and freshwater education within formal and non-formal learning environments, including curriculum development, public outreach programs, and professional training initiatives designed to build capacity in marine and freshwater management.

Ocean-related problems are linked to social values, behaviour, and governance, and OL is important for addressing these issues. OL is viewed as both a process and outcome that helps society understand, value, and protect the ocean. OL has gained recognition as essential for international policy frameworks, ocean sustainability, and the UN Decade of Ocean Science for Sustainable Development, promoting societal behavior change for better ocean conservation. During the last years there have been a range of papers outlining different frameworks and approaches for Ocean Literacy (OL), of which their complexity may create challenges for those trying to apply OL. Although studies have analysed OL research, they overlook projects and initiatives outside academia, particularly in marine and aquatic education. This lack of a unified vision and coherence limits OL's practical implementation and its integration into decision-making processes. The aim of **scientific mapping** and developing **a database of projects and initiatives** in this report was to examine evidence base particularly for blue education in Europe. We adopted a bibliometric analysis for the scientific articles, and we used different databases to collect information and develop a database including initiatives and projects related to blue education. This collection of evidence enables us to build a thorough understanding of the evolving field, identify knowledge gaps and suggest pathways for future research and exploration. Hence, it can provide a go-to resource for practitioners and decision-makers expected to develop policy principles and operational procedures based on the most current and best available information.

According to Shellock et al. (2024), **OL research** appears to be driven by four core rationales or purposes. Defining and conceptualising OL, educational design and programming, evaluating and increasing OL. Similarly, though defining and conceptualizing blue education seems to be more specifically oriented than OL, integration and mainstream of “blue” into the educational systems across Europe will be an evolving procedure within the framework of the project by designing and programming experimentation educational strategies and plans among diverse geographical, cultural, and ecological contexts. Evaluating involves assessing individuals’ understanding related to different dimensions of OL (apart from knowledge, it could be attitudes, behaviour, communication, emotions, activism, access and experience, trust and transparency) evaluating existing educational programs’ efficacy, and measuring the impact of various interventions. These involve designing and developing engaging and informative educational tools, methodologies, innovative approaches (e.g. technologies) and resources as well as structuring effective educational initiatives to elevate school system’s understanding (e.g. students, teachers, principals and other blue education stakeholders) of the ocean’s importance. The complexity of these issues will necessitate true interdisciplinarity, transdisciplinarity and efforts, building on the progress and status of research, disciplines, sectors and networks that work in this space.

Research on marine and aquatic education has started many years before (’70s and ’80s) and in parallel with environmental education. Despite this, an eventual increase in blue education research in Europe has been observed after 2015, quite few years after the establishment of the Ocean Literacy framework (2005) in USA and the foundation

of European Marine Science Educators Association (2012) promoting the concept of Ocean Literacy across Europe. Since then, the number of relevant articles has been growing but still a relatively low number of them (~100 publications) has been published so far. Countries such as Portugal, Greece and Spain show active engagement and investment in advancing knowledge in blue education, indicating strong research infrastructures and robust academic networks. The results highlight the contributions of these nations in shaping the discourse and driving innovation, positioning them as key players in the global research landscape on blue education.

Scattered information concerning marine and freshwater components was found in articles related to environmental education, Education for Sustainable Development (ESD), climate education, STEM/STEAM education, non-formal education (including outdoor education), curricula analysis, pedagogy and teaching methods (including project-based, hands-on, transformative and experiential learning), digital learning and innovative technologies, teachers' knowledge and training, cultural and social dimensions (including citizenship and inclusive education), impacts, policy development & strategies. **Ocean Literacy is one of the main thematic areas in scientific articles** (~50 articles) targeting on primary and secondary level students with leading organizations numerous universities but also marine/freshwater research centres. The term of **(fresh)water literacy** imposing the freshwater component of the ocean (e.g. streams, rivers, lakes, wetlands) is emerging but remains one of the less frequent themes found targeting mostly on primary level students.

Ocean Literacy research is an interdisciplinary, cross-sector field of research which explores the diverse dimensions, drivers, influences and impacts of OL initiatives. It seeks to understand how these aspects may vary in different social, economic, cultural, political, and geographic contexts and is inclusive of diverse voices, actors and ways of engaging with the ocean. Ocean Literacy research: a) provides an assessment of the existing OL evidence; b) identifies research gaps – opportunities to expand methods, target audiences, policy applications and pathways to impact; c) promotes the role of technology in enhancing access and experience - and hence ocean connections and literacy; d) calls for improved investment and funding (Emma McKinley, pers. comm).

The data analysis of **European initiatives and projects** focusing on blue education of students and teachers (~140 initiatives & projects) reveals key insights into the region's efforts to deepen the connection between individuals and aquatic environments by increasing awareness, understanding, and appreciation of the importance of marine and freshwater ecosystems. The findings indicate a growing trend in the number of initiatives, with a significant concentration in countries such as Portugal, France, Sweden, Ireland and the UK. These countries are at the forefront of implementing blue education initiatives, showcasing a strong commitment to integrating marine and freshwater components into their educational frameworks. Additionally, the analysis highlights a diverse range of approaches, including formal education programs, school-community outreach, and professional development courses for teachers, all aimed at fostering a deeper understanding of marine and freshwater issues. These results underscore the increasing importance placed on blue education across Europe and suggest a coordinated effort to address marine and freshwater issues through education.

The **synthesized evidence** from this scientific mapping and project database can be used by stakeholders, policymakers, and practitioners to create or enhance blue education frameworks and strategies, as well as to prioritize resources and efforts in critical areas within educational systems across Europe. This review can also elevate the importance of blue education and Ocean Literacy among stakeholders and policy makers, fostering fruitful discussions and close collaboration with researchers and practitioners to develop a common framework for integrating blue education into existing policies/strategies or creating new ones where needed. By bridging scientific knowledge, practices, and governance, this collaborative approach—especially when involving diverse stakeholders like indigenous communities and underrepresented groups—can make blue education more inclusive and culturally sensitive. The mapping of scientific articles and initiatives offers a detailed overview of the current state of blue

education research, highlighting areas that require further attention. Addressing these gaps and recommendations will help advance the field and improve the practical implementation of blue education to support sustainable ocean management.

Regarding the integration of marine and freshwater topics or OL into **European school curricula**, there is a lack of ocean-related content, neglecting the ocean's importance for biodiversity, climate, and human well-being while teachers report that most school educational activities toward this area is often driven by personal initiatives. Significant variation is observed across EU countries with some nations incorporating ocean-related education more deeply than others. Cultural identity also plays a role; maritime nations like Portugal tend to emphasize ocean topics, while others may not. Harmonizing ocean literacy across Europe is seen as crucial, but challenges arise from the diversity of national curricula. Environmental education is fragmented across disciplines, and a more cohesive integration of sustainability and environmental topics is necessary while effective communication with schools and multidisciplinary approaches are essential for providing a holistic understanding of ocean-related content. A comprehensive blue education should emphasize marine ecosystems, human impacts, conservation strategies, and sustainability, engaging both experienced and younger teachers. School principals play a key role in coordinating curriculum changes, while teachers need clear goals, resources, and innovative methods and gamification to enhance student engagement. The United Nations have called for the integration of sustainable development, including ocean literacy, into national curricula. Although the EU cannot enforce educational reforms, it can offer guidance and support through programs and funding. European-wide projects like Blue Schools aim to foster citizen engagement, critical thinking, and project-based learning to incorporate blue principles into 21st-century education frameworks.

OL and blue education are largely absent from standard **teachers training**, leaving new educators unprepared to teach these topics. Integrating ocean literacy into pre-service teacher education is crucial for preparing future teachers to cover the ocean’s role in climate regulation, biodiversity, and the global economy. For current teachers, workshops, webinars, and field experiences, such as hands-on learning in marine environments and collaboration with marine scientists, help bridge knowledge gaps. Teacher networks are also vital for spreading blue education by fostering collaboration, sharing resources, and promoting peer mentoring. Platforms like the European Blue Schools (ESEP group) enable educators to stay updated on new research and teaching practices, inspiring teachers to influence their colleagues and expand blue education across school systems.

So far, no one can reliably **evaluate** the progress that has been achieved in OL and blue education as little research effort has been carried out in relation to common measurement tools which have to take into consideration not only the knowledge factor, but also other dimensions of OL proposed by different researchers and the multi-perspective approach proposed by the IOC-UNESCO.

Towards this direction, efforts are being made by the Escola Azul and Educar para uma Geracao Azul programs in Portugal and the Explorers program in Ireland. However, the **impact assessment** of these blue initiatives is challenging due to a lack of standardized assessment methods. Erasmus+ projects such as We are blue schools! and BlueSchoolsMed as well as EU4Ocean project BlueMinds4Teachers have been evaluated their performances focusing on students’ and teachers’ perspectives. Self-reported surveys have been carried out in Sweden (Swedish Network), while only sporadically in Spain (Escoles Verdes program), Croatia (Eco-schools), and in non-formal educational settings in Greece (HCMR and DUTH). In France, setting the goal of establishing 18,000 educational marine or terrestrial areas by 2030, can be considered as an indicator of relevant impacts. So, while some data collection exists, standardized assessment methods and in general comprehensive evaluation systems are missing.

Evaluation is integral in the development of blue education programs and initiatives which strive to reach common goals of responsible ocean citizenship and sustainable use of the water world. Based on partners' experience, indicators of knowledge-awareness, attitudes/values, behaviour change, actions, emoceans should be assessed through a pre- and post-survey design, to evaluate blue education activities that will be carried out in experimentation countries.

Universities and colleges emerge as a leading contributor, driving a significant portion of the initiatives, particularly by facilitating knowledge transfer and developing research-based courses, providing teacher training, and creating educational resources. Through partnerships with schools and educational authorities, academia has the potential to align blue education with broader educational goals, fostering a culture of sustainability at all school levels. **Research organizations** play an important role by developing science-based resources and teaching methodologies. Their expertise ensures that educational content is scientifically accurate, relevant, and aligned with current environmental challenges. By collaborating with schools, these organizations help integrate ocean and freshwater literacies into formal and non-formal education, fostering early awareness and understanding of marine issues among students. The **public sector**, including government agencies and public institutions, plays a crucial role in policymaking and funding support, facilitating broader access and participation as well as regulatory compliance. The **private sector** is also actively engaged, especially in areas such as industry partnerships and practical training programs for the blue economy sectors, aiming to bridge the gap between theoretical knowledge and real-world application. **Aquaria and museums** play a pivotal role by providing immersive, hands-on learning experiences that bring marine- and freshwater-related topics to life, making abstract concepts tangible for students. By offering interactive exhibits, educational programs, workshops, and courses for teachers, aquaria and museums help foster a deeper understanding of aquatic ecosystems. Their collaboration with schools ensures that blue education is not only accessible but also engaging, inspiring the next generation to value and protect the marine and freshwater ecosystems. **Networks and associations** also play a crucial role by providing a platform for collaboration, communication, resource and experiences sharing, enabling educators and practitioners to identify the most effectives ways to integrate blue education into the curricula. These networks help standardize educational approaches, promote best practices, and advocate for the inclusion of marine and freshwater topics in national and regional education policies. By connecting educators across Europe, they amplify the impact of blue education, ensuring long lasting results not only at the individual but also at the community level. This diverse involvement underscores the collaborative nature of blue education efforts across Europe, highlighting the complementary roles of different sectors in advancing sustainable practices.

The **Network of European Blue Schools** is evolving to better serve educators, students, and institutions. Initially a grassroots effort to certify schools for Blue Projects, NEBS has expanded across Europe and has the potential to grow the next years with local and regional support and funding into a vibrant community where educators can share resources, best practices, and collaborate on projects promoting water literacy, sustainability and environmental stewardship in schools.

The **barriers** to implementing blue education in Europe are multi-faceted and interconnected, spanning from policy and financial challenges to curriculum fragmentation and insufficient teacher training. Overcoming these obstacles will require a coordinated effort at local, national, and European levels, fostering stronger partnerships between the education sector and the broader ocean literacy community. By addressing these barriers, Europe can empower its future generations to understand and protect the marine environment, making ocean literacy a cornerstone of its educational landscape.

The comparison between the BlueLightS, the EU Blue School survey and Fauville et al.'s research highlights several recurring themes: insufficient funding, lack of institutional support, inadequate teacher training, and fragmented

curricula. These common barriers underscore the need for a coordinated approach that involves policy reforms, sustainable funding mechanisms, and enhanced professional development for educators. To effectively integrate blue education across Europe, it is crucial to address these systemic barriers and foster greater collaboration between national education authorities, schools, and marine institutions. Strengthening the alignment of ocean literacy with national educational priorities and enhancing teacher training programs will be key to embedding blue education into the heart of European curricula. By implementing the above-mentioned comprehensive **recommendations**, blue education can be better integrated into Europe's diverse educational landscape. A strategic approach that combines policy support, sustainable financing, curriculum innovation, teacher empowerment, and community engagement is essential to make blue education a fundamental part of tomorrow's education.

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8. Annexes

8.1. Questions used during interviews with experts

Questions
Can you briefly describe your background and experience related to blue education or related fields such as eco-schools, curricula development, or education for sustainable development (ESD)? • *How is blue education connected to your work?* • *How many years of experience you have in the field of (Blue) Education?*
How do you see the status of blue education in Europe? • *What are the main challenges in the implementation of blue education programs? How can these challenges be overcome?* • *What are the key elements that should be included in a blue education curriculum?* • *What should be added or modified in the curricula? What is missing in the curricula?* • *How can blue education be effectively integrated into existing school curricula?* • *Do you know an example on how is the ocean component, along with its connection to freshwater ecosystems, being addressed in educational programs or initiatives?*
Why do you think blue education is important? • *Can you share any examples or good practices of how blue education has positively impacted students or communities?*
Based on your experience, what recommendations would you provide for the development and implementation of blue education programs?
How do you envision blue education in the future? • *What opportunities do you see for expanding blue education at local, national, or European levels?* • *Who are the key enablers for success?*
Is there anything else you would like to add that we haven't covered? • Case-specific information that might need to be considered

8.2. Key instruments of blue education in experimentation countries

This annex provides details about the key instruments of blue education in the experimentation countries and their context. For each instrument, an historical perspective is given, as well as the challenges encountered and the impacts of the policy. 6 key instruments have been identified:

- *8.1.1. The setting up of Blue Education Networks in Sweden*
- *8.1.2. The return of the Framework for Blue Education in Greece*
- *8.1.3. Escola Azul and the rising Educar para uma Geração Azul program to mainstream blue education in Portugal*
- *8.1.4. Green as an opportunity to support Blue education in Catalonia (Spain)*
- *8.1.5. The externalization of Explorer Program to upscale Blue education in Ireland*
- *8.1.6. The rise of Educational Marine Areas in France*

8.2.1. The setting up of Blue Education Networks in Sweden

8.2.1.1. Blue education in Sweden

Freshwater and marine education in the Swedish national curriculum are included in activities related to the environment and sustainable development in a broader perspective. For this reason, the non-formal education is one of the main features of blue education in Sweden, in which science centers, aquariums and nature schools in collaboration with local municipalities are intermediaries between schools and environmental education (marine, freshwater and terrestrial). In this context, non-formal education has been integrated into schools to promote blue education, which has been seen by the active and voluntary participation of teachers to bring marine and freshwater education to the classroom.

8.2.1.2. Networks for blue education

In Sweden, two networks are playing a key role in supporting blue education for the past 6 years: the regional Marine Network for Water Education and the national Network for Limnic Pedagogy. The main aim of these networks for blue education is to create a space for collaboration among stakeholders and support educators in their projects offering digital and physical meetings, visits and workshops across Sweden. Thus, the networks' goals include actively engaging and inspiring their members, fostering cooperation and facilitating the exchange of knowledge and experience. To expand their impact, networks should strive to involve a wider range of actors by creating opportunities for collaboration and enhancing their visibility. The main tasks carried out by these networks include: (a) support information sharing between partners and members; (b) inform each member of the on-going opportunities, such as trainings, workshops, through a Facebook group; (c) publish a newsletter up to 6 to 8 times a year to announce new projects; (d) represent the Swedish Blue Education context in international discussions about ocean and water literacy. However, over the years, their assignments have evolved, with more attention given today to blue education conversations at the international level under the scope of the United Nations (UN) Decade for Ocean Science (e.g., Swedish plan on Ocean Literacy). The Facebook group, entitled “Nätverket för vattenpedagogik” (“Network for water

literacy"), is the same for both marine and freshwater network and it currently has 408 members. By June 2024, the marine network has 514 members and the limnic network has 265, but some members may be registered in both networks. Both networks cooperate closely with annual meetings in person, but each of them has its own secretariat (with 50 % of people equivalent full time for each). Thus, the secretariat of the marine education network is in Gothenburg, while the limnic network is in Uppsala. The current activities include organising an annual national conference (alternating between online and in-person formats), regional meetings, study visits, online training, and workshops. While the annual conference is a collaborative effort between both secretariats, the regional meetings, study visits, and workshops are often coordinated by a single secretariat. Regardless of the organizing secretariat, all members from both networks are invited to participate in all activities.

8.2.1.3. **Historical perspective**

A key milestone for setting the blue education scene in Sweden was the first UN Ocean Decade Conference that occurred in 2017 (New York, USA). The conference played a pivotal role in supporting ocean literacy-related projects, leading the Swedish government to support the creation of the Marine Network and Freshwater Network through fundings from the Swedish Agency for Marine and Water Management (SWAM). In 2018, the government's budget of 2.500.000 SEK funded various projects aiming to enhance ocean literacy, in which the Marine Pedagogic Workshop was among the funded projects (200.000 SEK) shedding the lights on the start of a marine ocean literacy network. In the same year (2018), a survey was conducted among key stakeholders in the ocean literacy landscape of the Swedish informal education to assess needs in relation to blue literacy in the country. The main outcomes of the survey were: (a) the establishment of the network; (b) the setting up of an easily accessible (digital) platform for sharing experiences and sources of inspiration; and (c) securing financial (public) support for the functioning of the network. Thus, the results obtained led to the successful creation and implementation of the Network for Limnic Pedagogy in 2018 by the Swedish University of Agricultural Science (SLU) with funding of 1.250.000 SEK, and of the Marine Network for Water Education supported by the University of Gothenburg in 2019 with funding of 1.250.000 SEK. The Swedish Institute for the Marine Environment, hosted by University of Gothenburg, runs the network for marine education, while the Swedish Centre for Nature Interpretation, hosted by the SLU, runs the network for freshwater education. Thus, since its implementation, the marine and limnic networks have been financed by the government through the SWAM with a budget of 1.000.000 SEK to partially cover the costs of workshops, the annual national conference, and other related activities. The funding varied throughout the years from 1.000.000 to 1.250.000 SEK, but it does not include salaries for coordinators and the primary goal is to reduce participation costs for members in events organized by the network secretariats. In 2019, two large conferences were arranged: (1) limnic education by the Swedish Agriculture University; and (2) marine education by the Swedish Institute for the Marine Environment (hosted by the University of Gothenburg).

