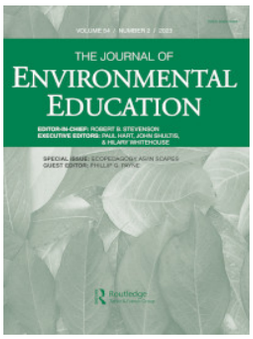

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RESEARCH ARTICLE

Education and the marine environmental issue: A historical review of research fields and the popularization on conservation and management of the sea and ocean in Brazil

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ABSTRACT

Worldwide initiatives have been promoting awareness on marine environmental issues. In Brazil Maritime Mentality Program arises from political disputes over the right to use maritime spaces, Coastal Marine Environmental Education shares the same theoretical basis as Environmental Education and Ocean Literacy appears in the USA and became globally widespread after its inclusion as one goal of Ocean Decade. Based on a literature review this article gives a panorama of the history, working groups, institutional links, theoretical framework and impact of the published material of these three working fields. The conclusion is that the conceptual framework of all three is limited and do not address the deep causes of environmental degradation which is the current social-political-economic system.

KEYWORDS

Ocean Literacy; marine education; environmental politics; review; ocean sciences education

Introduction

Human beings have been linked to the ocean and marine environments for a long time, due to the various essential resources and services they provide, such as the supply of food and raw materials, oxygen production, temperature and climate maintenance, nutrient cycling, protection against coastal hazards, among others (UNEP, 2006). While the importance of marine environments for society has been increasingly highlighted (Arkema et al., 2015; Costanza, 1999; Selig et al., 2019), evidence is accumulating of the negative impact that human activities have produced about them (Korpinen & Andersen, 2016; Lotze et al., 2018). This happens due to the increase in demand for services and resources, both determined by the growth of coastal populations (Sale et al., 2014). Allied to this, the utilitarian perspective (Pedrini et al., 2014) and the idea that marine resources are inexhaustible (Golden et al., 2017), have caused the extinction of habitats, species, and marine communities, putting at risk the life on Earth (Borja et al., 2016).

In Brazil, the country in Latin America with the longest coastline (about 7,500 km), coastal ecosystems present a wide variety of environments (including mangroves, coral reefs, dunes, sandy beaches, rocky shores, lagoons, estuaries, bays, salt marshes), all harboring a great diversity of species, many of which are endemic (Diegues, 1999; Miloslavich et al., 2011). In social and economic terms, the Brazilian coastal region concentrates about 40% of the population (Marroni & Asmus, 2013), 85% of energy consumption, and 93% of industrial production (CEMBRA, 2019). More than 90% of oil and 70% of natural gas are extracted from the sea, and maritime routes are responsible for more than 90% of Brazilian foreign trade (Beirão et al., 2018).

Despite the relevance and threats suffered, some studies have indicated that the world population still has limited knowledge about the ocean. Steel et al. (2005), for example, surveyed the North American population to assess the level of knowledge about oceanic and coastal issues, and their results indicated

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a low level of information on these issues. In Europe, Gelcich et al. (2014) noted that populations in 10 European countries felt only moderately informed about impacts on marine environments. Guest et al. (2015), investigating the knowledge of elementary students in Canada and Chen and Tsai (2016) doing the same with students in higher education in Taiwan, concluded that students value, as well as have positive attitudes, toward marine environments, however, they have a low to moderate level of knowledge about these environments. In Brazil, the situation is no different, in a national survey carried out in 2011 (CEMBRA, 2019), it was pointed out that for Brazilians the importance of the sea is limited to the source of food (67%) and leisure (39%). Still, this research points out that for 93% of respondents, the concern with the preservation of marine ecosystems should not inhibit the economic use of the resources of these environments (CEMBRA, 2019).

This societal knowledge gap has been identified as a factor responsible for human behaviors and actions that increase the degradation of marine ecosystems (Eddy, 2014; McKinley & Fletcher, 2012). An indicated solution to start reversing this scenario is to educate with the goal of raising people's awareness about the functions performed by the ocean and marine environments, as well as their impacts on human well-being, in addition to the way they have been affected by human activities (Heck et al., 2016; Jefferson et al., 2014; Steel et al., 2005). In this sense, some areas of study have been defined with the proposal to expand knowledge about oceanic and marine issues, aiming to engage the population in more environmentally sustainable behaviors regarding these environments. Internationally there are Ocean Literacy, Ocean Citizenship, Marine Mindset, and Coastal Marine Environmental Education.

Ocean Literacy (OL), proposed in the United States, was defined as the influence of humans on the ocean, as well as the influence of the ocean on humans (Ocean Literacy Network, 2020). Ocean Citizenship and Marine Mindset were proposed by UK researchers. Ocean Citizenship brings the notion of individual responsibility for the health of marine environments according to the choices made in their daily lives and how these choices impact these environments (Fletcher & Potts, 2007). Regarding Marine Mindset, Wyles et al. (2013) defined it as a state of mental readiness to deal with marine sustainability issues. Finally, Coastal Marine Environmental Education is an area of study that has been developed in several countries and emerged as a demand caused by the scarcity of environmental education works focused on the marine environment compared to what is produced in the terrestrial environment (Berchez et al., 2007). Of these four areas of study, two, Ocean Citizenship and Marine Mindset, do not seem to have found an echo in Brazil, since a search in large databases of international (Web of Science-WoS and Scopus), and national journals (Scientific Electronic Library Online-SciELO), in the period between 2000 and 2020, no articles published by Brazilian researchers and institutions were found. This search was carried out using terms such as "ocean citizenship", and "marine mindset", as well as their free translations into Portuguese ("*cidadania do oceano*"/"*cidadão oceânico*" and "*mentalidade marinha*").

