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# Middle school students' perception of marine and coastal environments

Grace V. B. C. L. Alves <sup>a</sup>, Renata Aparecida Alitto <sup>b</sup>, Thiago Antunes-Souza <sup>a</sup>  
and Simone A. A. Martorano <sup>a</sup>

<sup>a</sup>Programa de Pós-Graduação em Ensino de Ciências e Matemática, Universidade Federal de São Paulo, Diadema, São Paulo, Brasil; <sup>b</sup>Faculdade de Educação, Universidade de São Paulo, São Paulo, Brasil

## ABSTRACT

The marine environment has undergone transformations and degradations that are, in many cases, irreversible. Knowing and valuing this environment is the first step in the conservation process. We aimed to analyse the initial perception of Brazilian students from secondary school level about marine environments and their relationship with their daily lives. The instrument used to collect data was a questionnaire with three open questions. The answers were grouped by similarity, and then by categories. Most students were unable to relate their daily lives to the marine environment, with the most cited justification being the physical distance from the sea. When asked about their knowledge, most students mentioned subjects related to geography, while only a few cited ocean biodiversity. Another notable aspect was the prevalence of an anthropocentric worldview, in which the environment is seen as a collection of natural resources that are available for human use. To reverse this scenario, we advocate teaching practices through Environmental Education to expand students' knowledge about marine ecosystems, their preservation, and their impact on people's quality of life, even for those who live far from coastal areas.

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## Introduction

Within the various definitions for environmental education, we take as our starting point the first article of Law No. 9.795, of 7 April 1999, which deals with the subject and establishes the National Policy for Environmental Education in Brazil:

Environmental education is understood as the processes by which the individual and the community build social values, knowledge, skills, attitudes, and competencies aimed at the conservation of the environment, which is an asset for common use by the people being essential to a healthy quality of life and its sustainability. (Brasil 1999)

In line with this perspective, we also engage in dialogue with the Education for Sustainable Development movement, which has been led by UNESCO since 1992. In the current Agenda 2030, approved by the UN General Assembly in 2015, this movement advocates for the promotion of educational systems that prioritise training centred on environmental integrity. This approach is combined with the economic development of a just society for both present and future generations (Rieckmann 2017).

## ***Seas and oceans and their relationship with science education***

Throughout history and to this day, the oceans and seas are considered vital for trade, transportation, energy generation, wealth, and food. The oceans contain 97% of the planet's water and represent three-quarters of the Earth's surface (NOAA, 2023). More than 3 billion people depend on the seas and oceans for their livelihood. According to data from the 2010 Census of the Brazilian Institute of Geography and Statistics, 26.6% of the population lives in coastal zone municipalities, which is equivalent to 50.7 million Brazilians (IBGE 2011).

However, estimating the potential value of these resources is difficult, since there are millions of unidentified marine species and approximately 300,000 known species (Appeltans et al. 2012). For example, species of marine algae perform (El Gamal 2010) numerous biological functions, including the absorption of atmospheric carbon dioxide produced by greenhouse gas emissions. These emissions have led to the acidification of seas and oceans as well as a rise in global temperature, which are the main adverse effects (Behrenfeld 2011; Ragazzola et al. 2012).

These same species that help regulate the planet's climate participate in the trophic chain that feeds billions of people who depend solely and exclusively on the oceans. Indirectly, fishing employs and provides food for the world's population. However, when practised unsustainably, it contributes to the depletion of many fish species, and hinders the organised and sustainable management of global fisheries, leading to immeasurable social, environmental, and economic losses. It is estimated that up to 40% of the oceans are affected by human activities, such as pollution, fisheries depletion, and loss of coastal habitats (Valdés and Martha 2017). Besides illegal fishing, other threats to the biodiversity of the coastal zone directly or indirectly result from human occupation and demographic expansion. These include the overexploitation for consumption and/or commerce of ornamental fish, habitat degradation and/or de-characterisation, introduction of exotic species, uncontrolled tourism, maritime traffic, and pollution (Amaral and Jablonski 2005; Faria and Dal Maso Jardim 2012).

Considering such effects on the oceans by human action, we argue that knowing and valuing this environment is the first step towards the preservation and conservation process. Environmental Education plays a strategic role in promoting public and general awareness. This awareness enables students to make informed decisions regarding the sustainable use and protection of ocean and sea resources and biodiversity (Barradas 2020; Ghilardi-Lopes, Kremer, and Barradas 2019).