In 2020, both networks encountered challenges to achieve their goals due to the Covid-19 pandemic. But these challenges may have strengthened their resilience, as illustrated by the series of regional meetings (North Sea, Southern Baltic Sea, Northern Baltic Sea and Gulf of Bothnia) and the joint conference organised digitally potentially reaching a larger public than if it had been in-person. Alongside this, the Swedish government decided to include Ocean Literacy as one of the four main themes for the Swedish efforts during the UN Ocean Decade. In the following year, both networks focused on providing training to their members, via the organisation of courses and workshops, thereby complementing regional meetings and the national conference. In 2022, the network activities and meetings have increased, with up to 6 regional meetings organised throughout the year, and more activities documented by the Marine Network (e.g., experts exchange with network members). Despite the several challenges faced by both

networks due to constraints of digital meetings, more activities were being developed over the years leading to an increase in the number of members (e.g., teachers) joining the networks. The networks took part in their first international conference in 2023 under the scope of the EU Project BlueMissionBanos, which increased its visibility and shed light on the blue education landscape in Sweden. In 2024, the focus has been on supporting the development of blue schools, particularly in relation to the European Blue Schools Network of the EU4ocean Coalition (European Commission) alongside trainings and meetings provided by both the networks. Since its implementation, a rapidly growing number of teachers interested in developing and implementing blue education activities in Swedish schools has been reported by the networks. Both networks together have already more than 700 members thanks to its free membership, activities and resources provide (e.g., workshops, trainings, etc.) as well as direct involvement of members in the network processes and discussions.

8.2.1.4. **Challenges**

The government (financial) support contributed for the rapid development and activities of both networks, but several challenges still need to be overcome to further support the strengthening of blue education in Sweden. In this context, visibility is one of the main challenges that both networks face. For instance, information is not yet spread easily regarding the on-going activities and the steps of how to become a blue school are still unclear for many teachers. Even if more members are participating in activities, it remains low compared to the total number of members. Alongside this, teachers may feel disqualified to teach about the ocean or lack resources to integrate the blue into their teaching disciplines. The majority of teachers promoting blue education were former researchers (mainly marine biologists), which leads to the issue of reaching teachers that have no previous connection to marine topics. Improving visibility efforts may support the engagement of teachers to participate in the training meetings and study visits.

To overcome these barriers, the University of Gothenburg has integrated the ocean into the teacher education courses as it can be involved in different subjects (e.g., sustainability, climate, etc.). However, the extent to which other universities have adopted similar initiatives remains unclear. The weak connection between the networks and the formal education system remains a challenge to be overcome. Several actors in the ocean literacy field have played a key role in the same context by the creation of different initiatives, such as the "Deep Sea Reporters" (foreseen to August 2024) and "Ocean in the Classroom" (led by Gothenburg University) to share resources and actively engage teachers. But even if these actors developed toolkits (including information on EU Blue Schools Network), handbooks, events for Ocean Day and actively support teachers' projects, there is still not many blue schools nor integration within the national curriculum. Thus, teaching material can also be a challenge if it is not well integrated in the network where the teachers can also easily share resources and experiences. Therefore, the challenges faced by the networks raise questions about whether duplication might contribute to difficulties. This includes potential overlap in organized activities and the possibility that merging the networks could optimize budget allocation.

8.2.1.5. **Impacts**

The impacts are measured through surveys conducted by the network directly measured by its members. The initial survey was considered a state of play in the Swedish context conducted under the scope of the UN Ocean Decade in 2018. The survey mainly focuses on the assessment of the Swedish knowledge in the society about the ocean threats and willingness to actively participate in mitigating its impact. In the last survey (2021), most of the members expressed that the network has been important and useful, which led to the creation of a short movie to showcase

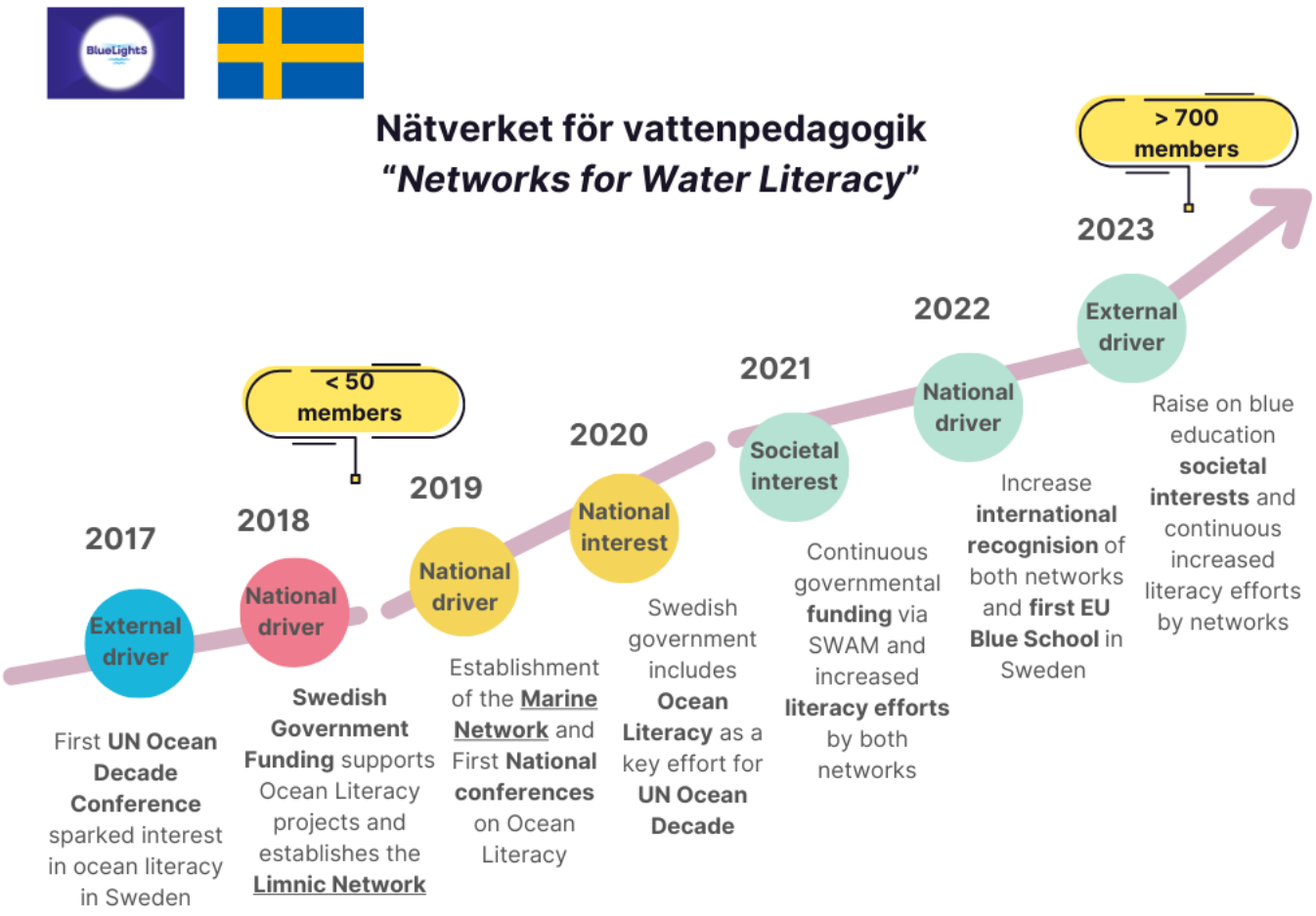
the Swedish work. Since 2018, both networks have increased their number of members over time, even if the rate is still slightly slow due to various reasons (e.g., Covid-19), for instance the networks had less than 50 members in 2018 and have reached more than 700 members in 2024. Therefore, the number of participants in the activities organised have significantly increased, in which there are 120 – 80 members in the annual national conference, 30 – 50 members per session of workshops or meetings that occurs 3 – 4 times per year by each network, and 15 – 30 members in regional meetings or study visits once or twice per year by each network. Yet, the number of schools and children involved in blue education projects remains unclear, but the coordinators foreseen to perform a survey by end of 2024.

Teachers are considered key stakeholders to upscale blue education into the Swedish educational system, for this reason the most recent assignment for the Marine Network is to secure more blue schools engaging teachers from coastal and inland schools to actively participate in trainings. In this context, a growing interest has been shown in teacher's willingness to be part of a blue school, seen in the last teachers training that involved 45 people from different regions in Sweden (including inland schools), over the years. But the impact with blue schools has not been measured yet.

8.2.1.6. **Final remarks**

The blue education scenario in Sweden shed the lights on the importance of collaboration between multiple stakeholders. The Freshwater and Marine Networks serve as effective instruments for upscaling blue education through teacher engagement and facilitating collaboration. However, challenges remain, particularly regarding communication strategies and teacher support in integrating blue education in the national curriculum. The recent commitment on the development of blue schools may pave the way for a continuum growth of these networks in Sweden. Therefore, the level of maturity on blue education in Sweden is growing in visibility and governmental and societal interest. However, to be mainstreamed in education, it should increase its efforts towards freshwater education too.

8.2.1.7. Timeline of key events



8.2.1.8. Evolution of the Networks in Sweden

2017 – external driver (global)

- First UN Ocean Decade Conference: This event sparked interest in ocean literacy in Sweden.

2018 – national driver influenced by the global driver

- Swedish Government Funding via SWAM: The government provides funding for ocean literacy projects (2.500.000 SEK), one of the projects is the Marine Pedagogic Workshop that shed the lights on the importance for an ocean literacy network in Sweden.
- Swedish Institute for the Marine Environment (hosted by University of Gothenburg) receives funding to conduct a Survey on Ocean Literacy (particularly on non-formal education): A survey among key stakeholders identifies the need for a network, platform, and financial support for blue education.

- The Swedish Government funded IOC-UNESCO's work with Ocean Literacy, for example the OL Toolkit for All.
- The Limnic branch of the Ocean Literacy Network was established: The Swedish Agriculture University creates the Freshwater Network. Funding: 1 250 000 SEK

2019

- The Marine branch of the Ocean Literacy Network was established: The Swedish Institute for the Marine Environment (hosted by University of Gothenburg) take over the responsibility and development of the Marine Network. Funding: 1 250 000 SEK
- First National Ocean Literacy conference in Sweden. Two conferences were arranged: one with a limnic theme arranged by The Swedish Agriculture University and one with a marine theme arranged by The Swedish Institute for the Marine Environment (hosted by University of Gothenburg).

2020

- The Swedish government took the decision that Ocean Literacy will be one of four main themes for the Swedish efforts during the UN Decade.

2021

- Continuous governmental financial support via SWAM and interest in the networks for water education
- Increased literacy efforts through various activities by both networks
- First workshop with Blue Schools as a theme for the marine network.
- Joint national conferences for both networks. Digital during the pandemic 2020 and 2021.

2022

- Joint national conference for both networks in Gothenburg.
- The international Conference One Ocean, One Planet, Ocean Literacy Action 2022 was arranged in Malmö, Sweden.
- Ocean Literacy workshop during The Ocean Conference in Lisbon: The Ocean Literate Society - Youth Engagement and Intergenerational Collaboration The Swedish Ocean Literacy Network was presented at the workshop.
- Fist European Blue School in Sweden: Heden skola, municipality of Öckerö.

2023 – external drive (EU-related)

- Continuous governmental financial support via SWAM for the networks. Raised focus and enhanced efforts to establish more Blue Schools in Sweden.
- Raise on blue education societal interests, partly due to international factors (e.g., conference within EU Project BlueMissionBanos)

- Continuing ocean literacy efforts through various activities conducted by both networks. Workshops, study visits and seminars.
- Joint digital conference for the members in the two networks.

2024 – national drive influenced by EU-related interest

- Continuous governmental financial support via SWAM for the networks.
- Second workshop with Blue Schools as a special theme for the marine network.
- On-going focus on supporting the development of blue schools in Sweden.
- Joint conference for the two networks in Uppsala in October.

8.2.1.9. Relevant references

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- *https://www.sjofartsmuseetakvariet.se/en/*
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8.2.2. The return of the Framework for Environmental Education in Greece

8.2.2.1. Blue education in Greece

Blue education in Greece is primarily driven by teachers, on a volunteer basis, lacking substantial government support or integration into the national curriculum. Coastal schools often incorporate marine topics due to proximity to research centers and relevant curriculum aspects. The national curriculum already includes topics that contributes directly or indirectly to blue education, such as climate change, water cycle and trophic chains, consequently these

are easily approachable by non-formal education actors (e.g., science centers, research centers, etc.) to contribute to include marine and freshwater knowledge into the formal education system. In this sense, marine knowledge may be less explored in inland schools because freshwater education is commonly integrated in terrestrial environments, related to water cycle, rivers and lakes. Still, teachers in secondary schools are involved in environmental education activities from different projects/initiatives developing and implementing blue projects during the year, which represents around 5 % of the Greek schools (mostly coastal schools). Therefore, non-formal education plays a crucial role in mainstreaming blue knowledge in coastal and inland schools.

8.2.2.2. The framework for environmental education

In Greece, the framework to promote environmental education has playing a key role in supporting the integration of aquatic and terrestrial knowledge into the formal education systems by teaches on a voluntary basis. The main aim of the framework is to raise awareness of the student's relationship to the natural and social environment, of the problems connected to it, and how to contribute to tacking these problems. Thus, the framework has two main components: (1) school program, and (2) centers of environmental education. In regards to the school program, teachers can implement environmental education in different educational stages that may last up to 2 months: (a) kindergarten: integrate within formal programs in connection to the subjects in the national curriculum; (b) primary school: integrate through cross-curricular projects (grade 1-4) or formal subject in the national curriculum (grade 5-6); and (c) secondary school: integrate as an extra-curricular activity, upon parental consent. Alongside this, there are currently 52 Centers of Environmental Education in different prefectures in Greece that support non-formal education through local field trips (e.g., beaches, wetlands, forests, etc.) for both primary and secondary schools free of charge. Commonly, NGOs and universities/research centers collaborate with schools to support the framework, for instance the Hellenic Centre for Marine Research (HCMR) receives around 3,000 students each year in their premises in Crete and Athens.

8.2.2.3. Historical perspective

Unofficially, environmental education started to be integrated into the Greek educational system in the 80s. Followed by an increased interest by teachers, a framework for environmental education was established in the beginning of the 90s, in which teachers may integrate environmental education in the classroom voluntary. Ten years after the development and implementation of the framework, teachers were mostly carrying out environmental education projects or implementing activities within the curriculum on a volunteer basis. The growing interest of teachers in including environmental education in the classroom led to the proposition of a Cross-Curricular Programme Framework of Studies under the scope of the curriculum for the Environment and Sustainability in 2010, but the framework was not implemented.

The Centers of Environmental Education played a key role in mainstreaming environmental education, including aquatic knowledge, to schools in Greece by supporting and empowering teachers, particularly rising over the past ten years. In 2022, the largest fire ever recorded in the European Union (EU) happened in Alexandroupolis (Greece) with 96,000 hectares burnt. The unfortunate incident shed light on the importance of environmental education to preserve natural environments, in which the Institute of Educational Policy proposed the creation of a framework to the Ministry of Education as a recommendation for teachers of kindergartens, primary and lower secondary schools (Government Gazette 2820/2022, Issue B). Consequently, the Ministry of Education supported the development and implementation of the Framework of Environmental Education (terrestrial and aquatic) in Greece by the end of 2023.

The Greek National Curriculum for the "Environment and Education for Sustainable Development" framework proposed the integration of environmental education through projects and relevant activities as a compulsory cross-curriculum subject, in which the Curriculum is currently in the process of revision. Interestingly, the cross-curriculum includes blue education under two specific thematics towards marine knowledge: (a) protection of biodiversity', and (b) sea in danger. Besides the rise on Centers of Environmental Education over the past 10 years, currently half of them were due to the economic crisis.

8.2.2.4. **Challenges**

Despite the successful development and implementation of the framework, some barriers need yet to be overcome. For instance, not necessarily all teachers know about its existence, in which the school directors are intermediate vectors responsible for informing the teachers about the new existing framework. Alongside this, even if the national curriculum offers the teachers some flexibility to integrate environmental education in the classroom, the framework does not provide any guidance, support or the possibility of collaboration with partners for the successful implementation of the framework within the teachers' work. Alongside this, ocean literacy has been included in two thematics, but teachers may still prefer to work with terrestrial environments because of their lack of knowledge on aquatic ecosystems to integrate in their projects or activities. Particularly on blue education, teachers do not have access to a lot of resources regarding marine environments, which highlights the importance that non-formal means, such as NGOs and research centers, play in integrating blue into the existing formal education system in Greece.

Additionally, the Centers of Environmental Education could be key vectors of blue education in the Greek schools, but various factors are constraining such development. Despite the financial issues, accessibility to marine ecosystems is one of the biggest challenges, particularly to in-land schools, along with lack of knowledge and time. Consequently, the integration of blue knowledge in the classroom is constrained particularly by the lack of resources and knowledge of teachers. To overcome such challenges, the support from the Ministry of Education shed the lights on the importance of collaboration between science centers and universities with schools to upscale blue education in Greece. Alongside this, strengthening the skills of teachers becomes essential to wider their possibilities of including blue (e.g., marine issues, etc.) into the already existing school curriculum through training and empowerment promoted by the environmental education centers. Consequently, key stakeholders include the Ministry of Education, science centers, universities, and environmental education centers, in which these entities can collaborate to create a supportive path for Blue Education in Greece.