Coastal Marine Environmental Education (CMEE) is known in Brazil as *Educação Ambiental Costeira Marinha*. Some studies in CMEE have been developed since the late 1990s aiming to understand the perception of negative impacts of human activities on marine environments, and the importance of implementing actions to mitigate these effects (Pedrini, 2010a). More recently, OL has also arrived in Brazil and been officially translated to Portuguese, in 2019, as *Cultura Oceânica*. Apart from these areas of international scope, Brazil has created its area of study to disseminate information about the ocean and marine environments and their conservation, known as Maritime Mentality Program (*Programa de Mentalidade Marítima*-PROMAR). PROMAR was created in 1997 and defines the maritime mentality as the conviction or belief, individual or collective, of the importance of the sea for the Brazilian nation and the development of habits, attitudes, behaviors or willingness to act to use the potential of the sea sustainably (CEMBRA, 2019).

In Brazil, these three areas (CMEE, PROMAR, and OL) have produced and disseminated knowledge and awareness of the importance and sustainable use of the ocean and marine environments. Despite being distinct, these areas have often been worked on and referred to as if they were equivalent. Therefore, this work proposes to make a historical review of CMEE, PROMAR, and OL to enlighten, define, and characterize them, specifying their goals and fields of action. To do so, a historical review of the events that led to the constitution of each of these areas will be carried out and how they have been developing and changing over time. Finally, the main working groups in action and their institutional links will be

identified, as well as in which spaces they have acted. In short, our study aims to provide tools for practical distinction of these areas, facilitating the engagement and work of all those interested in promoting sustainable behavior and actions toward the ocean and marine issues, thus producing a healthy ocean.

Areas in action

Coastal Marine Environmental Education (CMEE)

CMEE history is directly related to that of Environmental Education (EE), and both have their roots in the environmental movement of the 1960s and 1970s (Marrero & Mensah, 2010). The growing interest in the preservation, maintenance, and development of the environment was spurred by the 1972 United Nations Conference on the Human Environment (Stockholm Conference). The document "Declaration of the United Nations Conference on the Human Environment" therein produced recommended the establishment of an international program of environmental education. In 1977, at the First Intergovernmental Conference on Environmental Education (Tbilisi Conference), the goals, characteristics, and strategies of EE were defined, and this theoretical foundation has been used since then, as a basis for studies in CMEE (Marrero & Mensah, 2010).

These international events had repercussions in Brazil. In 1973, the *Secretaria Especial do Meio Ambiente*-SEMA (Special Secretariat for the Environment) was created and, in 1981, the first law was passed that provided for the national environmental policy, its purposes, and mechanisms of formulation and application (Brasil, 1981). In 1987, efforts to include EE in Brazilian education systems began, having been determined by the Ministry of Education in 1991 to include EE in school curricula. In 1996, new guidelines for school curricula came into force, the National Curriculum Parameters, which stated that EE had to be taught in a transversal way to the curricular contents of all subjects. All these efforts culminated, in 1999, with the enactment of the *Política Nacional de Educação Ambiental*-PNEA (National Environmental Education Policy), which characterized EE as an integral, essential and permanent component of national education at all its levels. Furthermore, in 2012, the National Curriculum Guidelines for Environmental Education were approved, which guided the implementation of the PNEA in Brazilian education systems (Resolution CNE-2, 2012). However, after so many efforts to integrate EE into Brazilian school curricula, the most recent curricular orientation in force in Brazil, the *Base Nacional Comum Curricular*-BNCC (National Common Curriculum Base), approved in 2017, neglected EE, which is no longer present in the contents, skills or competencies proposed as guidelines for the country's school curricula (Frizzo & Carvalho, 2018). In the academic field, research in EE in Brazil began in the 1980s, with the first master's thesis on the subject in 1981 and the first doctoral thesis in 1989 (Carvalho et al., 2018).

Since the establishment of EE in the late 1970s, marine environments have gained prominence in environmental movements. While the Declaration of the United Nations Conference on the Human Environment only referred to the need to conserve the marine environment, Agenda 21, a document generated at the United Nations Conference on Environment and Development in 1992 (UNCED; Rio-92), devoted an entire chapter to the marine environment, chapter 17, concerning the protection, rational use, and development of marine environments and their resources. This document points out the marine and coastal environments as essential components for maintaining the conditions of life on Earth, in addition to indicating the need to develop education, awareness, and information programs for the public through the incorporation of these themes into teaching curricula and campaigns of public awareness. In subsequent UNCEDs, the Rio +10 held in 2002 in Johannesburg and the Rio +20 in 2012 in Rio de Janeiro, the marine environment was also highlighted.