The present study, which is part of the thematic project 'The BIOTA-FAPESP Program in basic education: possibilities of curriculum integration (grant number 2016/05843-4)', aims to contribute to the expansion of knowledge on the conservation of the marine environment and its biodiversity in science education.

In this context, the careful management of oceans and the sustainable development of populations are intrinsically linked to the construction of understanding that addresses the relationship between seas, oceans, and people's quality of life. This understanding is facilitated through an educational process that incorporates this subject into its curriculum in social, political, economic, and cultural terms.

On this aspect, the City of São Paulo Curriculum relates its learning objectives to the 17 Sustainable Development Goals (SDGs). The integration of the City Curriculum with the SDGs occurs both through thematic choices of subjects that can be worked on in the classroom in the various curricular components, and in the choice of teaching methodologies that prioritise a comprehensive education, in line with UNESCO's Education for Sustainable Development (ESD) proposal.

ESD brings a cognitive, socioemotional, and behavioural approach and seeks to foster competencies for citizens to act responsibly to deal with the challenges of the 21st century. ESD ultimately offers the systemic perception and anticipatory capacity necessary for the very nature of the SDGs to be integrated, indivisible, and interdependent (São Paulo 2019).

The present study is part of a larger research project that aims to contribute to the expansion of knowledge about the perception of middle school students regarding the marine environment. In this text, we aim to analyse the initial perception of middle school students, from two schools in the state of São Paulo, about the marine environment and its relationship with their daily lives.

Hence, we will present the results found from the administration of data collected (an open-ended questionnaire with three questions) from 299 students in eight middle school classes in two Brazilian schools in the state of São Paulo.

## Methods

This qualitative research study sought to identify the perception of 299 students, aged between 11 and 16 years, and regularly enrolled in 7th, 8th, and 9th grades in two Brazilian public schools; the Professora Philo Gonçalves dos Santos Municipal Elementary School, located in the city of São Paulo, in the Perus neighbourhood, and the Maria Catharina Comino State School, located in the city of Taboão da Serra, in the state of São Paulo. It is important to highlight that both schools are located, approximately, 100 km away from the coast.

This study follows the qualitative methodology because it is an investigation of phenomena involving human beings and their social relationships, making all perceptions relevant, and can be studied through various ways and angles (Lüdke and Eliza Dalmazo Afonso André 1986, 2013).

The data collection took place *online* (google forms platform). To respect the ethical aspects of the research, permission was requested from the school, parents, and students. The grant number of the ethics and research committee is *CAAE 29,439,120.30000.5505*.

The administered questionnaire contains three open questions: 1) When thinking about the seas and oceans, what are the first six words that come to your mind?; 2) Is there any relationship between your daily life and the seas and oceans? Justify; and 3) What did you learn in your school about seas and oceans?

The students' answers were analysed according to Wachelke and Wolter (2011), considering each questionnaire as a document to identify the students' perception of the questions related to the marine and coastal environment. Thus, the answered questionnaires went through content analysis, grouping answers (particularly the questions 2 and 3) by semantic criteria, and classifying them according to a common meaning (Bardin 2011).

The first question of the survey instrument, which aimed to identify the students' perception of the sea and oceans, was developed using the Free Word Association (FWA) technique (Martorano, Bruna Carneiro Aragão, and Arroio 2022). The data were analysed with the help of freely licenced textual analysis computer *software* (EVOCATION\_2005<sup>®</sup>) to ascertain the frequency of the words evoked by the students in response to this question.

Among the various possibilities offered by the programme for analysing textual material, we used the Word Cloud (WC), since it illustrates the *corpus* by graphically grouping words according to their frequency (f). Such a classification is guided by the definitions of Oliveira et al. (2020) (15): 'In reading the information, the size of the word and its proximity to the others are considered, so that the larger the word, the more expressive it is in the *corpus*, and the closer they are, the more connected they are'.

However, we emphasise that rather than conducting a purely descriptive analysis involving a static arrangement of words, we relied on Oliveira et al. (2020) to construct interpretations that shed light on evidence and perspectives derived from the presented content and the reasons for connections between the constituent words of the cloud.

In other words, we aim to understand the relationship that may exist between these students and the seas and oceans, as well as the knowledge they have acquired about them at school. Those were the objectives of the other two questions. The students' answers to these questions were analysed by the content analysis methodology (Bardin 2011), allowing the construction of representative categories of the students' knowledge of marine biodiversity and the meaning of this categorisation.