8.2.2.5. **Impacts**

Measuring the impact of Blue Education in Greece remains challenging because formal education lacks established mechanisms, while non-formal education providers typically conduct their own impact assessments. In which, teachers usually do not assess the impact of its activities, nor are they instructed for it. Until 2012, the Ministry of Education required teachers to fill in a questionnaire, which included an impact assessment, but since then the impacts are not measured anymore during the school year. Regarding the impacts related to Framework of Environmental Education, it may be difficult to quantify yet due to its recent implementation (December 2023), but now there are no specific guidelines that recommend teachers to assess the impacts of environmental education activities.

Non-formal activities play a key role in measuring the impacts of their interventions with schools, mostly through pre and post questionnaires. A specific case study reflects the importance of guidance for teachers to support the

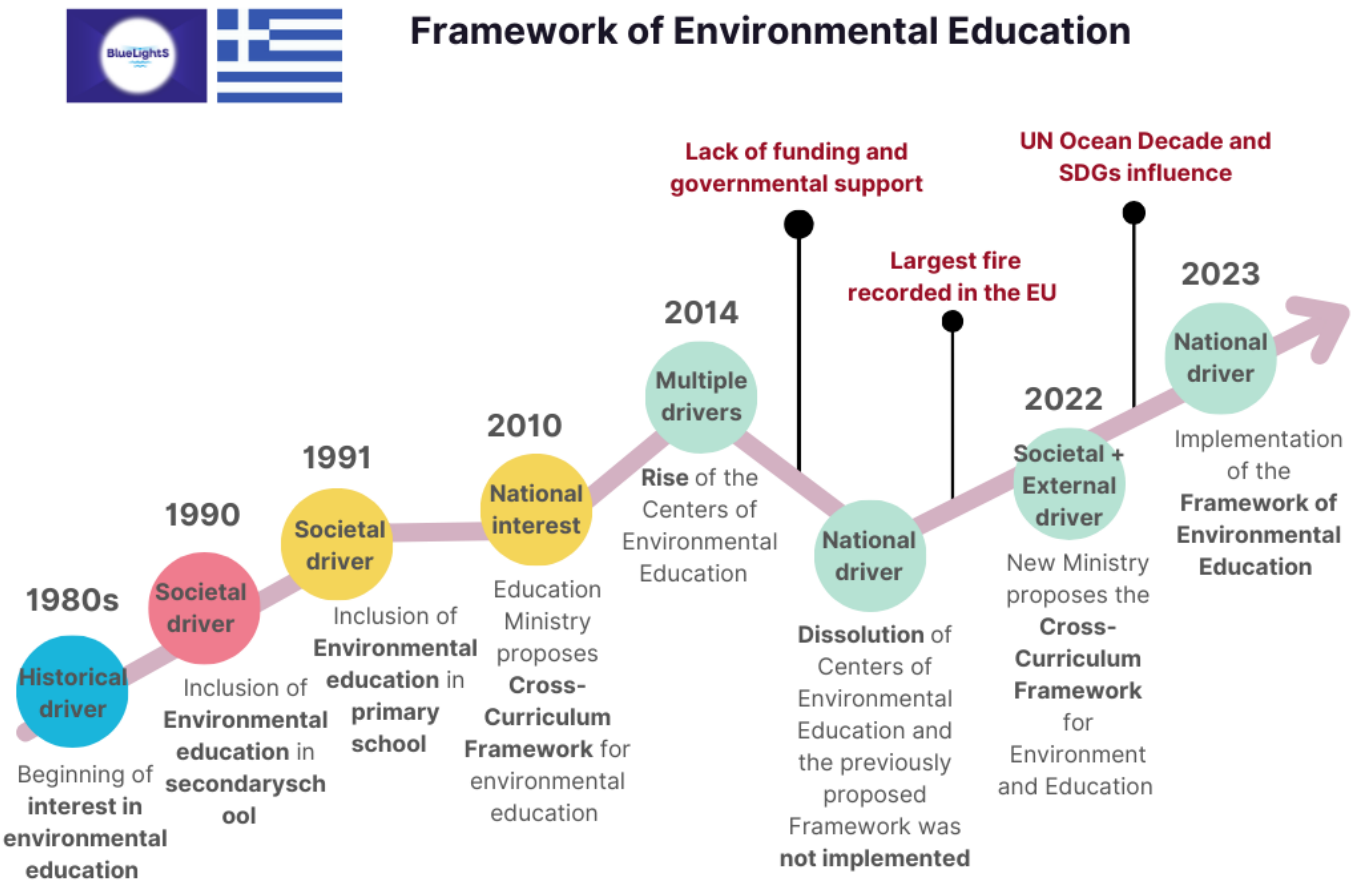
implementation of the framework in their classrooms, in which the Institute of Marine Biology & Genetics in Crete (HCMR) collaborated with teachers to implement blue education project in coastal schools. A survey was carried out before and after the students participated in laboratory and field visits to a coastal marine area to assess the impacts of this kind of intervention, which had an overall significantly good impact on the students' blue knowledge.

8.2.2.6. Final remarks

While Greece faces challenges in implementing a robust Blue Education program, the recent Framework of Environmental Education and the already existing Centers of Environmental Education lay the groundwork for progress. In which, the Framework of Environmental Education may be an opportunity to support the implementation of a blue education program through the already existing Centers to mediate non-formal means with the schools along with NGOs and research centers. Therefore, Greece has been gaining stronger societal and governmental interest in upscaling blue education.

8.2.2.7. Timeline of key events

Evolution of the Framework in Greece



8.2.2.8. Evolution of the Framework in Greece

1980s

- Beginning of interest in environmental education

1990

- Environmental education was officially introduced in the Greek law for secondary school

1991

- Environmental education was introduced in the Greek law for primary school

2010

- Ministry of Education proposes a Cross-Curricular Programme Framework of Studies for implementing environmental education

(Framework was not implemented)

2012

- Ministry of Education declares that teachers no longer need to fill an impact assessment questionnaire

2014

- Rise of the Centers of Environmental Education

2022

- Largest fire recorded in the EU
- Proposition of a compulsory cross curriculum subject through a framework for “Environment and Education for Sustainable Development” to the Ministry of Education

2023

- Implementation of the Framework of Environmental Education (aquatic and terrestrial) by the Ministry of Education

2024 (On-going)

- Half of the Centers of Environmental Education were dissolved (due to the reduction of financial support from the government)
- The compulsory cross curriculum subject is currently in the process of revision

8.2.2.9. Relevant references

- *https://www.esos.gr/sites/default/files/articles-legacy/fek-2022-tefxos_b-02820-downloaded_-08_06_2022.pdf*

8.2.3. Escola Azul and the rising Educar para uma Geração Azul program to mainstream blue education in Portugal

8.2.3.1. Introduction

Blue education has been integrated into formal education through a blue school program with a nationwide reach, including both coastal and inland schools. Most schools independently have been developing projects and the collaboration between coastal and inland schools is generally limited to regional meetings. Inland schools may have a stronger emphasis on freshwater education due to their geographic location, but the overall goal of blue education remains to increase ocean awareness. Alongside this, non-formal education has been closely linked to the blue school program through partnerships that involve a wide range of national initiatives (e.g., NGOs, research centers, science centers, etc.) complementing formal education.

8.2.3.2. The Portuguese Blue Schools (Escola Azul)

The Escola Azul program is a national education initiative created by the Ministry of Maritime Affairs to promote ocean literacy in schools through an integrated political strategy that engages different sea sectors. The program aims to cultivate a deeper understanding of the ocean's significance and foster human interconnectedness with it through hands-on learning experiences and sense of environmental stewardship supported by various partner initiatives, such as universities, municipalities, NGOs, and others. To become a Portuguese Blue School, educational institutions must demonstrate a commitment to ocean literacy by meeting specific criteria. This includes exploring ocean-related issues, encouraging student-led initiatives, and collaborating with local partners. The program provides a supportive framework for schools, offering resources, networking opportunities, and professional development. There is a national coordination team composed of three individuals who implement the project integrated into the Directorate General for Maritime Policy (DGPM). This team is responsible for implementing the Blue Schools by reviewing the application submitted which highlighted the need for a Scientific and Pedagogical Commission to better understand the strategies constituted by various partners that review specific projects according to their expertise (from aquariums to water management). A network of municipalities provides additional support to Blue Schools, in which two municipalities (Faro and Setúbal) highly value the program and are part of the committee to provide assistance. In addition to the national coordination, there is a regional coordination in Madeira, which supports and manages the region farthest from the mainland committee. Therefore, the partner network offers educational programs and activities for schools. There are 120 available activities, both free and paid, that schools can participate in, which can take place at schools or at other locations.

8.2.3.3. Historical perspective

Escola Azul emerged from a collaboration with the United States (U.S.), inspired by the U.S. Ocean Literacy Network. The National Oceanic and Atmospheric Administration (NOAA) initiated a joint project with Portugal to bring students to experience scuba diving in 2003 - 2004. Subsequently, NOAA funding facilitated teacher training programs across Portugal strengthening its cooperation and laying the groundwork for the creation of blue education initiatives. The U.S. Ocean Literacy Framework involves multiple stakeholders in the decision-making process, which similarly was adapted to the national curriculum in Portugal supported by Ciência Viva in 2011 (Ciência Viva 2020). The support

from Ciência Viva, teacher training conferences, and international recognition of the OL Portuguese framework in the European Commission's recommendation in 2013 were key factors driving the future development of the Escola Azul program. In the same year, a joint Declaration on Atlantic Ocean Research and Innovation Cooperation, entitled the Belem Statement, was signed and Portugal was included in the discussions on ocean literacy, which consequently sparked governmental and societal interest at a national level. Therefore, the importance of ocean literacy was recognized by the Ministry of the Sea and included in the National Strategy for the Sea 2013-2020 (Direção-Geral de Politica do Mar, 2014). In 2015, external factors played a key role in supporting the establishment of Escola Azul in Portugal, namely the European Marine Science Educators Association (EMSEA) conference, set the development of a European Blue School concept as a long-term initiative and shed the lights on the ideal setting to effectively establish a Blue School programme in Portugal. Thus, the Escola Azul program gained traction and secured its development through financial support from the Ministry of the Sea. By the end of 2015, the Portuguese Blue School concept has been shaped by multiple stakeholders (e.g., representatives of Ministries of Sea, Education and Science; universities; museums; non-governmental organizations; school directors and teachers; Portuguese National Commission for UNESCO; among others).

Consequently, the Escola Azul program was developed and launched as a pilot-programme in the 2017/18 school year with financial government support annually of 100.000 euros. The Ministry of the Sea continued its support by including ocean literacy in public policies 2020-2023 (Governo de Portugal 2020). The pilot-programme started at the same time as the Ministry of Education was experimenting with giving schools more freedom in how they teach (Curricular Autonomy and Flexibility; Governo de Portugal 2017), which encouraged schools and teachers to be more creative and receptive to the program. However, over the years financial support reduced to 50.000 euros per year. Additionally, Ciência Viva has been a essential stakeholder on bridging the gap between scientists and schools, since its implementation supported in 1996, contributing to the cultural and societal successful expansion of the Escola Azul program in Portugal. The program has successfully promoted ocean literacy with positive behavioral changes among students and strengthened partnerships with multiple stakeholders, despite its budget reduction over the years. Alongside this, partner research institutions have been playing a key role in supporting blue education through their outreach teams, actively participating in school activities supported often by the municipalities or other funding sources.

8.2.3.4. **Challenges**

Escola Azul faced various obstacles during the development and implementation of the programme, such as supporting personnel shortages due to the fluctuation fundings from the Ministry of the Sea over the years. The financial support for schools was limited and mostly would rely on calls for funding (e.g., European projects) launched by the Ministry of the Sea. Alongside this, the in-person meetings with coordinators of blue schools became challenging to organize over time. Despite these hurdles, Escola Azul significantly increased the number of schools and partners across the country. However, the Escola Azul programs still face significant challenges, such as political instability and personnel shortage, for example in the 2022/23 school year there was only two people to carry out the outreach activities and in person school visits, which becomes quite challenging. While schools and partner initiatives can maintain their efforts independently, government support is crucial for scaling up and maintaining the programme in the future. Moreover, the awareness of the program remains low outside the educational sector and has reached a steadiness phase in terms of governmental and societal interest. To overcome these challenges, the program needs to increase international recognition and local partnerships, particularly fostering inland initiatives, along with increased financial support to maintain the annual conference, events and in-person school visits by its personnel.

8.2.3.5. **Impacts**

Escola Azul employs a monitoring system, performed by an external agency without a specific timeframe, that includes: (a) online questionnaire for students, teachers, partner initiatives and program's coordinators (include questions regarding the number of students reached and educational stage); (b) data gathering of kindergarten activities through an online instrument; (c) focus group with student ambassadors and coordinators of schools; (d) interview with politicians directly involved in the program (e.g., Minister of the Sea and Directorate General for Maritime Policy). The monitoring has been done through regional meetings that initially were in person led by the national commission team between April to May. As the number of schools started to grow, the regional meetings became online during one full day per region to discuss the main activities carried out by the teachers, challenges and solutions. In 2024, due to personnel shortage, the regional meetings were divided in small groups leading to 23 meetings with 10 teacher each for 2 hours, in which 200 teachers and 555 schools were assessed this year. Alongside this, there is a Facebook group that aims to inspire and share materials among teachers with 5.934 members in 2024. The first exploratory report occurred in the 2017/18 school year with 12 participants, including students (4), teachers (3) and partner initiatives (5) across Portugal. The following in-depth report, in the 2020/21 school year, shed light on the expansion of the program throughout the country with the wide participation of students (4.126), teachers (521), partner initiatives (49), municipalities (8), program's coordinators (5) and political decision-makers (2). Therefore, from the participation of 29 schools (13.172 students), 40 stakeholders, and 120 initiatives for schools in the pilot school year (2017/18) to 366 active schools (81.675 students), 109 stakeholders and 390 initiatives for schools in 2022/23. Alongside this, the assessment of key indicators occurs through an annual questionnaire and in-person visits. By June 2024, there are 418 schools, reaching around 85.000 students. The number of schools fluctuates because the teachers apply for a 2-years project and can decide to continue or leave the program. If proceeding to continue in the program, it is necessary to re-apply a project. As the number of schools participating in the program grew, the program transitioned to regional meetings and regular phone calls, supplementing in-person visits when necessary. Thus, a robust monitoring system, involving annual questionnaires and in-depth impact assessments, has ensured continuous evaluation and improvement, but there should still be a constancy in the period for external assessment (e.g., every two years). Consequently, the maximization of the impacts relies on the continued support from the current Ministry of Economy, collaboration between different stakeholders, and evaluation mechanisms.

8.2.3.6. **Educar para uma Geracao Azul Program**

Recently, a parallel program has emerged aiming to upscale blue education in Portugal. The Educar para uma Geracao Azul (EGA) program, developed by Fundação Oceano Azul and the Lisbon Oceanarium in partnership with the Directorate-General for Education, aims to focus on teachers as main vectors of behavioural change to foster ocean literacy among primary school students. Initiated in 2018, the pilot-program started in 8 municipalities and in the Azores island, including an in-land school. The program focuses on training primary school teachers, providing educational resources and support throughout the school year from the 1st to the 4th grade of primary school through an interdisciplinary approach. It includes the development of soft skills is included for both teachers and students. The previous year to its implementation, in 2017, a crucial factor has helped its development: the *curricular autonomy and flexibility for schools* have been implemented, allowing schools to choose interdisciplinary themes, in which some schools have created a 1-hour weekly subject called 'More Sea' that focuses on ocean literacy. Currently, the project is in a transition phase to become an official project expanded to become mandatory in all primary schools through collaborative work with municipalities across the country. Through a bottom-up approach focused on teachers, the

program evolved to a complementary top-down approach supported by the Ministry of Education since its early stages, in which the training content and material for the schools has been previously validated by the Ministry. The global estimated costs of the pilot project is around 500.000 euros financed solely by the Fundação Oceano Azul and the Lisbon Oceanarium. As the project has been approved by the actual Ministry of Education to expand across the country, the costs would likely increase, and external financial support would be required in the long term. The partnership with the municipalities plays a key role in supporting local schools with transportation for school visits (e.g., aquariums, to the beach, etc.) and in bridging the gap between the training centers and the program. Thus, the program's success hinges on its localized implementation, with each municipality responsible for delivering the curriculum training.

While not directly supporting the Escola Azul program, EGA indirectly contributes by equipping teachers with the necessary knowledge and tools aligning with the 2030 strategy to mainstream blue education in Portugal. The program provides a handbook to support teachers on the integration of ocean literacy-related themes in different curricular subjects (e.g., Portuguese, mathematics, etc.). Additionally, the program promotes credited teacher training by the Teacher Scientific-Pedagogical Council for Continuous Training (CCPFC) with 30 hours of b-learning in the continent, and 15 hours of e-learning in the Azores Island with certificated by the Regional Directorate for Education and Educational Administration (DREAE). Alongside this, teachers have access to a customized Moodle platform that includes: (a) support for teacher training actions; (b) the Blue Generation Community for communication – with news, challenges for student mobilization, live streaming actions, etc.; and (c) a repository of educational resources (+ 50 activities available to be explored by teachers). Currently, the program has been coordinated by a team of four personnel and foreseen to be managed solely by the Lisbon Oceanarium through an education team. One of the key challenges observed is that after the 3rd year of implementation, the teachers start to be less motivated. For this reason, the program in partnership with the Ministry of Education aims to overcome this challenge by integrating blue education in the national curriculum of primary schools. The EGA program has already demonstrated a positive impact, particularly in enhancing students' environmental awareness and behaviour, in which 900 teachers (public, private and cooperative schools) and 15.000 students participated in the first year of the program. Currently, the project is implemented in 8 municipalities in the continent and 9 islands in Azores, reaching 278 schools, 1.349 professors and over 24.700 students. The impact assessment is through a 4-year external impact evaluation process to fully understand how teachers evaluated the program, whether they felt equipped to teach about the ocean, or to identify what was easiest or most difficult for them. Additionally, it has provided a comprehensive set of indicators to measure student impact, such as whether students learned and became more aware of ocean-related issues. This evaluation has been conducted annually since 2018, so the impact evaluators and its structure have been adjusted over the years, identifying opportunities for improvement. To maximize its impact, the program could benefit from expanding the program to include other educational stages in the long-term.