Whether in its terrestrial or marine aspect, EE in Brazil has been developed on multiple pedagogical currents. Layrargues and Lima (2014) identified three political-pedagogical macro trends of EE in Brazil: conservationist, pragmatic and critical. The conservationist current, which prevailed at the beginning of the environmental movements, approaches EE from the perspective of raising people's awareness and has a natural and technical orientation. The pragmatic current proposes education for sustainable development and consumption, based on the responsibility of individuals and changes in the way of life to

overcome environmental degradation. In turn, the critical environmental education opposes the conservationist and pragmatic currents by adopting Freirean thinking, including in the environmental debate the understanding that human-nature relationships are mediated by historically constructed sociocultural and class conditions (Freire, 1967, 1987). The work by Sauvé (2010) identified 15 currents of EE, among which are included the three macrotrends described by Layrargues and Lima (2014) for Brazilian EE. According to the PNEA, EE in Brazil adopts the Earth Treaty for Sustainable Societies as a model, which seeks an emancipatory, transformative, holistic, critical, interdisciplinary, permanent and comprehensive EE (Pedrini, 2010a), thus approaching the critical current of EE described by Layrargues and Lima (2014) and Sauvé (2010).

Regarding the literature, the works on EE carried out in the terrestrial environment far exceed those related to CMEE, whether in the international context (Marrero & Mensah, 2010) or national (Berchez et al., 2016). Marrero and Mensah (2010) indicated that the literature published in the United States on CMEE has been sparse, with mostly local and small-scale studies, published mainly as dissertations and theses. Although still reduced, the review carried out by Fortner (2010) for the United States, indicated an increase in the number of authors involved with CMEE, from 47 authors in 1990 to 345 authors in 2010. In Brazil, the first works on CMEE date only from the end of the 1990s (Pedrini, 2010a), and from there on the publications are still concentrated in abstracts presented at congresses, symposia, and other events of the academic community, as well as in the production of monographs, dissertations, and theses (Berchez et al., 2016; Pedrini, 2010a).

Maritime Mentality Program (PROMAR)

While CMEE arises in the context of a concern with the conservation of coastal marine ecosystems, seeking a sustainable interaction between human beings and these environments, PROMAR arises in the context of the defense of the Brazilian maritime space, as well as the exclusive use of its resources, being linked to the international movement for the establishment of the United Nations Convention on the Law of the Sea (UNCLOS). Until the mid-1950s, there were no legally defined rules recognized by most nations for the use of maritime space (Pereira & Pereira, 2014). This absence of a definition that caused a series of conflicts between several countries expanded the world discussion about the need to establish rules for the use and exploration of maritime spaces and culminated, in 1958, in the First Conference on the Law of the Sea and, in 1960, at the second conference, who were not successful in defining regulations for the use of the seas and ocean (Silva, 2012).

This world scenario and the recognition of the potential of the sea stimulated the creation, in 1974, of the *Comissão Interministerial para os Recursos do Mar*-CIRM (Inter-ministerial Commission for the Resources of the Sea), under the responsibility of the Brazilian Navy and whose purpose is to regulate the sea use and coastal region planning in Brazil (Soares, 2014). Eight years after its creation, in 1982, the III Conference on the Law of the Sea took place, in which the UNCLOS, or as it is known as Law of the Sea, was finally created, which only came into force in 1994 and today has the signature of 162 States Parties (Soares, 2014). This law recognizes the maritime area (Exclusive Economic Zone), as well as seabed and maritime subsoil (Continental Platform), to which nations have the right of exclusive use. CIRM played a key role in defining the limits of the Brazilian continental shelf by coordinating the *Levantamento da Plataforma Continental Brasileira*-LEPLAC (Brazilian Continental Shelf Survey Program; Soares, 2014).

Although the importance of the ocean and sea is well established in the Brazilian government and Navy, several publications related to this body state that the common citizen "still does not understand the real dimension of the economic, scientific, environmental, and sovereignty aspects of the sea" (CEMBRA, 2019). Thus, to make society aware of (a) the importance of the sea and its resources for the development of Brazil; (b) the responsibility to exercise rational and sustainable exploitation of these resources; (c) the need to preserve this environment; CIRM created, in 1997, the *Programa de Mentalidade Marítima*-PROMAR (Maritime Mentality Program) with five goals: (1) propose the inclusion of themes related to the sea in the curricula of elementary and secondary education; (2) increase the holding of traveling exhibitions and lectures on maritime matters; (3) expand the distribution of material to publicize

CIRM activities; (4) strengthen ties between the community and the sea through the promotion of oceanographic museums; (5) increase to 2.4 million the estimated number of people reached annually by actions related to developing a maritime mindset. By its aspirations and objectives, it is possible to approach PROMAR to the sustainability current defined by the Sauvé (2010) typology for EE currents. In other words, PROMAR perceives the environment as resources for economic development and aims to promote the country development.

In 2020, with the approval of the *X Plano Setorial para os Recursos do Mar*-PSRM (X Sectoral Plan for Sea Resources), PROMAR underwent an update. Its original acronym was kept but is now being called *Promoção da Mentalidade Marítima* (Promotion of Maritime Mentality). All its goals remained the same, except for the "strengthening of ties between the community and the sea through oceanographic museums", which gave way to "training multipliers in themes of Ocean Literacy and disseminating the best available sea-related activities". PROMAR, therefore, brings as a novelty an approach to the study area of OL.

To achieve the proposed objectives and goals, PROMAR has, since its creation, disseminated content aimed at arousing interest in the ocean and marine environments for a diverse audience. This has been done through its social networks (https://www.facebook.com/promar.secirm), publications of periodicals to publicize activities in the *Amazônia Azul* (Blue Amazon) and Antarctica such as Infocirm (https://www.marinha.mil.br/secirm/promar), as well as books and booklets for teachers and students. In addition to holding lectures and traveling exhibitions.