## Results and discussion

Supported by the assumptions of data analysis and construction explained earlier, we present below the interpretation of 299 students' answers about marine and coastal environments.

Regarding the first question (When thinking about seas and oceans, what are the first six words that come to your mind?), the Word Cloud (Figure 1) shows the words that were evoked most frequently by the students. These words were the most repeated when students thought about the seas and oceans.

Out of the 13 words most frequently evoked by students, only four are biotic elements: fish, shark, whales, and marine animals. Among these, fish appears first and most frequently ( $f = 150$ ), followed by sharks ( $f = 66$ ), whales ( $f = 34$ ), and marine animals ( $f = 23$ ). Among the abiotic elements, the four most frequent words are water ( $f = 114$ ), beach ( $f = 63$ ), boat ( $f = 47$ ), and waves ( $f = 39$ ) (Figure 1).

The fact that 'fish' is the word most frequently evoked by the students may be a consequence of the use of textbooks that portray this word more recurrently. All public school students have access to the same textbooks offered to schools as part of the National Textbook Program (*Programa Nacional do Livro Didático* in Portuguese). These books were analysed by Calegari et al. (2021) in which the authors characterise, through basic statistics and qualitative interpretation, how biodiversity is approached in a collection of textbooks for the final years of elementary school. The authors concluded that 'fish' is the fourth most mentioned living being in the analysed book collection with 9.68% of 527 mentions. The other three most mentioned living things are mammals (25.43%), arthropods (18.98%), and birds (15.94%). According to the authors, exclusive marine groups, such as cnidarians, echinoderms, and porifera are mentioned less frequently, at 3.8%, 2.09%, and 0.19%, respectively.

Even though Brazil is a country known for having an extensive coastal area (7,941 kilometres), the students' answers reveal the existence of a considerable distance to this environment. In line with question 1, the analysis of the second question gives us an insight into the students' perception of the marine environment. A total of 61% of students do not establish a relationship between their daily lives and the seas and oceans. Katon et al. (2013) asked this same question to students from a school in Ribeirão Preto (a city in the state of São Paulo and 500 km away from the coast). According to the authors, only 15% of the students know the relationship between seas and oceans and their daily lives; the rest showed a romanticised perception related to the peace and tranquillity transmitted by the sea.



Figure 1. Word cloud produced from the students' answers in question 1 (when thinking about the seas and oceans, what are the first six words that come to your mind?).

This last aspect identified by Katon et al. (2013) is confirmed in the answers we analysed, since the word ‘peace’, for example, appears in the word cloud. We could see that 15% of the students responded by making comparisons between the sea and feelings, memories, and beauty, showing a romantic vision. In this context, perceptions of the environment as ‘Mother Nature’ are manifested, and it is viewed as harmonious and balanced, always interpreted as a place of aesthetic beauty (Bezerra and Aparecida Cajueiro Gonçalves 2007; Rodrigues and Malafaia 2009).

Regarding the justifications for answering ‘no’ (2nd question), the majority (60.8%) of students do not understand the relationship between the seas and oceans and their daily lives because they live in cities without a coastline. This disconnect can be explained by the fact that the students live far from the coast and have only sporadic contact with the marine environment (Towata et al. 2013).

By contrast, in the reasons for answering ‘yes’ (2nd question), most students (56%) portray obtaining food and other resources as a justification to exemplify the relationship between seas and oceans and their daily lives (Figure 2).

According to Jefferson et al. (2014), we can consider that this is an anthropocentric and utilitarian view brought by the students, which considers the environment/nature as a source of resources to be used and managed by man. Still, the sea is seen as something ‘distant’ by many people, along with the benefits (especially in their quality of life and well-being) and the impacts related to it (Bombana et al. 2021).

When analysing student responses according to their grade levels (7th, 8th, and 9th grades), we noticed a slight difference between them. Students from 9th grade make more climate-related justifications than 8th and 9th grade students. This may be because in the 9th grade there is greater focus on climate-related issues in their textbooks.

Interestingly, a small number of students (5%) responded that the marine environment is threatened due to increased pollution. This comprehensive view can be considered globalising, attributing to humans the responsibility for threats to the marine environment, positioning people in relation to other elements without dominance, and encompassing social, natural, political, economic, philosophical, and cultural aspects.