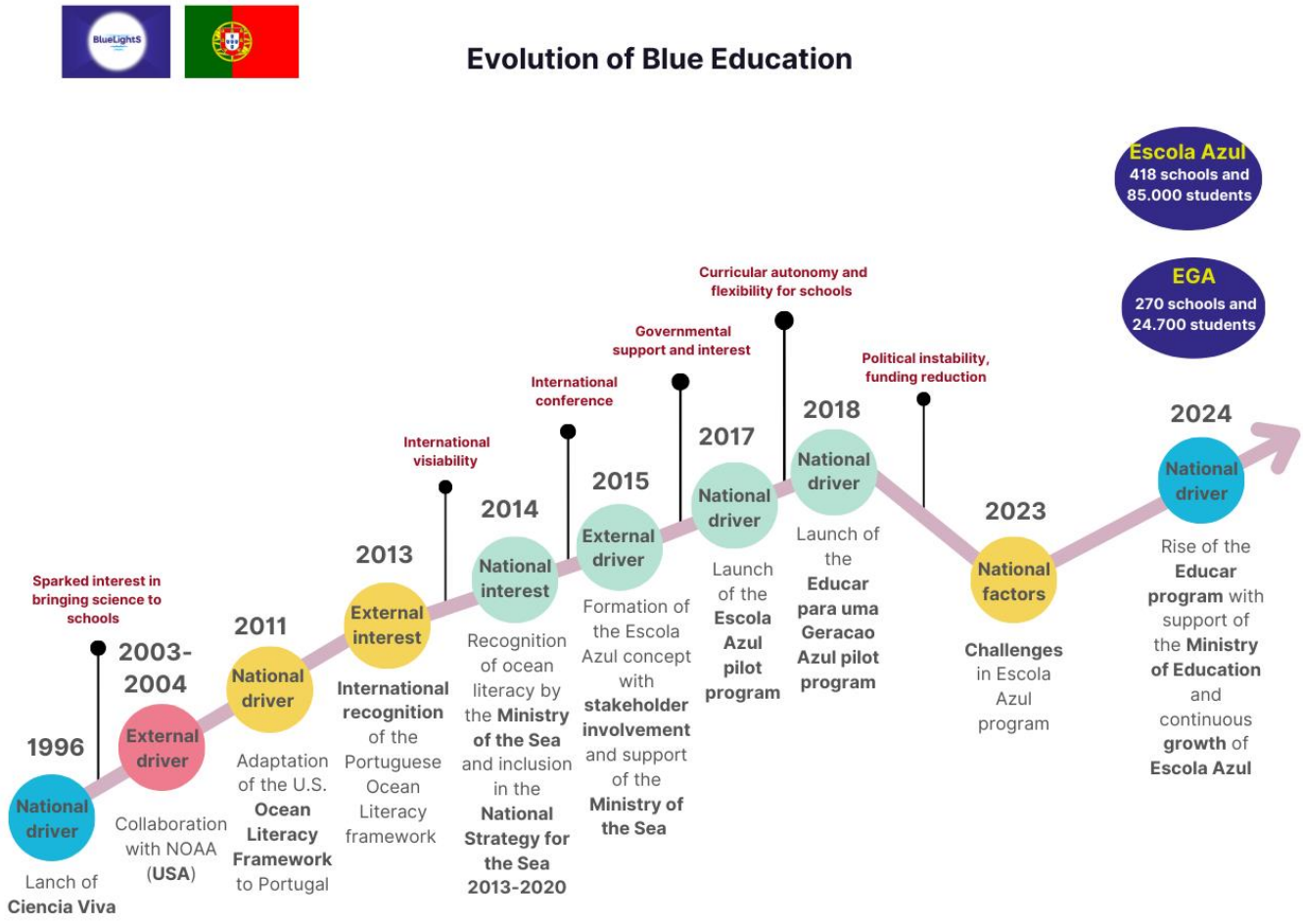
8.2.3.7. **Final remarks**

The Escola Azul program has made significant strides in integrating blue education into the Portuguese educational context through a nationwide reach. However, the program's impact is currently limited to a small percentage of schools, highlighting the need for broader expansion. Even if the numbers of schools participating in the program has successfully increased over the years, the engagement with inland schools remains a challenge. Additionally, the program relies on governmental support, which encompasses instability periods on a long-term basis. Thereby, the program expanded rapidly with the support of multiple stakeholders and the Ministry of the Sea but reached a period of steady due to the reduced societal interest and political instability. Despite these limitations, Escola Azul

has demonstrated the potential to promote ocean literacy and inspire environmental citizenship among students of different educational stages. To maximize its impact and ensure a continuous rise, the program must address key challenges, including securing consistent government funding through inter-ministerial support, expanding its reach to inland schools, and enhancing public awareness. In essence, the Escola Azul has positively impacted blue education with growing indicators and international recognition over the years. However, its success is contingent on sustained government support, strong partnerships, and a focus on continuously raising societal interest/awareness on the program.

Therefore, the emergence of the EGA program, started as a bottom-up and became a top-down approach supported by the Ministry of Education, contributes to a positive shift in the future of blue education in Portugal. The EGA program focuses on teacher training and aims to make blue education compulsory in primary schools, gradually expanding to other levels. While both initiatives (i.e., Escola Azul and EGA) have distinct approaches, their strategies may be complementary. Yet, the success of both initiatives is rooted in the broader context of Portugal's commitment to scientific culture and outreach. The introduction of the OL framework in 2012 served as a catalyst, inspiring numerous blue education initiatives. Moving forward, an inter-ministerial collaboration and a sustained focus on teacher development will be crucial for the continued growth and impact of blue education in Portugal, possibly leading to a future rise in Escola Azul program through the expansion of the EGA initiative.

8.2.3.8. **Timeline of key events**



8.2.3.9. **Evolution of blue education in Portugal**

1996

- **Launch of Ciencia Viva -** contributing to the cultural and societal interest in bringing science to schools

2003 - 2004

- Collaboration with NOAA and introduction of scuba diving program (external factor contribution)

2011

- Adaptation of the U.S. Ocean Literacy Framework to Portugal

2013

- International recognition of the Portuguese Ocean Literacy framework
- Signing of the Belem Statement (external factor contribution)

2014

- Recognition of ocean literacy by the Ministry of the Sea and inclusion in the National Strategy for the Sea 2013-2020

2015

- External factors: European Marine Science Educators Association (EMSEA) conference
- Formation of the Escola Azul concept with stakeholder involvement and Ministry support

2017

- Launch of the Escola Azul pilot program
- Inclusion of ocean literacy in public policies (governmental support and interest)
- Curricular autonomy and flexibility for schools (external factor contribution)

2018

- Launch of the Educar para uma Geracao Azul program
- Growth in the number of blue schools (rise in the program)

2023

- Challenges faced by the Escola Azul program (external factors political instability, personnel shortage) -> reduction in international activities
- Rise of the EGA program with support of the Ministry of Education

2024

- EGA program foreseen to expand to all primary schools across the country
- Escola Azul to start rising again and continue its international activities

8.2.3.10. Relevant references

- *https://escolaazul.pt/EscolaAzul_estudo%20IPSOS.pdf*
- *https://96594c97-1436-40ba-b257-d6d0d780b25f.filesusr.com/ugd/7a2e6a_b2f1d9c82f934887a20838033ef15fbf.pdf*
- *https://www.dgpm.mm.gov.pt/_files/ugd/7a2e6a_4245333977ac4ef0b115f13761e6f570.pdf*
- *https://www.dge.mec.pt/oceano-educar-para-uma-geracao-azul*
- *https://96594c97-1436-40ba-b257-d6d0d780b25f.filesusr.com/ugd/eb00d2_75476e45b61644fc9c981b5db94e2967.pdf*
- *Educating for a Blue Generation 2024 (youtube.com)*
- *Endorsed Book Patrulha Ação Azul - EGA (geracaoazul.org)*

8.2.4. Green as an opportunity to support blue education in Catalonia (Spain)

8.2.4.1. Introduction

Blue Education in Spain presents a fragmented picture. While there's a growing interest in marine and ocean-related topics, a cohesive national strategy is still lacking. Formal education, though incorporating Sustainable Development Goals (SDGs), particularly SDG14 (i.e., life below water), lacks a dedicated "blue line" curriculum. Consequently, marine content is often limited and inconsistent across schools. Non-formal education, conversely, offers a wider range of marine-focused programs, particularly during summer periods. However, the integration between formal and non-formal sectors remains underdeveloped. Blue Education primarily occurs in non-formal settings such as science centers, research institutions, maritime museums, and through specific university programs. School involvement is sporadic, with a low percentage of schools actively engaging in ocean-related activities. While initiatives like "Petits oceanògrafs" and "viu la vela" target both public and private schools, there's a geographic bias towards coastal areas. Teacher training in marine education is still in its early stages, hindering the incorporation of ocean-related content in classrooms. The "Escoles Verdes" program (i.e., Green Schools), initially confined to Catalonia, exemplifies the regional disparities in Blue Education efforts. A concerted national approach is crucial to unify these disparate initiatives and foster a more comprehensive and equitable Blue Education landscape in Spain.

8.2.4.2. The green schools

The Green Schools are educational institutions committed to sustainability that strive to promote eco-social education, transforming both the school and its surrounding environment. To foster collaboration, these schools

network with other local organizations. Established by the Generalitat of Catalonia, the Green Schools Program supports Catalan educational institutions in innovating, incorporating, advancing, systematizing, and organizing educational actions that address contemporary sustainability challenges and values. The program focuses on three primary objectives: (a) integrating sustainability values into all aspects of school life, including curriculum, management, and environmental interactions; (b) engaging the entire school community in environmental improvement efforts; and (c) facilitating knowledge exchange among schools through a network. The Green School Network (Xarxa d'Escoles Verdes, XEV) comprises preschools (0-6), primary, secondary, vocational, special, and adult education centers. The program offers an initial training course in Education for Sustainability (HE) to all Catalan schools seeking to develop and integrate HE into their educational projects. These courses, conducted by the Department of Education, target school teams including at least one management representative. During the training, each school team develops an Education for Sustainability Plan (PES) encompassing a self-assessment of HE implementation, strategic HE objectives aligned with the school's educational and management plans, and prioritized objectives for the management plan. Schools gain recognition as Green Schools after successfully executing their first School Action Plan and completing the initial school team seminar. The Green Schools Network is part of the Network of Schools for Sustainability in Catalonia (XESC), a collaborative network managed by the Catalan government and currently involving 17 municipalities: Barcelona, Vic, Cornellà de Llobregat, Sant Boi de Llobregat, Sant Feliu de Llobregat, El Prat de Llobregat, Badalona, Argentona, Gavà, Terrassa, Sabadell, Lleida, Vilanova i la Geltrú, L'Hospitalet de Llobregat, Sant Cugat del Vallès, Igualada, and Castelldefels. Currently, more than 1,500 schools (over 25% of Catalan schools) participate in the XESC. Complementing this, the sponsor schools within the Green Schools Network provide guidance and support to other schools in sustainability education. These schools share their successful projects, practical implementation strategies, and educational experiences. Acting as reference points, they facilitate the integration of new schools into the network.

8.2.4.3. **Historical perspective**

In 1998, the Generalitat of Catalonia launched the Green Schools Program to foster comprehensive environmental education in Catalan schools. Teacher training is a priority for the Departments of Education and Territory and Sustainability, as it supports and strengthens each school's educational project, promoting collaboration and professional development. The program offers various training modalities: (a) initial training for school teams in education for sustainability; (b) regional seminars for school teams; and (c) thematic training and workshops based on identified needs.

Twenty-five years ago, the program was a top-down government initiative with a focus on forests and rivers. Now, there's a growing interest in incorporating marine education, but discussions about creating a separate "blue schools" label are ongoing. Bureaucratic hurdles may deter some schools from participating, despite their interest in blue education. The possibility of integrating blue education into the existing program is being considered. Key stakeholders influencing this situation include environmental education organizations, government officials, school administrators and teachers, and communication channels. Strengthening collaboration among these groups, particularly through focused thematic meetings, is essential. In 2024, the Institute of Ocean Science (ICM) of the Spanish National Research Council (CSIC) launched the teacher training in blue education in partnership with Green Schools.

To effectively integrate blue education into the Spanish formal education system, a coordinated approach is needed. While the LOMLOE law offers opportunities for interdisciplinary learning and skill acquisition, specific policies

supporting blue education are still limited. Creating a national network of marine educators, similar to existing land-based networks, could facilitate knowledge sharing and collaboration. In 2024, this network is under development. It is made of regional networks which are also in creation, whose members are research institutes, museums, SMEs, aquariums. It aims to promote blue schools, give support to schools, create resources, exchange resources and best practices. The Blue Schools Clusters association, responsible for the national network, has been registered on the 5th of August 2024. Leveraging the Green Schools Program to expand into blue education is a promising avenue, especially considering the program's reach and existing teacher training infrastructure.

8.2.4.4. **Challenges**

Several factors have hindered the integration of blue education into the Green Schools program or the development of a dedicated Blue Education program in Spain. Geographical constraints, with limited access to water bodies for many schools, have restricted opportunities for regular aquatic experiences. Additionally, the relatively marginal status of outdoor education in the Spanish educational landscape and the absence of specific marine or freshwater content in standard curricula have posed significant challenges. A shortage of teacher training programs focused on these subjects further exacerbates the issue. Thus, implementing a comprehensive Blue Education program or integrating blue elements into existing programs (e.g., Green Schools) in Spain faces multiple hurdles. Clearly defining Blue Education within the curriculum, providing targeted teacher training, and offering logistical support to schools for accessing aquatic environments are essential steps. Promoting outdoor education as a core component of learning would also be beneficial. Leveraging and amplifying existing initiatives through increased visibility and networking could enhance the overall impact. To overcome these challenges, a strategic approach is necessary. Strengthening aquatic topics within existing environmental education networks can provide a rapid pathway for delivering effective training and support from non-formal to formal education sectors. Simultaneously, addressing curricular modifications, fostering outdoor education, and improving school organization can be pursued at a more gradual pace. A top-down approach can offer valuable guidance and support throughout this process.

The current educational landscape in Spain offers potential for integrating blue education with freshwater education and broader sustainable development goals (SDGs). The SDG framework provides a comprehensive umbrella under which various environmental topics, including water-related issues, can be addressed. This approach encourages collaboration between schools and external entities, fostering a sense of community involvement. While there's a growing recognition of the importance of environmental education, the integration of blue education is still in its early stages. A notable gap lies in the connection between formal education and citizenship education. While some environmental organizations offer programs for both students and the general public, there's a need for stronger collaboration and information sharing between these entities. Establishing clear pathways for the public to engage with school-based initiatives would significantly enhance the impact of blue education.

Therefore, a key challenge in developing a robust Blue Education program in Spain is the fragmentation of initiatives across different organizations and regions. To overcome this, a centralized platform for sharing resources, expertise, and best practices becomes essential. Building partnerships between educational institutions, research centers, and other stakeholders can facilitate knowledge exchange and resource sharing. Empowering teachers with the necessary knowledge and skills is crucial for effective Blue Education implementation. Providing targeted training programs and support networks can help teachers integrate blue topics into their curricula. Additionally, fostering collaboration between marine research centers and schools can create opportunities for students to engage with real-world research and contribute to scientific endeavors.

8.2.4.5. Impacts

The Green School Distinction is a seal of approval awarded to educational centers after a two-year training period, in which this distinction is renewed every four years through ongoing self-evaluation. Therefore, the impact assessment has two phases: (a) every four years, schools conduct a comprehensive self-assessment that includes a review of their Education for Sustainability Plan; and (b) every eight years, schools undergo an in-depth assessment involving a new situational analysis, identification of fresh strategic goals, prioritization of these objectives, and development of a new action plan for the following academic year. While the program has yielded positive results over time, its impact could be maximized by streamlining the bureaucratic process to encourage wider participation. Promoting the program more effectively would also be beneficial. Notably, the program encompasses both public and private schools.

8.2.4.6. Final remarks

While Spain has made strides in environmental education, particularly through initiatives like the Green Schools Program, the integration of Blue Education remains a complex challenge. The fragmented landscape, characterized by regional differences and complex coordination, hinders the development of a comprehensive and effective approach. Overcoming these challenges requires a multifaceted strategy that includes: (1) strengthening collaboration among government agencies, educational institutions, and non-profit organizations; (2) investing in teacher training and professional development in collaboration with green schools and other initiatives (e.g., Eco-Schools, We are Blue Schools, etc.); and (3) developing cross-curricular guidelines for Blue Education.

8.2.4.7. Timeline of key events

Evolution of Green Schools in Catalonia

Pre-1998

- **Growing Environmental Awareness:** A general increase in environmental awareness and concern for water resources.
- **Early Environmental Education Initiatives:** Isolated environmental education programs, possibly focusing on terrestrial ecosystems.

1998

- **Launch of the Green Schools Program:** A significant milestone in environmental education in Catalonia, with a focus on sustainability.

1998 - 2023

- **Evolution of the Green Schools Program:** Expansion and development of the program, including the introduction of various training modules.
- **Growing Interest in Marine and Freshwater Education:** Increasing recognition of the importance of aquatic ecosystems (external factor)

- **Emergence of Non-formal Blue Education Initiatives:** Development of marine-focused programs by science centers, museums, and other organizations.
- **Integration of SDGs:** Incorporation of Sustainable Development Goals, including SDG14, into formal education.

2024

- **Launch of the marine national network in Spain:** coordination of regional marine networks under development
- **Launch of teacher training in blue education by the Institute of Ocean Science (ICM) of the Spanish National Research Council (CSIC), in partnership with Green Schools:** efforts to improve teacher qualifications in marine education.