The maritime mentality was the theoretical basis of projects focused on increasing knowledge and awareness about the seas and ocean, such as the *Projeto Aprendendo com o Mar* (Learning with the Sea Project) of the *Instituto Federal de Santa Catarina* (Federal Institute of Santa Catarina), as well as the work of non-governmental organizations (NGOs), such as that developed at the *Núcleo de Educação e Monitoramento Ambiental* (Environmental Education and Monitoring Center), which developed from 1980 to 2002 the *Projeto Mentalidade Marítima: proposta de educação ambiental para a zona costeira do Rio Grande do Sul* (Maritime Mentality Project: proposal for environmental education for the coastal zone of Rio Grande do Sul; Crivellaro et al., 2001). Still, the maritime mentality appears commonly in journals linked to the Brazilian Navy, such as Revista de Villegagnon and, also, of the Brazilian Army as the *Cadernos de Estudos Estratégicos* (Journal of Strategic Studies, in English). Academic productions, such as monographs and dissertations, present the maritime mentality and PROMAR, as a Brazilian initiative to promote knowledge about the seas and ocean in the general population and basic education, as can be identified, for example, in the monographs by Franco (2015) and Dutra (2018), as well as in the dissertations by Paixão (2011) and Borges (2018).

Ocean Literacy (OL)

The most recent area of study aimed at promoting knowledge and awareness of the ocean is Ocean Literacy, which, in Brazil, has been translated as *Cultura Oceânica*. The history of OL began in 2002, with the online conference Oceans for Life conceived by the North American institution College of Exploration and the National Geographic Society, which started discussions on what content about the ocean should be presented in schools in the United States (Schoedinger et al., 2010). OL then gained strength with the publication, also in the United States, of two reports on the ocean: America's Living Oceans, by the Pew Oceans Commission published in 2003, and the An Ocean Blueprint for the 21st Century published in 2004 by the US Commission on Ocean Policy. These reports highlighted the importance of the ocean in people's daily lives, and concerns about the health of this environment, valuing education as a tool to motivate behaviors that allow maintaining the integrity and sustainable use of the ocean and its resources.

In 2004, the College of Exploration promoted an online workshop, The Ocean Literacy Through Science Standards, with the participation of more than 100 researchers, professors, and other professionals involved with ocean environments, education, and curriculum production (Schoedinger et al., 2010). In this workshop, OL was defined as "the understanding of the influence of the ocean on humans, as well as the influence of humans on the ocean" (Ocean Literacy Network, 2020). It was also discussed what all people should know about the ocean at the end of basic school education, which was summarized in the

seven essential principles, and 44 fundamental concepts of OL, and presented in the document Ocean Literacy the Essential Principles of Ocean Science K-12. Between 2006 and 2009, several events took place throughout the United States with the participation of scientists, educators, and curriculum developers aiming to align the North American science curriculum document with the principles, and concepts of OL to have OL developed continuously, from the initial grades to the last school year. The result of these meetings was the document known as the Ocean Literacy Sequence and Scope for Grade K-12 (Strang et al., 2010). In 2020, the Ocean Literacy the Essential Principles of Ocean Science K-12 document was updated and a new concept was added to the principle four, expanding the fundamental concepts of OL from 44 to 45 (Ocean Literacy Network, 2020).

About 10 years after its beginning in the United States, OL began to spread in several countries and continents, establishing itself through networks, and associations. In 2012, the European Marine Science Educators Association (EMSEA) was created. In 2014 the Canadian Network for Ocean Education (CaNOE) was established and in 2015 the Asia Marine Educators Association (AMEA). The most recent network created to promote OL is the *Rede de Educação Latino Americana para o Oceano*-RELATO (Latin American Education Network for the Ocean), created in 2020.

The international visibility of OL has been growing even more with the adhesion of intergovernmental agencies to this area. In 2015, the UN launched the 2030 Agenda, and the 17 Sustainable Development Goals (SDGs), which brings an SDG dedicated exclusively to the ocean and seas (SDG 14- Conservation and sustainable use of oceans, seas, and marine resources, for sustainable development). Two years later, in 2017, UNESCO, through the Intergovernmental Oceanographic Commission (IOC), launched the platform Ocean Literacy for all and the book, Ocean Literacy for All: a Toolkit (Santoro et al., 2017). Also, in 2017, the Decade of Ocean Science for Sustainable Development (Ocean Decade) was announced for the period 2021-2030. The Ocean Decade aims to bring together all stakeholders in ocean issues to manage the ocean for the benefit of humanity, as well as boost scientific research and development, in search of a productive, resilient, and sustainable ocean, with OL being one of the goals to achieve the goals of the Ocean Decade (United Nations, 2018).

Although well spread across the globe and with an emphasis on intergovernmental actions, OL took a long time to establish itself in Brazil. Two events held in 2019 marked its arrival. The first was the *Conexão Oceano* (Ocean Connection), event held at the Museum of Tomorrow, in Rio de Janeiro, and the second was the *Seminário Cultura Oceânica e os Objetivos de Desenvolvimento Sustentável* (Oceanic Culture and Sustainable Development Goals Seminar) held in the city of Santos, in which the Brazilian translation of Ocean Literacy to *Cultura Oceânica* took place, with the launch of the Portuguese translation of the book Ocean Literacy for All: a Toolkit (*Cultura Oceânica para todos-Kit Pedagógico*). The option to use the word *cultura* ("*culture*") instead of the literal translation of the English word "literacy" that means *letramento* in Portuguese aimed to reflect the idea of connecting society in all its diversity with the ocean, besides encompassing the various forms of knowledge related to the ocean (Worm et al., 2021).