8.2.4.8. Relevant references

- *https://mediambient.gencat.cat/ca/05_ambits_dactuacio/educacio_i_sostenibilitat/educacio_per_a_la_sostenibilitat/escoles_verdes/el_programa_escoles_verdes/*
- *https://www.miteco.gob.es/es/ceneam/programas-de-educacion-ambiental/programas-de-otras-entidades/escoles_verdes.html*
- *https://www.miteco.gob.es/es/ceneam/recursos/mini-portales-tematicos/reeducamar/reeducamar-red.html*
- *https://www.barcelona.cat/barcelonasostenible/sites/default/files/2024-07/CatalegActivitatsEinesMar_Juny2024.pdf*

8.2.5. The externalization of Explorers program to upscale blue education in Ireland

8.2.5.1. Introduction

Blue education has been integrated into the formal context over the years due to the already stablished environmental education efforts in Ireland. The growing efforts of non-formal initiatives, participation in international projects and the establishment of the Irish Ocean Literacy Network supported the blue education landscape across the country. Therefore, various factors supported the successful integration of ocean and freshwater literacy, through a cross-curricular approach, into the Irish national curriculum. Thereby, climate change will be a subject on the curriculum from 2024 onwards in the secondary schools, primary school teachers are supported by the Department of Education and Skill to integrate marine themes in the classroom. Alongside this, official teacher training is provided throughout the country to support the mainstream of blue education.

8.2.5.2. The Explorers Education Program

The Explorers Education Program is a cornerstone of blue education funded by the Marine Institute, Ireland's state agency for marine research and development. The Explorers Programme is managed jointly by Camden Education Trust and Galway Atlantaquaria as a 5 year contract (2024-2028). The Camden Education Trust is responsible for the strategic development and management of the program, and the Galway Atlantaquaria supports services to management and outreach teams. The Marine Institute are the State agency (Government body) for marine research and development in Ireland fully fund the Explorers Education Programme, in which a number of organisations are contracted to work on the Programme. This includes an education management and communications team, outreach, training and events management team, as well as outreach teams in different counties of Ireland that work with schools. There are currently 2 management teams and 8 outreach teams covering 14 coastal counties. The Department of Education has a dedicated Teacher Education section and provides separate funding to the regional education support centres (Galway, Tralee, West Cork, Waterford) that run the summer CPD teachers training programmes, which include 5 days training for Explorers programs. The Explorers Education Teachers Training is approved by the Department of Education to run the summer CPD courses through these centres.

Therefore, the program has effectively reached over 12,000 children annually for the past two decades. The program has four main goals: (a) educate and inspire children, educators and the education network to adopt the ocean literacy principles and support the engagement within the United Nations (UN) Sustainable Development Goals; (b) coordinating professional development training and workshops for teachers, trainee teachers, and outreach teams; (c) develop materials, resources and activities for students through STEM and STEAM projects, cross-curricular modules and lesson plans; and (d) promote ocean literacy and marine outreach activities with local communities, educators and influences. By delivering marine modules for the classroom and out-door education, providing official teacher training, and developing accessible online resources, the Explorers program has significantly contributed to integrating ocean literacy into the national curriculum. This concerted effort, coupled with the broader support of government agencies and organizations, has fostered a robust blue education ecosystem in Ireland, particularly within primary and secondary schools.

8.2.5.3. Historical perspective

Prior to the Explorers program, Ireland had a fluctuating history with environmental education. A strong foundation was laid in the 1970s but waned in the following decades. The resurgence of environmental education in the 1990s, particularly with the introduction of a new science curriculum, paved the way for incorporating marine education. However, challenges persisted due to a lack of science background among some teachers. This is where non-formal education played a crucial role in teacher training and capacity building. While Ireland's island geography fostered a strong marine culture, a significant portion of the population lived inland, limiting direct ocean connection. Nevertheless, various initiatives, including programs focusing on inland fisheries and the salmon lifecycle, were already promoting marine awareness. Freshwater education was also integrated into the new primary school curriculum, with a strong emphasis on the country's land, sea, and rivers. Despite these efforts, barriers such as limited resources and a lack of comprehensive online materials hindered the effective teaching of ocean literacy.

The Explorers program evolved from a grassroots initiative to an externalised nationwide program. Initiated in 2000 as a response to teacher needs, it began by bringing marine experts into classrooms and collaborating with aquariums. Over time, the program expanded its reach and impact through strategic partnerships and rigorous evaluation. While primarily focused on marine education, Explorers has indirectly contributed to freshwater

awareness by incorporating broader environmental themes. Its success is attributed to a collaborative approach, engaging with teachers, students, and other stakeholders to develop and deliver relevant and engaging marine education experiences. The Explorers program's expansion was driven by several key factors. A shared vision of fostering ocean literacy among young people, coupled with the recognition of teacher training as a vital component, propelled its growth. Formal integration into the Irish education system, through mandatory teacher training, significantly expanded the program's reach. Additionally, a collaborative approach, valuing teacher input and feedback, proved instrumental in adapting the program to meet evolving needs. By broadening the scope beyond science to encompass other subjects, Explorers maximized its potential to engage students with diverse interests and learning styles, ultimately contributing to its sustained success.

The Explorers program gradually transitioned from being solely Marine Institute-led to a more integrated national approach. Teacher training, once primarily managed by the Marine Institute in Galway, expanded to a nationwide system funded by the Department of Education. This shift, initiated by the Marine Institute, led to the establishment of regional training centers and a standardized five-day course for all Irish teachers. In parallel, the program developed the "Ocean Legends" project in 2019, focusing on storytelling and marine heritage to engage schools with a maritime connection. To increase program reach without creating new modules, the "Ocean Champion" initiative was launched. This project empowered schools to select and lead their own marine-focused projects, fostering ownership and collaboration among teachers. The annual Ocean Champion awards recognized outstanding initiatives, encouraging broader participation. The 2023 curriculum reform in Ireland aligned perfectly with the Explorers program's goals, emphasizing project-based learning, citizen science, and environmental education. This provided a framework for integrating marine education across subjects and enhancing the impact of the Ocean Champion projects.

Teachers were undeniably pivotal in the expansion of the Explorers program. Their direct feedback and engagement shaped the program's evolution. Collaborations with teacher training institutions were crucial in integrating marine education into initial teacher preparation. Beyond educators, partnerships with organizations and initiatives like Green Schools, Something Fishy, and Curious Minds enriched the blue education landscape. These collaborations facilitated knowledge sharing, resource development, and a more holistic approach to environmental education. In 2016, the Irish Ocean Literacy Network emerged as a significant platform for connecting stakeholders, promoting marine education, and providing resources such as the Blue School webpage. Initiatives like Explore Your Shore and Leave No Trace-Ireland, under the IOLN umbrella, offered practical tools and citizen science opportunities, enhancing the program's impact. While the exact timeline of private sector involvement in blue education requires further research, it is likely that their contributions have become more prominent in recent years, aligned with growing corporate social responsibility and sustainability goals.

8.2.5.4. **Challenges**

One of the initial challenges faced by the Explorers program was the need for expert support in classrooms. This was addressed by establishing collaborations with marine experts and developing teacher training modules to equip educators with the necessary knowledge and skills. Integrating marine education into existing programs, such as the Green Flag initiative, presented additional hurdles. However, through perseverance and collaboration, the marine flag was successfully introduced, providing a framework for schools to focus on marine-related activities.

The primary challenge in advancing blue education in Ireland lies in shifting mindsets and demonstrating the tangible value of marine education within the formal curriculum. Convincing policymakers and educators of the social and

economic benefits of ocean literacy is crucial. While numerous outreach initiatives and EU programs contribute to overcoming this challenge, building strong partnerships and demonstrating clear impacts remains essential. Additionally, addressing the diverse needs of local communities, including those reliant on traditional marine industries, is vital. By highlighting the potential of ocean-based economic opportunities and emphasizing the role of marine education in addressing climate change, it is possible to foster a more supportive environment for blue education.

Leveraging media to enhance marine education has been a focus of the Explorers program. By providing films through national television, the program aimed to increase accessibility to ocean-related content for students. However, broader access to high-quality marine documentaries remains a challenge. The recent introduction of climate change as a core subject in secondary schools presents both an opportunity and a challenge. While it creates a platform for integrating marine content, it also places additional demands on teachers, necessitating comprehensive support and resources. The development of age-appropriate materials and the provision of in-classroom support are crucial to ensure effective teaching. The Explorers program has played a vital role in teacher training, building capacity and enthusiasm for marine education. However, the challenge of translating resources into Irish, coupled with the time-intensive nature of cross-curricular integration, highlights the ongoing need for sustained support and investment in blue education.

8.2.5.5. **Impacts**

The Explorers program has demonstrated a positive impact on marine education in Ireland, fostering increased knowledge, attitudes, and values towards the ocean among students. Rigorous evaluation methods, including quantitative and qualitative data collection, have been employed to measure the program's effectiveness. However, challenges persist in translating these outcomes into systemic change. The fragmented governance structure in Ireland, with multiple agencies involved in education and marine affairs, hinders the program's full potential. While the bottom-up approach of the Explorers program has yielded impressive results, a top-down strategy is equally essential to ensure long-term sustainability and widespread impact. To overcome these challenges, enhanced collaboration between government departments, particularly the Departments of Education and Agriculture, Marine, and Food, is crucial. A more coordinated approach, including pilot programs and long-term impact assessments, would strengthen the evidence base for the importance of marine education. By investing in a comprehensive and sustained strategy, Ireland can maximize the benefits of the Explorers program and position itself as a leader in ocean literacy.

8.2.5.6. **Final remarks**

The integration of blue education into the Irish blue educational landscape has evolved significantly, driven by a combination of governmental initiatives, non-profit efforts, and a growing societal awareness of ocean conservation. The Explorers Education Program has been instrumental in fostering ocean literacy among students and teachers alike, but challenges remain in terms of systemic integration and resource allocation. To fully realize the potential of blue education in Ireland, in a long-term perspective, a concerted effort is required to address these challenges, strengthen collaborations, and secure long-term funding.

8.2.5.7. **Timeline of key events**

Evolution of the Explorers Program in Ireland

1970s

- Initial surge of environmental education

The Department of Education included Environmental studies on the primary school curriculum in the 1970's. This led to a number of pilots carried out with primary schools to deliver this subject. Some pilots were school based with classroom touch-tables to others including outdoor fieldtrips to local forests, and seashores.

1980s

- Decline in environmental education

The environmental studies continued to be included and the implementation of how it was delivered was at the discretion of the primary school teachers.

1990s

- Resurgence of environmental education, introduction of new science curriculum

The introduction of new science curriculum was launched in 1999 by the Department of Education. This was included in the Social Environmental and Scientific Education curriculum, which included: Science, Geography, and History.

This led to an increase in the number of State agencies (Government bodies), science organisations, universities, and businesses (aquariums, outdoor education centres, science education centres) creating outreach programmes that encouraged and supported teachers to deliver science on the curriculum.

The Marine Institute has been the lead agency in developing and supporting marine education at primary school level through the development of resources, outreach in schools, teachers training, 3rd level student teachers training, and events.

Initiatives relating to science have been led by Science Foundation Ireland - SFI Discover Programme. This supports projects that inspire public awareness of the impact of STEM on society. Science Week is a week-long event in Ireland each November, celebrating science in our everyday lives with a wide variety of events throughout Ireland. The government has recognised the value of STEM as a driver of employment through R & D

2004-2006

- Launch of the Explorers Education Program, initiated by the Marine Institute working with a collaboration of experts including the Galway Education Support Centre, Galway Mayo Institute of Technology,

2006

- Introduction of cross-curricular approach

The Explorers Education Programme has always adopted an approach where teachers are encouraged to use marine themes as part of cross-curricular teaching. There is a base line of using sciences (.e.g. learning about species, energy & forces, environmental awareness and care). Other subjects are used to teach through geography, history, arts, languages.

2007

- Launch of CPD official teachers training

The Explorers CPD, official teachers training was established with the Galway Education Centre in 2007 funded by the Department of Education. CPD training is provided on an annual basis as part of the teachers training requirements held in the first week of July.

The Marine Institute's Explorers Teachers Training is still delivered on an annual basis and has expanded to other education support centres in counties Galway, Kerry, West Cork, Waterford, and Dublin. The delivery has involved marine scientists from Marine Institute and other educators that specialise in outdoor education, English, arts, and music. The teachers training continues to be delivered involving the Explorers outreach team members in the counties noted above. An online CPD training option is also provided. All training includes a cross curricula approach where the delivery is week-long.

2016

- Establishment of the Irish Ocean Literacy Network

The Irish Ocean Literacy Network is an all-island network. It was first established as part of the Irish deliverables as for the EU Horizon 2020 funded project Sea Change during 2015-2018. The Irish Ocean Literacy Network was established as a non-formal network in 2016. Its activity and development were guided by a steering group, made up of a diverse group of Ocean Literacy advocates. They came together up to four times a year to plan the actions of the network in communication with the Secretariat Galway Atlantaquaria (2018-2023). The previous secretariat was Susan Heaney from Blue Inspiration (2016-2018). Seed funding for the secretariat role from 2016-2022 was provided by the Marine Institute. Support was also provided by Bord Iascaigh Mhara from 2021-2022. It should be noted that many of the members have provided large amounts of in-kind contributions since 2016 to bring the IOLN from where it began to where it is now. In 2023 established itself as a CLG Company Limited by Guarantee in 2023. Membership includes company members and associate members throughout Ireland.

2024

- Introduction of climate change as a core subject in secondary schools

The Department of Education and the Government of Ireland has decided that two new subjects will be introduced in schools on a phased basis from the start of the 2025/26 school year. Following an open call to schools for applications in April 2024, 57 schools were selected to introduce Drama, Film and Theatre Studies, and 43 schools to introduce Climate Action and Sustainable Development.

8.2.5.8. Relevant references

- *https://www.marine.ie/site-area/areas-activity/education-outreach/explorers/explorers-outreach-schools*
- *https://www.marine.ie/site-area/about-us/about-us?language=en*

8.2.6. The rise of Educational Marine Areas in France

8.2.6.1. Introduction

The French Ministry of Education and Youth has launched and coordinates numerous initiatives and programmes related to Blue Education, in collaboration with various partners. Some of the examples include the establishment of a national committee dedicated to Blue Education and the provision of information and resources for teachers, national programmes which include marine educational areas, and "les classes Enjeux Maritimes" in partnership with the Fondation de la Mer and the French Navy, are notable efforts. Additionally, the ministry has initiated educational actions on polar issues and launched the "Brevet d'Initiation à la Mer" (BIMer), a certificate introducing maritime culture and sea-related skills and careers. The fastest growing initiative is the **Educational marine areas**[3]**.**

8.2.6.2. The Educational Marine Areas (Aires Marines Educatives)

An Educational Area (EA) is a small coastal maritime zone (EMA) or a terrestrial or aquatic area (ETA), more or less impacted by human activity (urban park, beach, wasteland, wetland, mangrove, forest, river, etc.), managed participatively by pupils (8-18 years old) from one or more classes. Accompanied by their teacher and an environmental education specialist, the pupils study this area and democratically decide on actions to preserve its natural and cultural heritage. Through this project, they develop skills and concepts from the school curriculum and explore their local area and its stakeholders: the relevant municipality, as well as user associations, environmental protection organisations, and other local actors. (Office français de la biodiversité, 2020.) The projects which completed specific criteria[4] receive a label. Between 2023 and 2024, 1138 Educational Areas were established (343 EMA and 795 ETA) while the government is calling for 18,000 schools, i.e., one-third of all schools in France (Office français de la biodiversité, 2024).

[3] For further information see: https://ame.ofb.fr/lib/exe/fetch.php?media=docs_cadrage:guide_methodo_creation_ae_v3_final_charte.pdf and https://www.calameo.com/ofbiodiversite/read/00350294814098beea5f3

[4] The criteria for labelisation is available on pg.37 of this document: https://ame.ofb.fr/lib/exe/fetch.php?media=docs_cadrage:guide_methodo_creation_ae_v3_final_charte.pdf

8.2.6.3. **Historical perspective**

The first Educational Marine Area was created in 2012 on the Marquise Islands (French Polynesia), as an education tool of the local marine protected area.

In 2016, the French Office for Biodiversity (OFB) started a pilot project with 8 schools to develop a specific methodology for Educational Marine Areas (EMA). From there, the word of mouth among teachers, students and education stakeholders led to the creation of many new EMAs: about a hundred for the 2018-2019 school year. The methodology had to be adapted to meet the needs of a more diverse audience: initially deployed for children age 9-11, teachers from other age groups started to get interested, including younger pupils, but also students in middle school and high schools.

In 2019, the methodology was extended to the creation of Educational Terrestrial Areas (ETA).

In 2021, regional steering groups made up of the OFB's regional directorates, the academies, the Ministry of the Environment's regional directorates, regional environmental education associations, etc, were created in all French regions to handle the evaluation of school projects in sight of labelling, teachers training on the EMA/ETA methodology, networking and follow up with the schools.

In 2022, a Convention was signed between OFB and the French Education Ministry.

Since 2016, a steering committee gathers OFB, the Ministry of Ecology, Ministry of Education and Overseas territory supervises the EMA/ETA policy.

The rapid development of EMAs and ETAs is facilitated by the fact that it does not add yet another topic to teach in the curricula, but constitute an alternative way of teaching, which allows to teach mandatory subjects while involving Blue topics. Hence, it allows to adapt to governmental priorities in terms of curriculum.

The involvement of the Ministry of Education is another key factor in the development of the EMA/ETAs, ensuring their support while the policy remains under the responsibility of a somehow more flexible public agency (OFB). The role of OFB in arguing in favour of the development of EMA/ETAs is then key to maintaining governmental support.

The development of EMA/ETAs is so far on a bottom-up basis: schools can submit projects and get funding from OFB and/or local sources (associations, local authorities…). This voluntary approach allows growth in number of participating schools, since the EMA/ETA approach has been rewarding for many of the teachers who tried it: the methodology developed for the EMAs and ETAs is based on an innovative pedagogical approach, with a concrete, learning-by-doing and collective component, a territorial approach that promotes eco-citizenship. Since the EMAs and ETAs come with a clear methodology, the teachers are provided guidelines to develop their blue project.

The methodology of educational areas is applicable to all ecosystems (freshwater, marine, terrestrial). This methodology encompasses both education for sustainable development and education for citizenship. By managing a small piece of land, pupils not only learn about biodiversity and develop scientific skills, they also develop their eco-citizenship: throughout the project, the pupils debate together on how to protect their educational areas and exchange their opinions; they also interact with the adults in charge of local administration and the users of the areas: mayors, managers of natural areas, fishermen, farmers, etc. Nowadays, the objective of developing 18,000 educational areas as part of the national biodiversity strategy is directly supported by the Ministry of Education, which has fully integrated it into its strategy for developing education for sustainable development.

8.2.6.4. **Challenges**

Although, the innovative methods of EMA/ETAs come with an entry cost of the teachers who decide to apply it (it can take 1 to 3 years for the teacher to master the methodology). The fast increase in number of new schools creating EMA and ETA over the last years is partly due to the fact that the most motivated teachers went first. It is expected that further development, relying on the will of the other teachers, will require more support from the regional steering groups. Therefore, the capacity of those local groups to offer training, facilitation and individual follow up to each EMA or ETA project is key, and is becoming more and more challenging due to the increasing number of projects.

The labelling process is seen as an administrative burden by the schools and represents a large undertaking for the regional groups. For now, the label has a limited added value for the schools: they receive a flag and a diploma, it helps the reputation of the school, but they can receive funding whether or not they are labelled so the incentive is low. The label might mandatory the case in the upcoming years (it is an ongoing project in OFB). Another ongoing development is the integration of the EMA/ETA methodology as mandatory in the initial training of teachers, which should lead to a national mainstreaming of the method. These developments pose an issue of capacity for the regional groups, which in the one hand will have to train more and more teachers and spend time evaluating the projects in view of certification.

The schools who develop an EMA or ETA project are not systematically funded by OFB (in 2024, about 600 are funded by OFB, out of 1138). OFB's funding are mainly used to finance the structure which support the teacher in implementing the project. The projects that are not funded by OFB use local funders (associations, local authorities…) or are supported by an organisation which does not require funding (a protected area which has sensibilisation goals in its missions and in which there is a person dedicated to support schools for free, for instance). The increasing number of EMA and ETA projects have shown the limits of local funding capacities, particularly for the NGOs, which are now often not in capacity to fund or offer services to new schools.

Funding is also required to maintain and develop the online platform for EMA and ETA teachers (https://sagae.ofb.fr/). For now, it provides teachers with information and allow them to apply to create and EMA or ETA. Further development should allow the platform to become a functional social network for EMA and ETA teachers, to display the instrument to external stakeholders and to centralized funding demand and offer. However, the current investment in this platform does not allow such features.

The methodology for adapting the EMAs and ETAs for middle school and high school students is currently under development. However, some projects are already ongoing in such schools, which result in a lack of support to the teachers who took initiative.

Another challenge is the research aspect: the effects of the EMA and ETA on students and communities need to be documented, in order to be able to justify the governmental support to EMA/ETA policy at all levels (national, regional, local) and improve the quality of the approach. A research project (RAME) is currently ongoing at the CNRS to start tackling this issue (https://rame.hypotheses.org/).

Lastly, the development of the EMA/ETA policy depends on governmental willingness to invest in education and make environmental education a priority.

8.2.6.5. **Impacts**

The teachers who are currently applying the method report positive impacts on the group dynamic between students, an increased motivation and interest from the children because the project makes sense to them, motivates them, and they learn all the better for it, and this is felt in all subjects. The fact that the class takes place outside and relies more on voluntary basis are also factors that increase the student's motivation (interview with a school teacher in Réunion, 2021). Indeed, it has positive impact on general competences (language, writing, mathematics, sciences, etc.). The project places experiential learning at the heart of the educational process (Bertin-Renoux, Fuchs, 2023): pupils appropriate knowledge because they go out into the field: because it is concrete, they remember it more easily than if they had learned from books.

The EMAs and ETAs are very attractive to schools in underprivileged areas and classes for children with specific needs, because it represents an alternative way of teaching that motivate kids beyond formal skills

These projects also have a positive impact on the way the pupils perceive the ecosystems surrounding them and on their scientific knowledge. Indeed, for some pupils, they only know about biodiversity through what they can see on television. The development of digital technology in our daily lives is helping to accentuate a virtual relationship with nature and diminish the link we have with biodiversity. For some students, the initial challenge is becoming comfortable with the natural environment, as observed by researchers studying the impact of educational areas. At first, they were hesitant to walk on small paths, worried about dirtying their shoes. However, as the trails became narrower and hillier, they began to run, finding it exhilarating and enjoyable. The activities encourage them to observe the biodiversity around them. One student was amazed to see a butterfly "for real," while others spotted a squirrel in an oak tree. Over time, they learn to identify chestnut and hazel trees and know they can collect their fruits in the fall. These outdoor experiences are crucial for helping students develop knowledge rooted in their environment (Bertin-Renoux, Soyez--Lozac'h, Fuchs, Gottsmann, 2023)

Finally, this methodology, by being designed as a teaching method in which pupils go all year long outside to learn about their surrounding ecosystems, and not as a one-shot project, allows a change in their relation with nature.

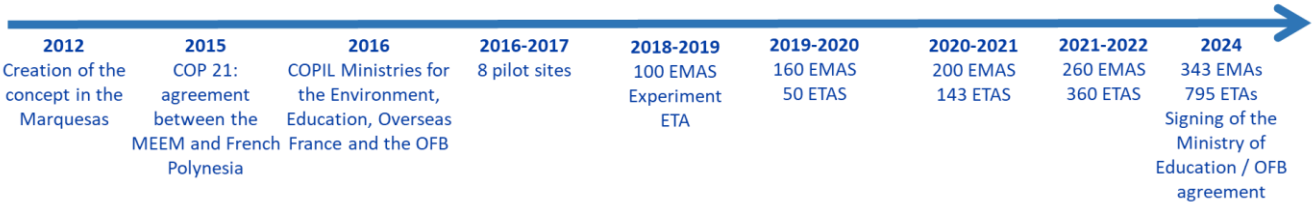
The impacts of educational areas are currently being measured by the RAME research program. To measure the impact of AMEs on pupils' relationship with nature, a qualitative, longitudinal study is carried out over the course of a school year. The quality and quantity of interactions with nature are cross-referenced with verbalisations in situations and during accounts of experience to understand the process (brakes/leverages) of transforming the relationship with nature. Interviews are being conducted, and questionnaires, psychological tests, children's drawings and comprehensive interviews are used to measure changes in pupils' representations of nature. Interviews with teachers, environmental educators, policymakers and archives (administrative, documentary, press, etc.) are also carried out to understand the obstacles and levers that encourage teachers to become involved in a scheme such as the EMAs, and to understand the development/deployment of the EMAs.

8.2.6.6. **Final remarks**

The Educational Marine and Terrestrial Areas are a fast-growing initiative for environmental education in France, going from 8 pilot areas in 2016 to 1138 in 2024. The number of schools taking part in such policy is expected to grow with the integration of the methodology in the teacher's initial training. To ensure success, the capacity of those

local groups to offer training, facilitation and individual follow up to each EMA or ETA project is key and will require a regional governance for supporting local nonprofit organizations who work in collaboration with schools. While work is ongoing to streamline the tools and process, long term funding is a core issue, at both national and regional levels. Anchoring EMA and ETA in local sources of funding is key.

8.2.6.7. Timeline of key events



8.2.6.8. Relevant references

- *https://www.ofb.gouv.fr/aires-educatives*
- *https://rame.hypotheses.org/*

8.2.7. Conclusion on the key instruments for Blue Education in BlueLightS' experimentation countries

The analysis of the key instruments contributes to the understanding of the current Blue Education landscape in experimentation countries. The report provided an overview on the key instruments in selected countries, focusing on their development, challenges and impacts over time aiming to support the future development of blue education in Europe. The data gathered from the semi-structured interviews showcase a rising in blue education in non-formal and formal context over the last years, particularly various initiatives promoted by research centers, science museums, aquariums, and NGOs contribute to bring the blue to the classroom. Therefore, the key take-home messages compiled from the national instruments presented in this report, are as follows:

(1) Teachers are key stakeholders

Bottom-up initiatives, focusing on teachers training and empowerment, are essential to effectively integrate blue education into the curriculum in the long-term perspective. Providing teachers with adequate training, resources, and support is essential for the success of blue education initiatives, as seen through the different national instruments.

(2) Collaboration is key to upscale blue education along with a community platform

An effective blue education program requires a multi-stakeholder approach that supports the program through a network of partnerships, resources, materials, or financially. Thus, collaboration among educators, scientists, policymakers, and the availability of a common community platform for exchanging knowledge, resources, and best practices is vital.

(3) Cross-curricular approach contributes to the integration of blue into the formal education system

A cross-curricular approach allows for a holistic understanding of the ocean and its connection to various subjects. By integrating blue education into different disciplines, the challenges faced such as lack of time available for teachers or lack of ministerial support, may be overcome.

(4) External factors, as a solely top-down instrument, may contribute to a rapid rise, but it can also lead to long-term challenges

Top-down initiatives can quickly introduce blue education, but without local ownership and engagement, sustainability may be compromised. Overreliance on external funding and mandates can hinder long-term development and adaptation to specific regional needs. Particularly if the project relies on a specific ministry, which in periods of political instability may put the project in decline.

(5) Combining bottom-up and top-down approaches may contribute to a long-term success

A balanced approach that combines top-down policy support with bottom-up grassroots initiatives can create a synergistic effect. This approach ensures that blue education is aligned with national priorities, possibly guarantee the support from the government, while also responding to local needs and capacities, with regional partnerships.

(6) Continuous evaluation contributes to a long-term success

Regular assessment of blue education programs is essential to measure their impact, identify strengths and weaknesses, and inform future improvements. By gathering data on student outcomes, teacher satisfaction, and program effectiveness, stakeholders can make data-driven decisions to enhance the quality and reach of the instrument.

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8.3. Publishing outlets in Marine Education (2003-2023)

Sources	Articles
MEDITERRANEAN MARINE SCIENCE	8
FRONTIERS IN MARINE SCIENCE	7
ENVIRONMENTAL EDUCATION RESEARCH	6
SUSTAINABILITY	6
MARINE POLICY	4
MARINE POLLUTION BULLETIN	4
EDUCATION SCIENCES	3
JOURNAL OF ENVIRONMENTAL EDUCATION	3
11TH INTERNATIONAL CONFERENCE OF EDUCATION, RESEARCH AND INNOVATION (ICERI2018)	2
JOURNAL OF BIOLOGICAL EDUCATION	2
OCEANS 2023 - LIMERICK	2
12TH INTERNATIONAL CONFERENCE OF EDUCATION, RESEARCH AND INNOVATION (ICERI2019)	1
12TH INTERNATIONAL TECHNOLOGY, EDUCATION AND DEVELOPMENT CONFERENCE (INTED)	1
2017 FIFTH IFIP CONFERENCE ON SUSTAINABLE INTERNET AND ICT FOR SUSTAINABILITY (SUSTAINIT 2017)	1
2ND INTERNATIONAL CONFERENCE ON HIGHER EDUCATION ADVANCES,HEAD'16	1
AQUATIC CONSERVATION-MARINE AND FRESHWATER ECOSYSTEMS	1
BIOMIMETICS	1
CAHIERS DE BIOLOGIE MARINE	1
ECONOMIC, SOCIAL AND POLITICAL ELEMENTS OF CLIMATE CHANGE	1
EDUCATION AND EDUCATION MANAGEMENT	1
EDUCATION AND INFORMATION TECHNOLOGIES	1
ESPACIO TIEMPO Y EDUCACION	1
EUROPEAN JOURNAL OF MARKETING	1
HELIYON	1
HYDROLOGIE UND WASSERBEWIRTSCHAFTUNG	1
ICERI2014: 7TH INTERNATIONAL CONFERENCE OF EDUCATION, RESEARCH AND INNOVATION	1
ICES JOURNAL OF MARINE SCIENCE	1
IEEE ACCESS	1
INTED2016: 10TH INTERNATIONAL TECHNOLOGY, EDUCATION AND DEVELOPMENT CONFERENCE	1
INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH	1
INTERNATIONAL JOURNAL OF SCIENCE EDUCATION	1
INTERNATIONAL RESEARCH IN GEOGRAPHICAL AND ENVIRONMENTAL EDUCATION	1
OCEANS 2015 - GENOVA	1
ONE EARTH	1
POLAR RECORD	1
PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA	1
PROJEKTOVE VYUCOVANI V PRIRODOVEDNYCH PREDMETECH XIV	1
RENDICONTI ONLINE DELLA SOCIETA GEOLOGICA ITALIANA	1
REVISTA ELECTRONICA EDUCARE	1
TECHNOLOGY AND INNOVATION IN LEARNING, TEACHING AND EDUCATION, TECH-EDU 2022	1
TECHNOLOGY ENHANCED LEARNING: QUALITY OF TEACHING AND EDUCATIONAL REFORM	1
TECHNOLOGY PEDAGOGY AND EDUCATION	1
WATER	1

8.4. Publishing outlets in Freshwater Education (2003-2023)

Sources	Articles
SUSTAINABILITY	6
WATER	2
12TH INTERNATIONAL CONFERENCE OF EDUCATION, RESEARCH AND INNOVATION (ICERI2019)	1
12TH INTERNATIONAL TECHNOLOGY, EDUCATION AND DEVELOPMENT CONFERENCE (INTED)	1
AQUACULTURE INTERNATIONAL	1
DESALINATION	1
ECO-ARCHITECTURE II: HARMONISATION BETWEEN ARCHITECTURE AND NATURE	1
ENVIRONMENTAL EDUCATION RESEARCH	1
HYDROLOGIE UND WASSERBEWIRTSCHAFTUNG	1
INTERNATIONAL RESEARCH IN GEOGRAPHICAL AND ENVIRONMENTAL EDUCATION	1
IRISH EDUCATIONAL STUDIES	1
JOURNAL OF BALTIC SCIENCE EDUCATION	1
JOURNAL OF CURRICULUM STUDIES	1
MEDITERRANEAN MARINE SCIENCE	1
NEW PERSPECTIVES IN SCIENCE EDUCATION, 8TH EDITION	1
PLOS ONE	1
PROJEKTOVE VYUCOVANI V PRIRODOVEDNYCH PREDMETECH XIV	1
SUSTAINABLE DEVELOPMENT	1
VIII INTERNATIONAL CONFERENCE ON INTERCULTURAL EDUCATION AND INTERNATIONAL CONFERENCE ON TRANSCULTURAL HEALTH: THE VALUE OF EDUCATION AND HEALTH FOR A GLOBAL, TRANSCULTURAL WORLD (EDUHEM 2018)	1
WASSERWIRTSCHAFT	1

8.5. Barriers to develop blue across national educational system of experimentation countries (D3.1)

The barriers to develop blue across national educational system of each experimentation country based on the survey carried out by EUN within WP3 (Task 3.1, Q10[5]) are followed.

[5] D3.1-A report on proposed blue education experimentation in selected countries

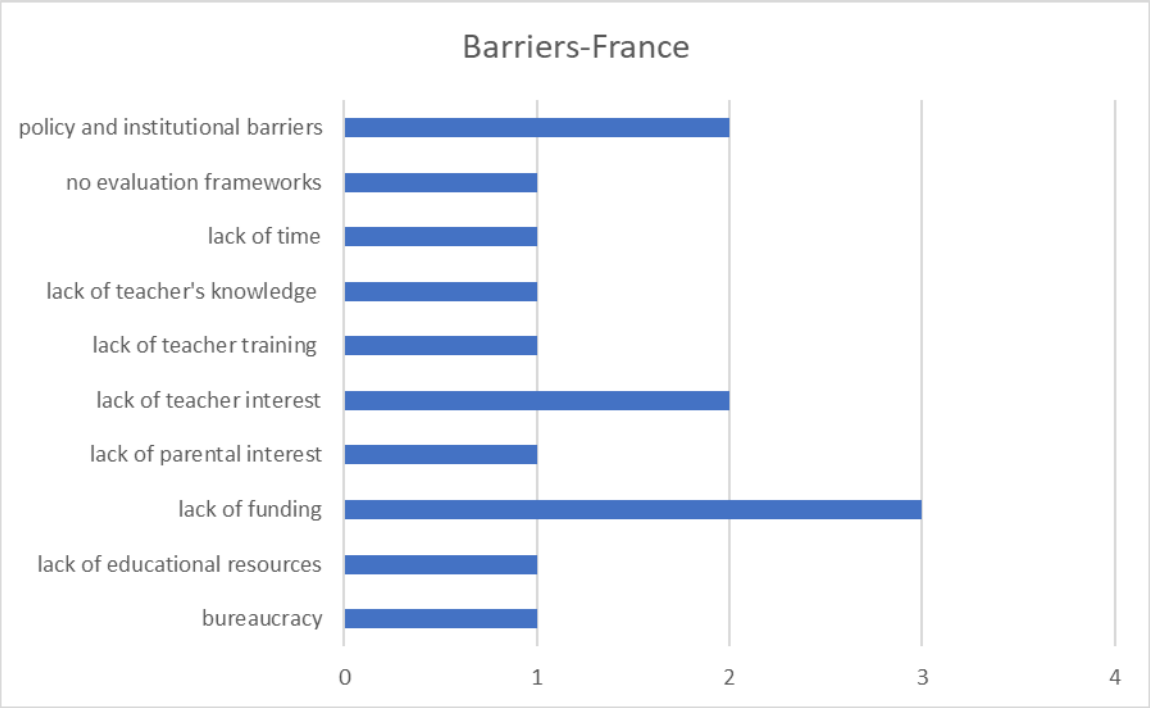

Figure 25. Barriers to develop blue across national educational system of France

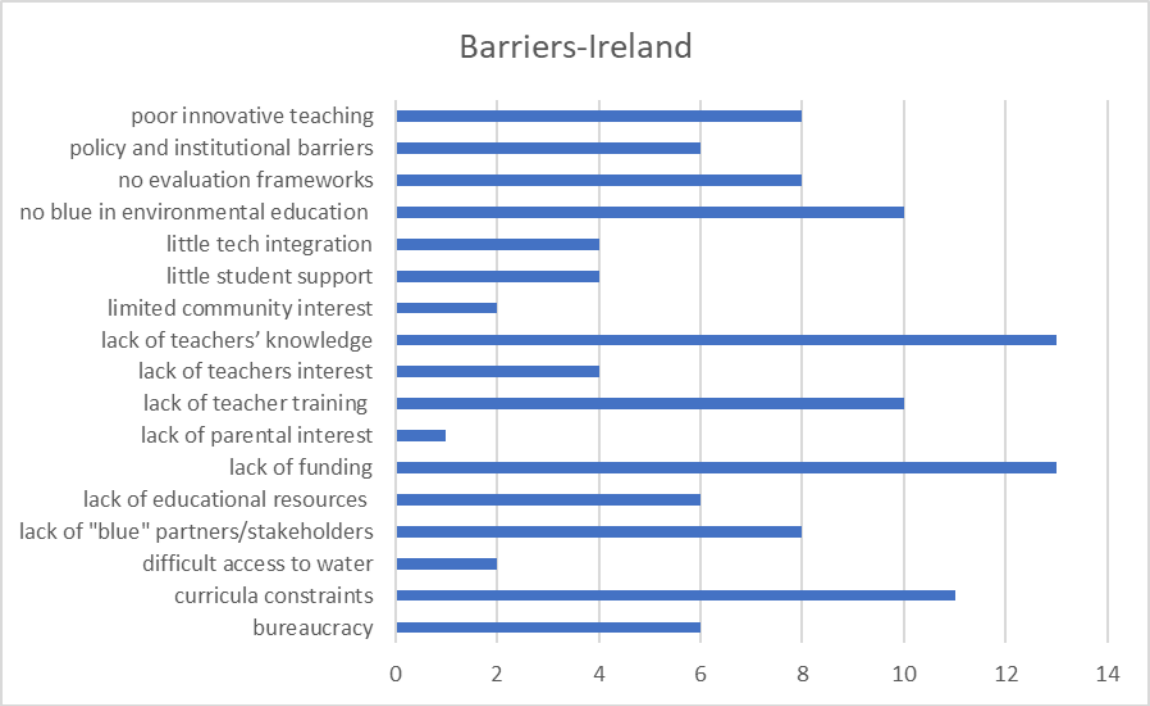

Figure 26. Barriers to develop blue across national educational system of Ireland