The first publication with OL principles carried out in Brazil and published in a high-impact journal also dates from 2019 (Stefanelli-Silva et al., 2019). Thus, the Brazilian literature on OL is just in its beginning, but the growth of actions for the promotion of OL can be noted, for example, the creation of the web series *Futuro do Oceano* (Future of the Ocean), the development of websites with information on the subject such as the *Cátedra UNESCO para a Sustentabilidade do Oceano* (UNESCO Chair for Ocean Sustainability), as well as educational actions such as the *Maré de Ciência* (Science Tide, in English) and the *Olimpíadas Brasileira do Oceano* (Brazilian Ocean Olympics).

OL international mainstream is in accordance with what in the typology defined by Sauvé (2010) would be the scientific trend which aims to increase the population's knowledge about the ocean and awareness about environmental problems concerning marine environments. With the inclusion of OL in the UN 2030 Agenda and as one of the goals to achieve the aims of the Ocean Decade, OL has been approaching what was characterized by Sauvé (2010) as the sustainability trend in EE. In Brazil, this area of knowledge is still very recent and there are few works published on this theme, all in line with international production. Taking into account the history of Brazilian EE influenced by the precepts of popular education of Paulo Freire (Freire, 1967, 1987), OL in Brazil will probably at some point bring to the debate

of the environmental issue not only the properly scientific issues, but also a historical perspective which includes sociocultural and class relations.

The historical synthesis of the main events constituting PROMAR, CMEE, and OL is outlined in Figure 1, highlighting both the international and national context.

Current context

Updating information

Data referring to the literature published in the three research fields were based mainly on Pedrini (2010a) and Pazoto, Silva, et al., (2021) and updated based on searches performed on Web of Science (WoS) and Scientific Electronic Library Online (SciELO) for indexed articles; Google Scholar for articles written in Portuguese and/or referring to dissemination among teachers and congeners and *Estado da Arte da Pesquisa em Educação Ambiental*- EArte (State of the Art of Research in Environmental Education) which is a bank of for theses and dissertations produced on Environmental Education in Brazil (http://www.earte.net/). The time span considered was from 1980 to 2022, except for EArte which include only the time span from 1981 to 2020. Word and terms used included "maritime mentality", "marine environmental education", "coastal marine environmental education" and "ocean literacy", both in English and in their translation to Portuguese ("mentalidade marítima", "educação ambiental marinha", "educação ambiental marinha costeira" and "cultura oceânica", respectively) searched in title, abstract and keywords.

Panorama

Among the three areas dealing with the conservation and management of the seas and ocean in Brazil (CMEE, PROMAR, and OL), the one with the largest bibliographic production published in indexed scientific articles is CMEE (Pedrini, 2010a; Pazoto, Silva, et al., (2021). Moreover, three books have already been published (Ghilardi-Lopes et al., 2012; Pedrini, 2010b), one of them in English (Ghilardi-Lopes & Berchez, 2019), presenting the state of the art in this area in Brazil. In addition, 49 theses and dissertations on CMEE were found in the EArte database. Based on this production, 229 researchers involved with CMEE could be identified, most of them (79.5%) linked to universities (Table 1) and, most of which

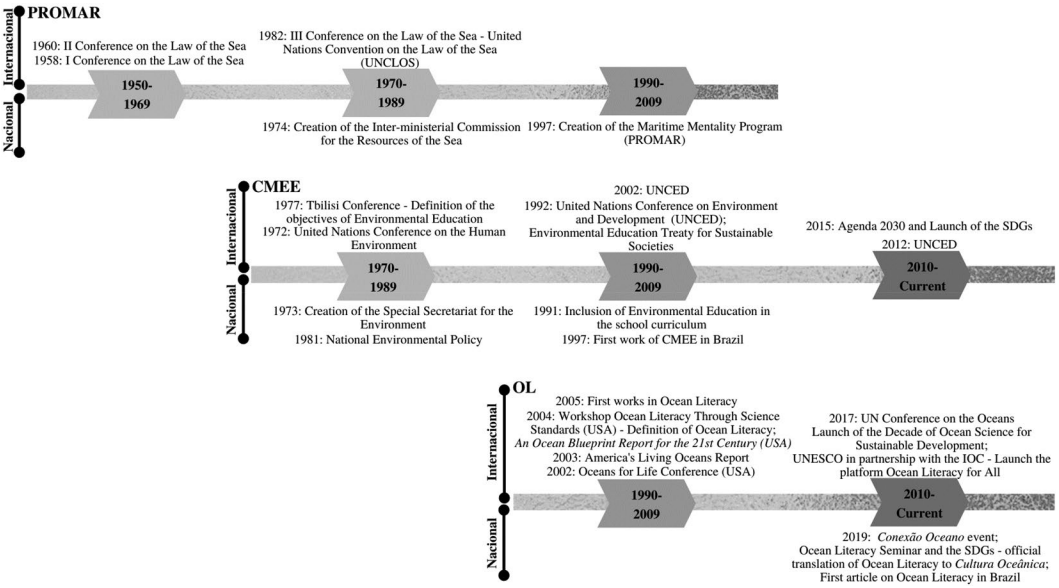

Figure 1. Timeline of the international and national historical events that had led to the development of PROMAR (Brazil Maritime Mentality Program), CMEE (Coastal Marine Environmental Education), and OL (Ocean Literacy).