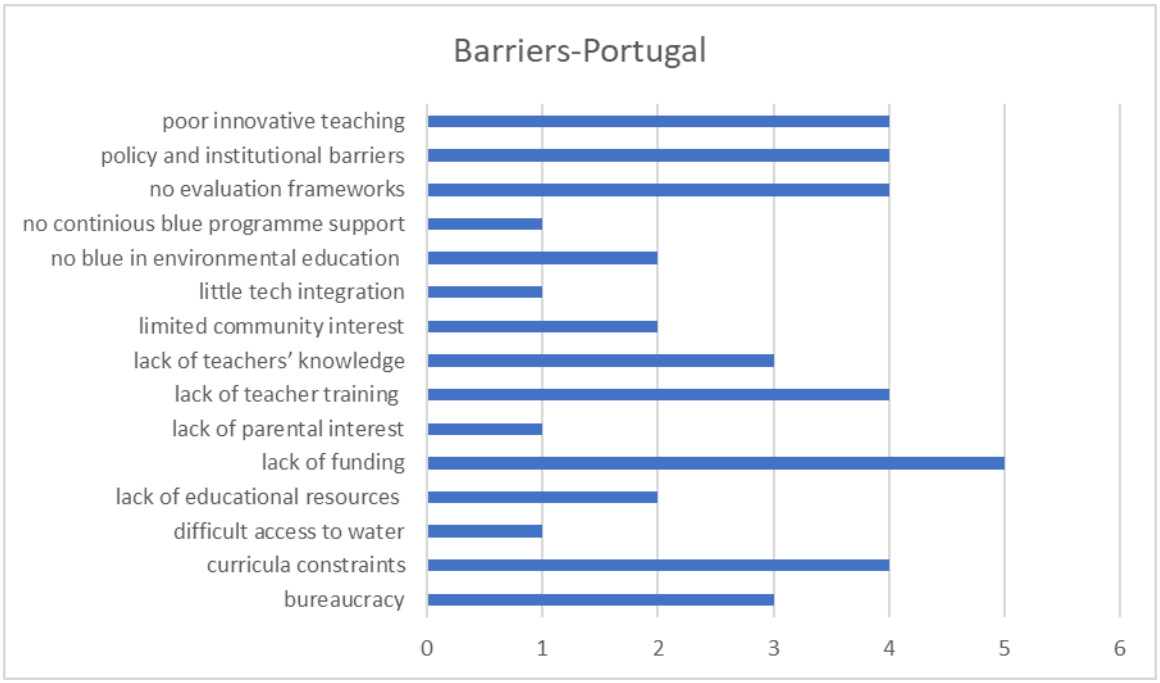

Figure 27. Barriers to develop blue across national educational system of Portugal

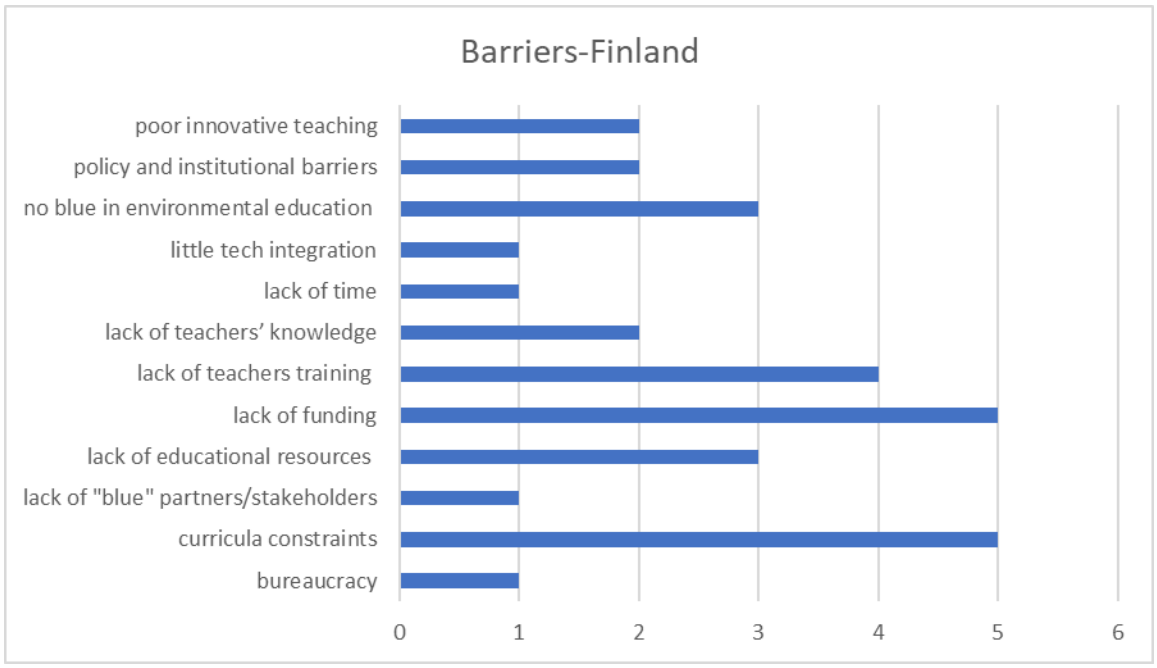

Figure 28. Barriers to develop blue across national educational system of Finland

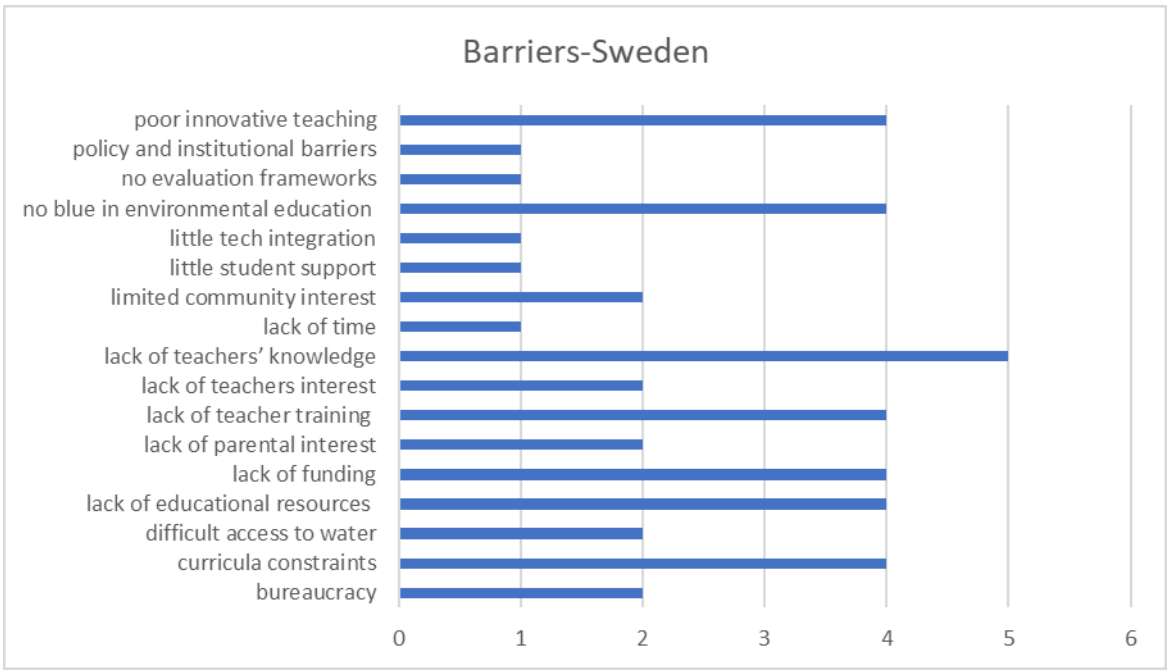

Figure 29. Barriers to develop blue across national educational system of Sweden

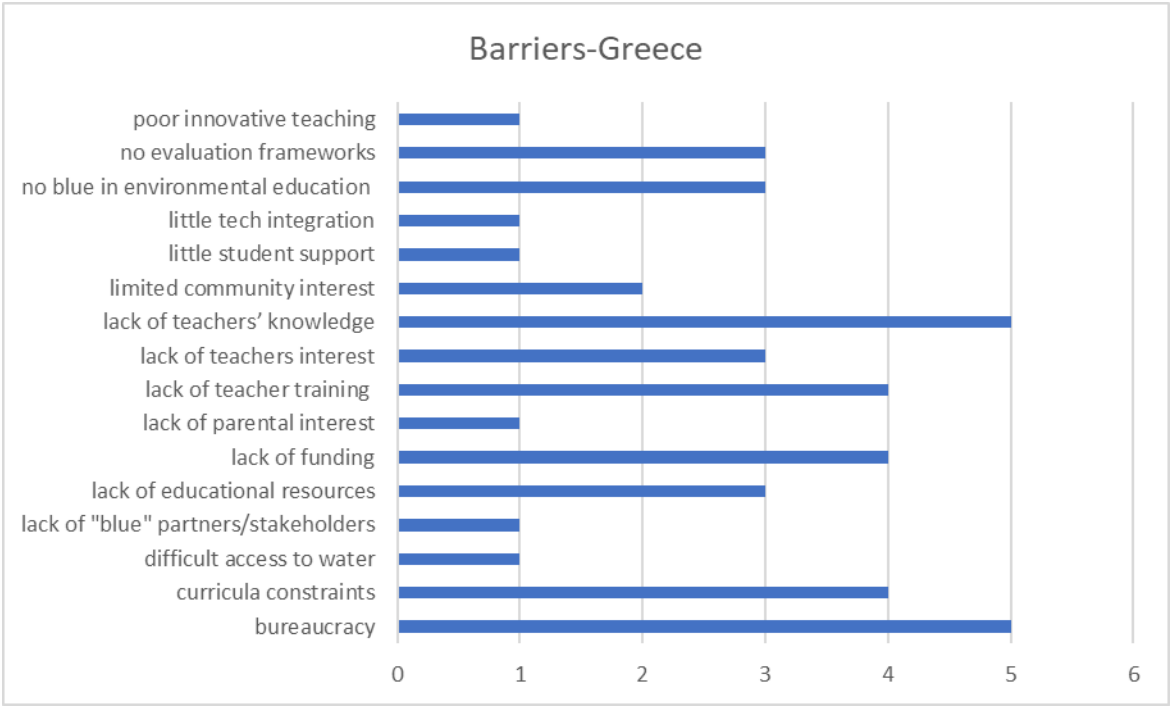

Figure 30. Barriers to develop blue across national educational system of Greece

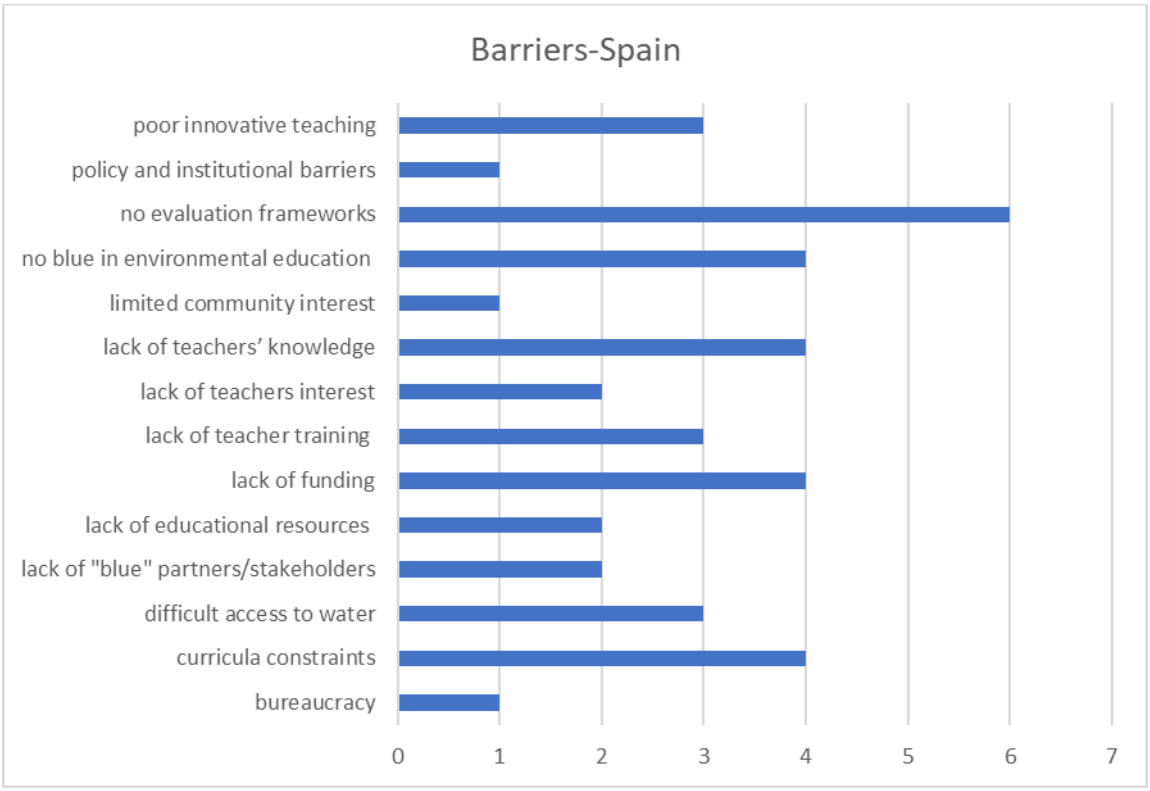

Figure 31. Barriers to develop blue across national educational system of Spain

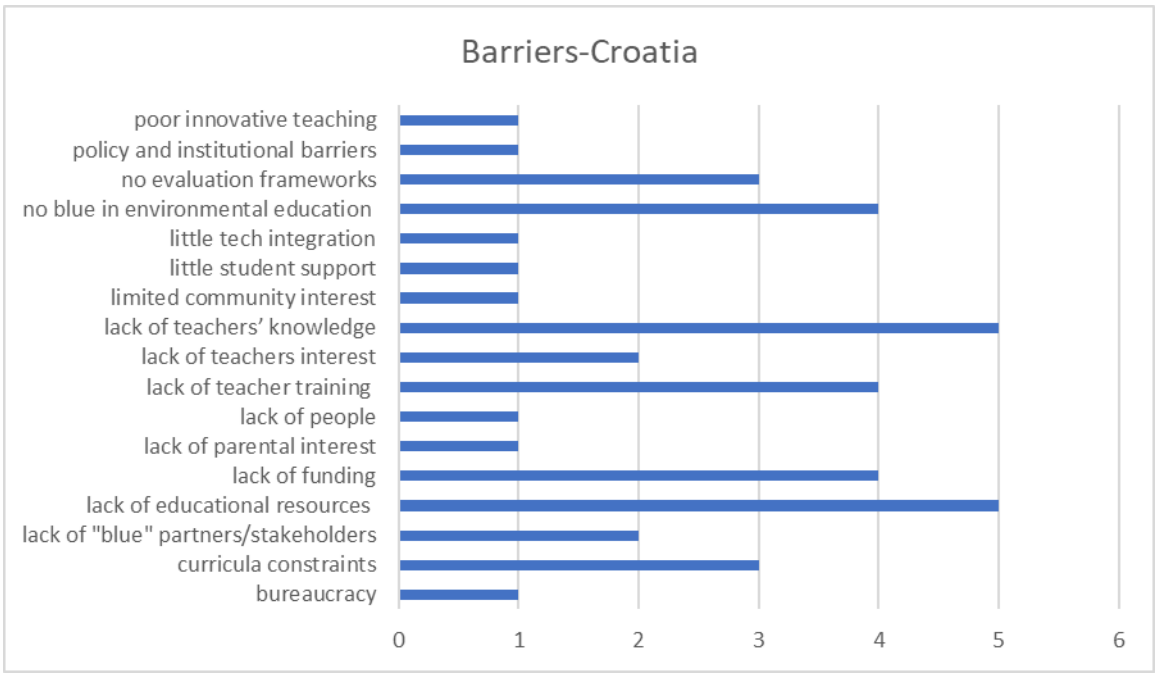

Figure 32. Barriers to develop blue across national educational system of Croatia

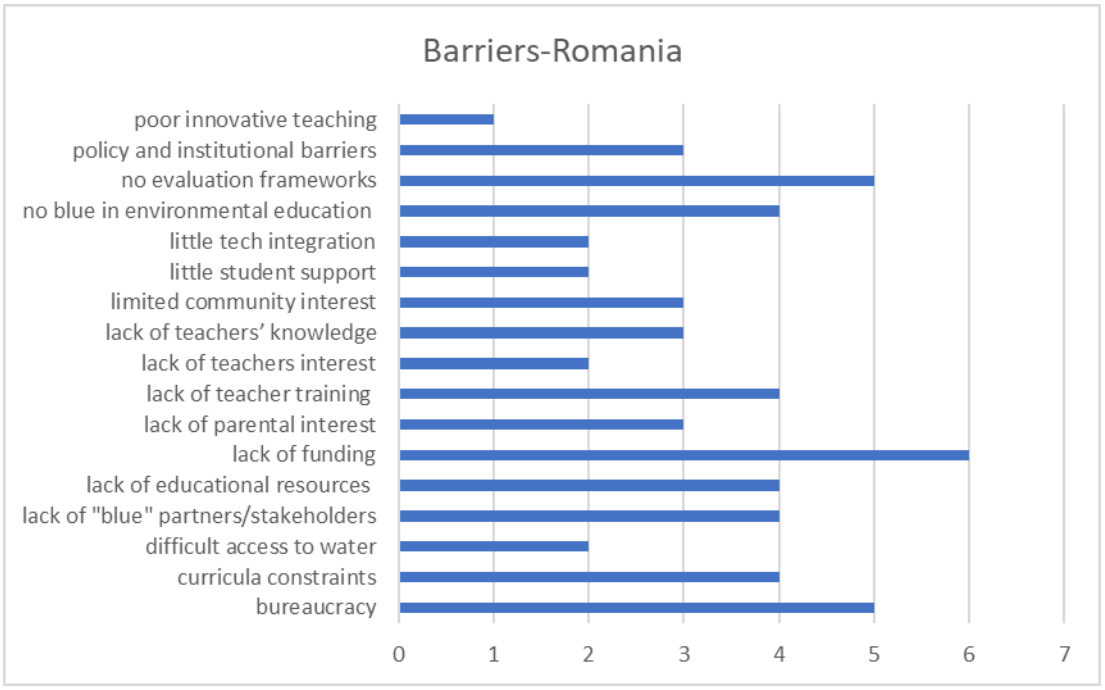

Figure 33. Barriers to develop blue across national educational system of Romania

8.6. Barriers to develop blue across national educational system of experimentation countries (Fauville et al., 2018b)

The barriers to develop blue across national educational system of some of the experimentation countries (Sweden, Ireland, Portugal, Spain, Greek) have been investigated before based on a survey carried out by Fauville et al. (2018b). Structural maps are followed.