Table 1. Institutional affiliation, number (N) and percentage (%) of authors involved in CMEE publications.

Institutional Affiliation	N	%
Non-Formal Educacional		
Aquário de Ubatuba-São Paulo (Ubatuba Aquarium-São Paulo)	2	0.9
Jardim Botânico Benjamin Maranhão-Paraíba (Benjamin Maranhão Botanical Garden-Paraíba)	1	0.4
Non-governmental organization	25	10.9
Governamental Agencies		
Brazilian Navy	1	0.4
Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (Brazilian Institute for the Environment and Renewable Natural Resources), *Instituto Chico Mendes de Conservação da Biodiversidade* (Chico Mendes Institute for Biodiversity Conservation), *Instituto de Pesca* (Fisheries Institute), *Instituto Florestal* (Forestry Institute), and *Ministério do Meio Ambiente* (Ministry of the Environment)	10	4.4
Formal Educational Institutions		
Instituto Federal de Santa Catarina-Campus Itajaí (Federal Institute of Santa Catarina- Campus Itajaí) and Instituto Federal do Espírito Santo (Federal Institute of Espiríto Santo)	5	2.2
Primary and secondary education	2	0.9
Universities	182	79.5
Public	166	72.5
Private	16	7.0
Intergovernmental Body (UNESCO)	1	0.4
Total	**229**	**100**

Data are based on Pedrini (2010a) and Pazoto, Silva, et al., (2021) and updated based on searches performed on Web of Science, SciELO, Google Scholar, and database of EArte.

originated in the Southeast (Figure 2). Although the number of researchers involved with CMEE is not small, most of them published only one work, which indicates a weakness of research groups in the area. Based on the continuity of production, three well-established research groups could be identified, namely: the *Laboratório de Algas Marinhas na Universidade de São Paulo* (Laboratory of Marine Algae at the University of São Paulo), which is coordinated by Professor Flávio Augusto de Souza Berchez, with publications in CMEE since 2005; the *Laboratório de Ficologia e Educação Ambiental da Universidade do Estado do Rio de Janeiro* (Laboratory of Phycology and Environmental Education at the University of the State of Rio de Janeiro), which is coordinated by Professor Alexandre de Gusmão Pedrini, with works published from 2007 onwards; and the research group by the researcher Natália Pirani Ghilardi-Lopes of the *Centro de Ciências Naturais e Humanas da Universidade Federal do ABC* (Center for Natural and Human Sciences of the Federal University of ABC), in activity since 2010.

Regarding the academic production of dissertations and theses, the CMEE is also better represented than the areas of PROMAR and OL. The search in the EArte retrieved 49 documents from which 42 were produced in public institutions (universities and federal educational institutes) and only 7 from private educational institutions. The majority of these theses (47) were from northeast, southeast and south of Brazil. From the already established research groups only that leading by Natália Pirani Ghilardi-Lopes is registered in the EArte database. A small fraction of the dissertations and theses database (0.8% from a total of 6142 documents) corresponds to research carried out in marine and/or coastal environments and efforts will likely wither even further as a result of policies put forward by the government elected in 2018 which weakened the *Política Nacional de Educação Ambiental*-PNEA (National Environmental Education Policy) both in the administrative spheres and in the non-democratic mode of public management, even suspending the PNEA advisory committee (Layrargues, 2020).

PROMAR, on the other hand, has no indexed scientific production (Pazoto, Silva, et al., 2021), or any thesis or dissertation on it in EArte. Articles referring to the area being found only in searches carried out on Google Scholar and, generally, associated with journals linked to the Brazilian Armed Forces (Figure 3). In this sense, representative research groups could not be found since more than 50% of the 22 authors of the nine publications retrieved in the search are not linked to research and/or teaching institutions (Figure 4). Corroborating Martins (2011), who stated that "the Navy is the major driver of

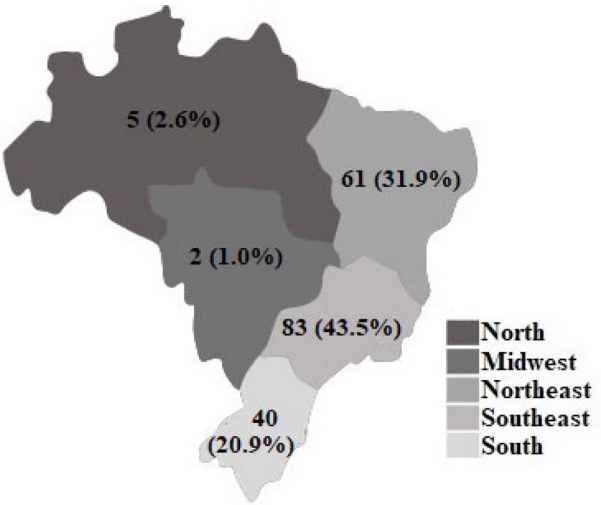

Figure 2. Map of Brazil with the number and percentage of researchers involved in bibliographic production on CMEE per Brazilian geographic region. Data are based on Pedrini (2010a) and Pazoto, Silva, et al., 2021 and updated based on searches performed on Web of Science, SciELO, Google Scholar, and database of EArte.

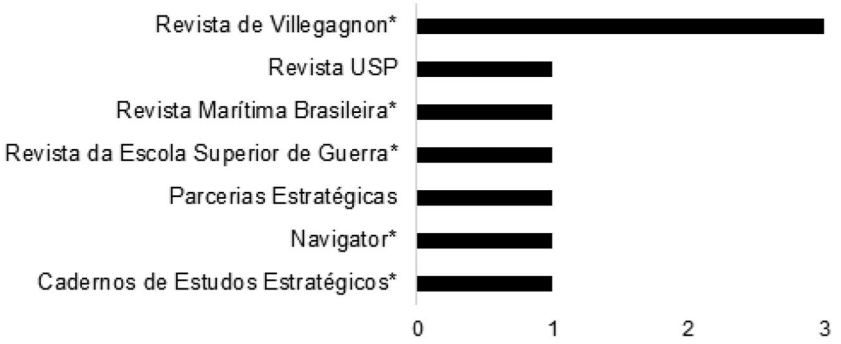

Figure 3. Scientific journals and number of publications in the field of PROMAR. *Periodicals related to the Brazilian Armed Forces.

maritime mentality in Brazil", all PROMAR teaching materials for students and educators are produced and made available with the support of the CIRM, which is a body linked to the Brazilian Navy.

The literature review carried out by Pazoto, Silva, et al. (2021) indicates that the first scientific production in the field of OL in Brazil dates from 2019 (Stefanelli-Silva et al., 2019) and summing up to that only three more articles (Pazoto et al., 2022; Kasten et al., 2021; Worm et al., 2021) were produced to date. In addition to these articles, a Google Scholar search shows the existence of production in national (Mauricio et al., 2021; Pazoto, Duarte, et al., 2021; Barata, 2021; Barradas, 2020; Pontes & Silva, 2021), and international journals (Motokane et al., 2021), aimed at scientific dissemination, and updating basic education teachers. The search done in EArte was not able to recover any document referring to "cultura oceânica". Even taken together, production in OL is still lower than those in CMEE, which probably reflects the recent arrival of this study area in the country. However, it is possible to infer a greater internationalization of OL studies, given that most articles were published in English and with international collaborations. The number of Brazilian authors in OL is still small and, similarly to what was observed for CMEE, most of them are linked to research and/or teaching institutions in the southeastern region of Brazil (Figure 5). The link between OL and academia is already expected since this field of research emerged from the efforts of researchers and educators to expand the inclusion of ocean-related content into formal education school curricula (Schoedinger et al., 2010).

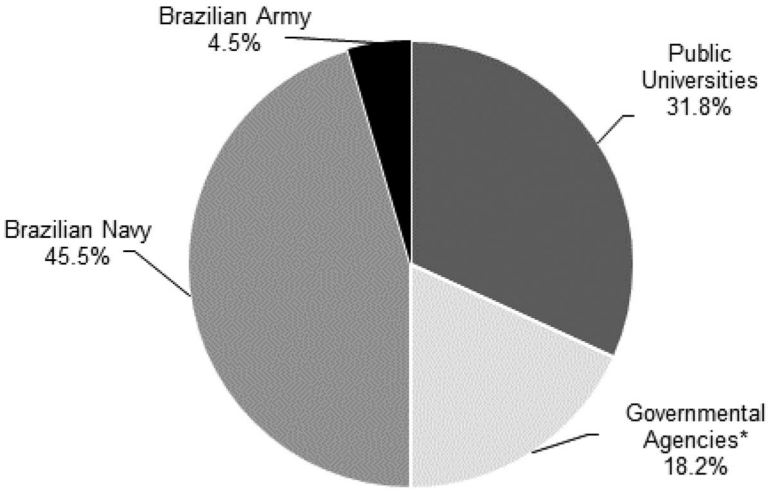

Figure 4. Institutional links and percentage of authors involved in publications in the area of PROMAR. *Representing the following bodies: *Arquivo Público de Pernambuco* (Public Archives of Pernambuco), *Instituto de Pesquisa Econômica Aplicada e Instituto do Patrimônio Histórico e Artístico Nacional* (Institute of Applied Economic Research and Institute of National Historical and Artistic Heritage).

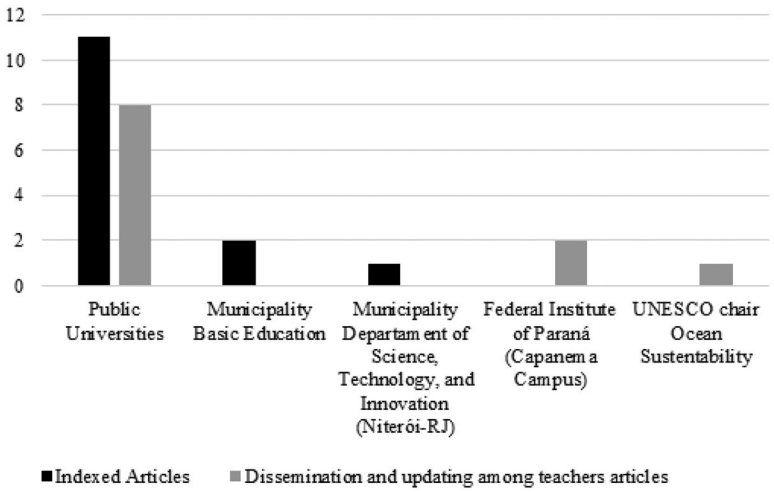

Figure 5. Number of authors involved in OL publications concerning institutional affiliation. Indexed articles: obtained from searches carried out in Web of Science and SciELO; dissemination and updating among teachers articles: obtained from searches carried out on Google Scholar.