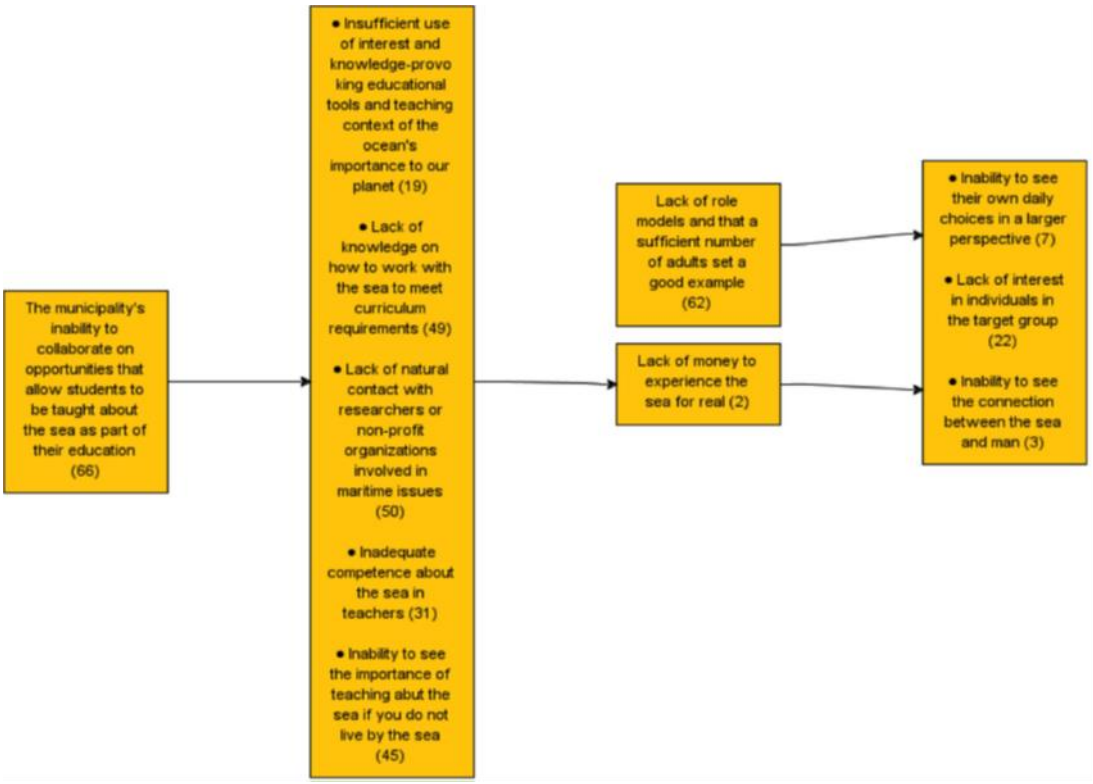

Figure 34. Barriers structural map from the Swedish CI consultation

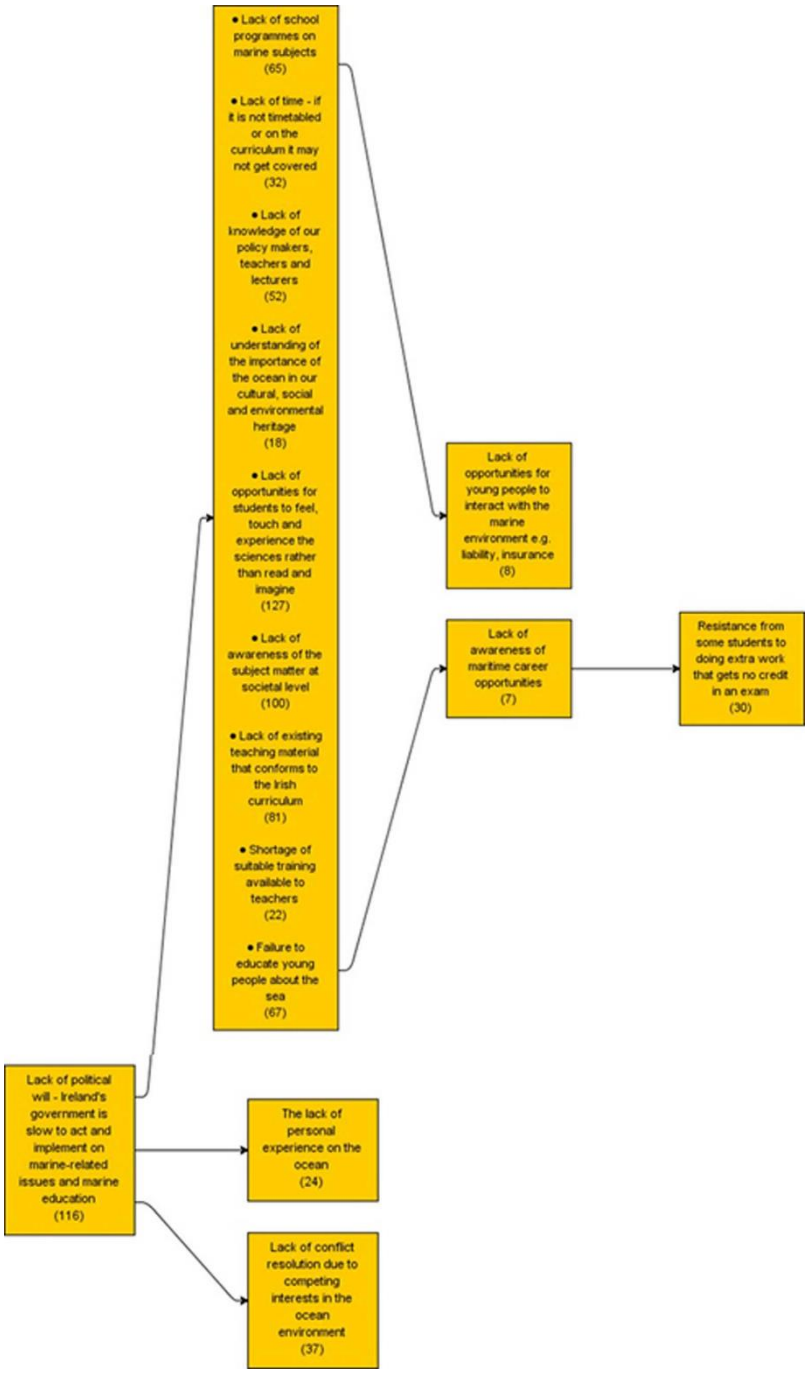

Figure 35. Barriers structural map from the Irish CI consultation

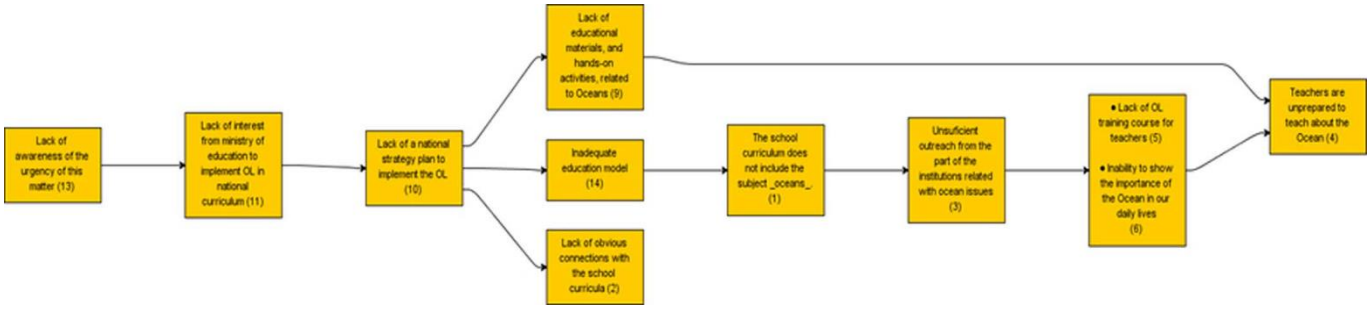

Figure 36. Barriers structural map from the Portuguese CI consultation

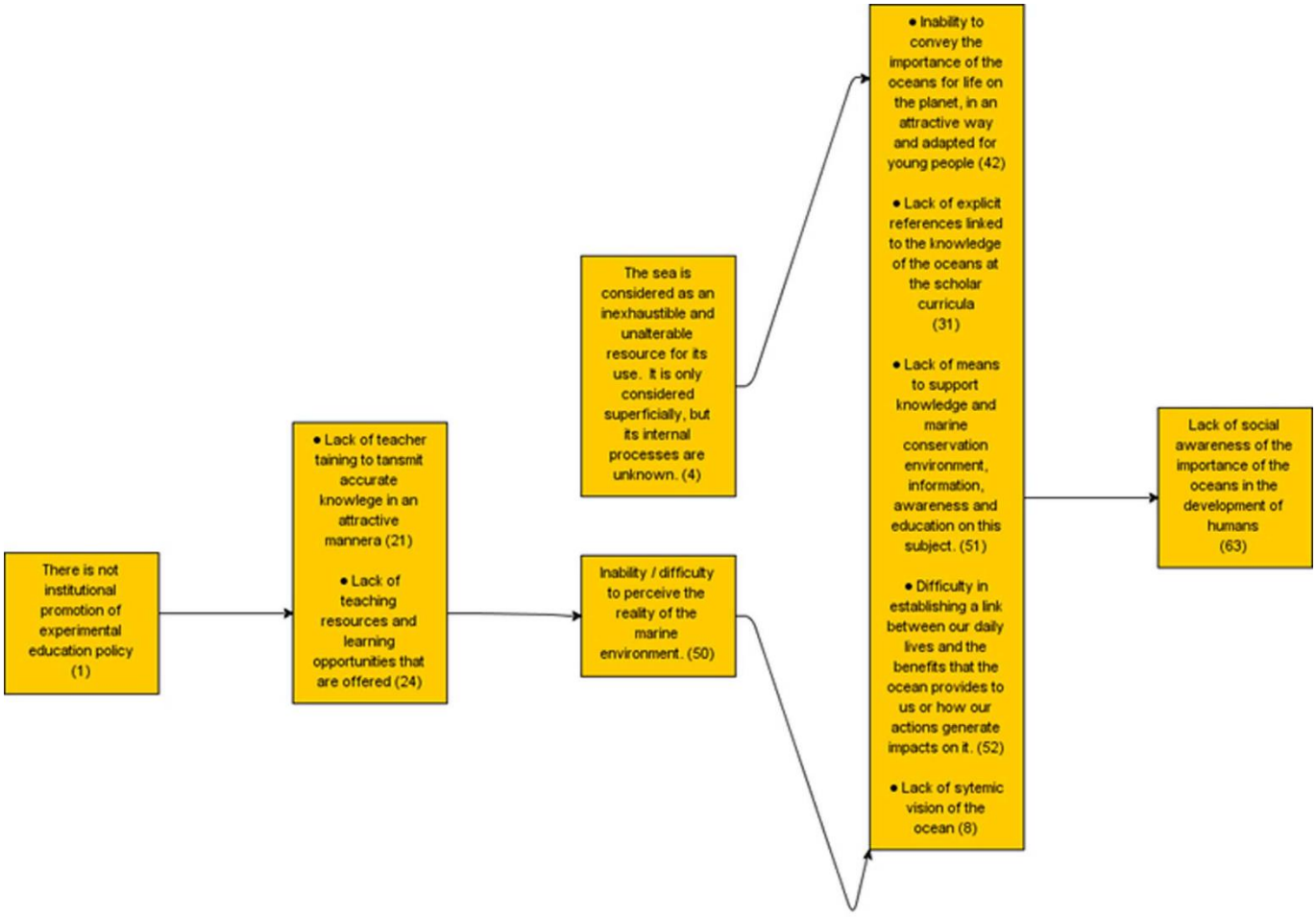

Figure 37. Barriers structural map from the Spanish CI consultation

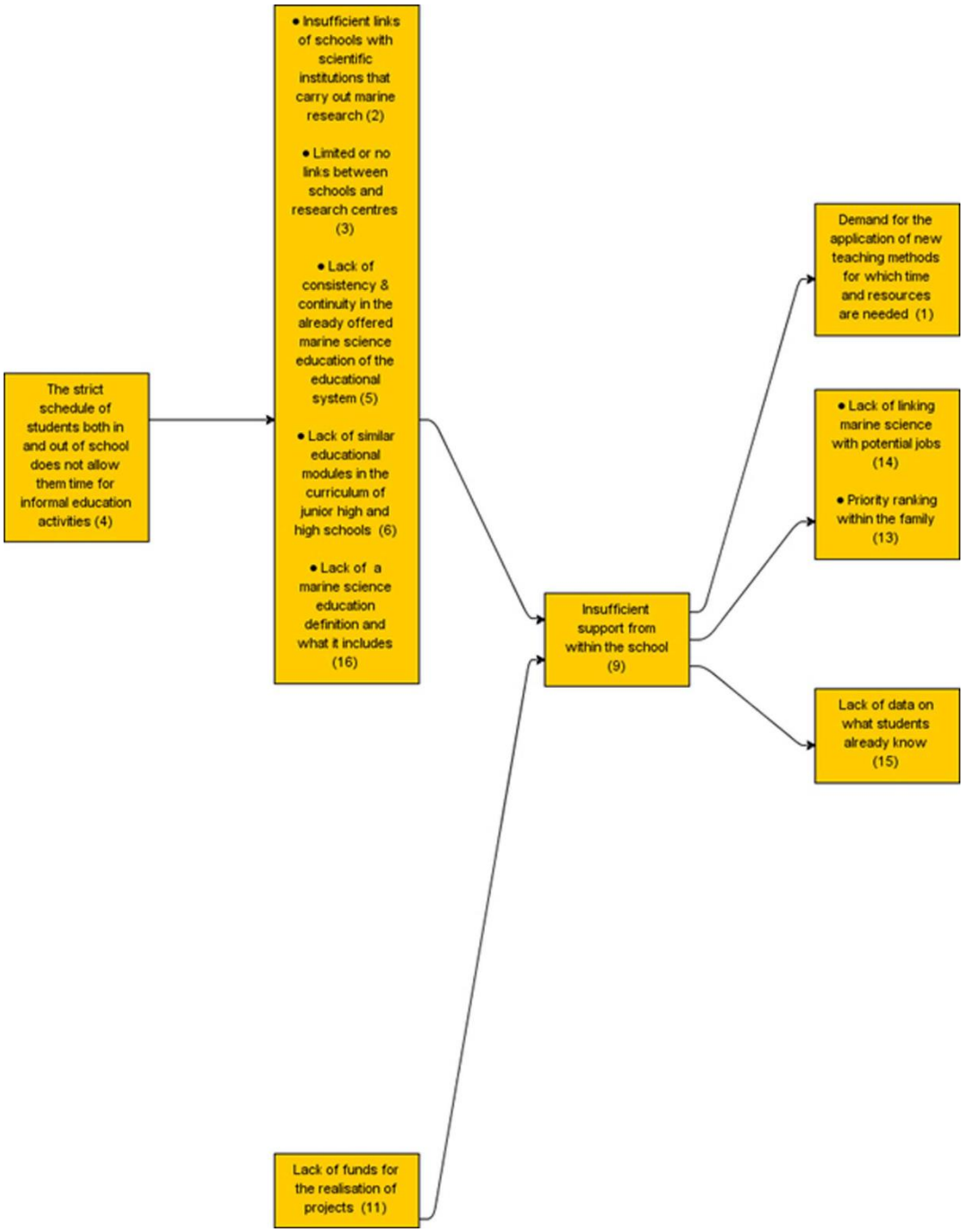

Figure 38. Barriers structural map from the Greek CI consultation