Final considerations

Based on the historical review and current context of each of the three areas of study dedicated to the conservation and popularization of the ocean and marine environments in Brazil, theoretical and practical distinctions and similarities can be established among PROMAR, CMEE, and OL.

PROMAR is an initiative restricted to Brazil that arises from political disputes over the right to use maritime spaces, and it has always aimed to define and subsequently expand the country's jurisdictional waters (Caroli, 2010). The foundation of PROMAR is to establish the strategic importance of the marine environment for national defense and security, as well as understanding the maritime space as an important expression of National Power (Lopes et al., 2014). In this sense, PROMAR develops educational activities in schools and non-formal education spaces (Martins, 2011). With the same intent, the term

Amazônia Azul (Blue Amazon) is used to designate maritime space, making an analogy to the riches and dimensions of the Amazon (Caroli, 2010).

Conversely, CMEE is a global initiative deeply related to EE, which, in turn, has its roots in the environmental movements that started in the 1960s (Marrero & Mensah, 2010). Whilst environmental movements developed among different sectors of society and intertwined environmental issues with social, economic, and political issues for social transformation, EE redirected discussions toward solutions focused on changing the behavior and attitude of citizens toward the environment (Silva & Andrade, 2012). It became institutionalized and quickly acquired strong links with the academic sector. CMEE, which focuses on environmental issues related to coastal-marine environments, has the same theoretical basis as EE, which is marked by its transdisciplinary character. In other words, it crosses several disciplines, extends to people of all ages, promotes actions aimed at formal, non-formal, and informal education and, thus, has actions based fundamentally, although not exclusively, on the work of NGOs (Pedrini et al., 2019).

In turn, OL, which appears locally in the USA, has become more widespread globally, especially after its inclusion as one of the objectives to achieve the goals of the UN Decade of Ocean Science for Sustainable Development (United Nations, 2018). Even so, it still develops mainly in the United States and countries in Western Europe (Costa & Caldeira, 2018; Pazoto, Silva, et al., 2021). The initial focus of OL on restructuring formal education school curricula remains present in OL works and has been influencing public educational policies in the USA (Strang et al., 2010), Europe (Mokos et al., 2020), and even in Brazil, having been included in 2022 in the school curriculum of municipal schools in the city of Santos, in the state of São Paulo (Santos, 2021). In places where it has been established for a longer time, OL has influence not only in the educational field, but also in the definition of marine public policies, as in Europe (French et al., 2015), and in new sectors of the economy, such as the so-called Blue Economy (Paredes-Coral et al., 2021). In addition, both in Brazil and in other countries, OL radiates in nonacademic spaces but is aimed at scientific dissemination, from artistic movements (Dupont, 2017; Michalowska, 2020), social media (Kopke et al., 2019), blogs, and programs such as podcasts, and YouTube channels (Barata, 2021).

An approximation between PROMAR and OL can be observed, with the incorporating of the goal of "training multipliers in OL themes and disseminating the best available practices related to sea activities" into PROMAR. This approach is related to government bodies such as the Ministry of Science, Technology, and Innovation (from the *Programa Ciência no Mar* - Science on the Sea Program- https://decada.cienciamamar.mctic.gov.br/sobre-a-decada/), and the Navy of Brazil (involved in implementing the Ocean Decade). Similar approaches have also taken place between CMEE and OL (Ghilardi-Lopes et al., 2019; Santos et al., 2018; Stefanelli-Silva et al., 2019). In common, all three areas propose the overcoming of environmental problems and the spread of knowledge and information to citizens regarding marine environments. The premise is always that knowledge leads to a change in the habits of citizens toward more environmentally sustainable behaviors. However, the belief that knowledge alone can generate a new attitude toward the environment is a typical Enlightenment conviction. Furthermore, the marine environmental issue has causal links as background, and interventions and problem-solving depend on the understanding of the relationships that several groups and governments maintain with nature, and for what purposes (Loureiro, 2012). In this sense, the transformation of these relationships seems to depend a lot on a society mobilized to defend common interests to the detriment of private appropriation of the environment. Hereupon, it is important to note that parallel to these three initiatives (CMEE, PROMAR, OL) there are others such as (a) those related to the religion and spirituality in Afro-Brazilian cults; (b) engagement and organization of traditional communities linked to the sea such as "*jangadeiros*" and "*caiçaras*"; (c) some feminist movements as "*Liga das Mulheres pelo Oceano*" (League of Women by the Ocean, https://www.mulherespelosoceanos.com.br/); (d) political projects in municipalities (Projeto Orla- Beachfront Project, Ministério da Economia, 2022) among others which were not addressed here due to the scope of this review (research and popularization of the conservation and management of the seas and ocean).

In summary, as PROMAR, CMEE, and OL have acted in research and popularization of the conservation and management of the seas and ocean in Brazil, their conceptual framework seems to be limited

to addressing the deep causes of environmental degradation, that is, the current social-political-economic system.

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The authors report there are no competing interests to declare.

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