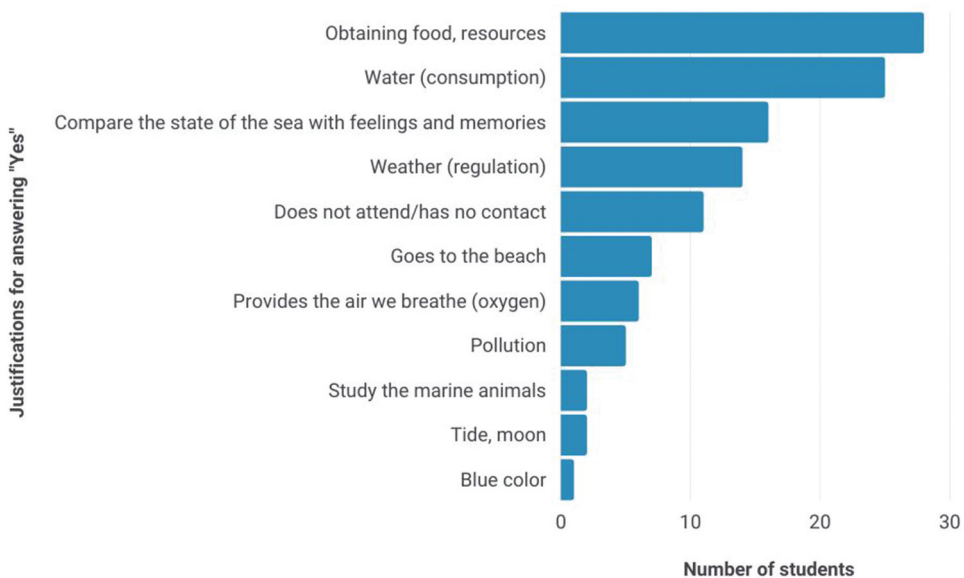


Figure 2. Justifications for answering yes on the 2nd question (is there a relationship between your daily life and the seas and oceans?). The answers were grouped by semantic criteria and classified according to a common meaning.

The students' answers analysed so far allow us to deduce two aspects. First, the lack of understanding of the complex aquatic system. Second, the lack of understanding about the relationship of the seas and oceans with our daily lives. Both characteristics are in line with other Brazilian studies, for example, Katon et al. (2013), Towata et al. (2013), Katon et al. (2014), and Ursi and Towata (2018).

Question 3 proposed to identify which contents related to seas and oceans were learned at school. By analysing the students' answers (Table 1), we can observe that 31% (100 students) indicated that they learned about their location, types of oceans, their extent, depth, and chemical composition at school. However, 19.2% (62 students) say that they have not had contact with this content in class. A relevant aspect is that when asked about the content they have learned, the majority of the students refer to the subject of geography, rather than science. This fact can be considered as one of the reasons for the lack of answers related to marine life in these environments, which is only 14% (45 students).

As seen in Table 1, a high number of students 17% (55 answers) gave answers related to the environment (conservation, pollution, treatment). This result is similar to that found in a recent study, where researchers concluded that there is a high interest of young Brazilians in conservation issues, especially in local biodiversity (Franzolin, Garcia, and Bizzo 2020).

But how can you preserve something you do not know about? According to Dr. Sylvia Earle, one of the world's most influential oceanographers and president of the 'Mission Blue' project, the biggest threat to the oceans, and therefore to us, is lack of awareness. Thus, learning about oceans is a fundamental step for students to take effective conservation actions (Ursi and Lopes Scarpa 2016).

Specifically for oceans, students in general are expected to complete basic education by knowing the seven basic principles of the oceans (Santoro et al. 2020): 1) The earth has global and very diverse oceans; 2) Oceans and marine life have a strong action on the dynamics of the earth; 3) Oceans exert an important influence on the climate; 4) Oceans allows the earth to be habitable; 5) Oceans support an immense diversity of life and ecosystems; 6) Oceans and humanity are strongly interconnected; 7) There is much to discover and explore in the oceans.

These seven basic ocean principles are part of the so-called 'ocean culture'. Working with students to explore this culture and the principles related to it aims to facilitate the development of an ocean-aware society capable of making informed and responsible decisions about ocean resources and sustainability (Santoro et al. 2020).

Despite all this importance, the oceans and ocean culture are not given due value in the new Brazilian curriculum, known as the 'Base Nacional Comum Curricular' (BNCC) (Brasil 2018). A recent study pointed out that the representation of ocean culture in Brazilian documents is below the recommended level for a person to be considered 'literate', especially for topics dealing with environmental risks in coastal areas (Pazoto, Pereira Silva, and Rezende Duarte 2022).

**Table 1.** Student responses to the 3rd question (what did you learn in your school about seas and oceans?). The answers were grouped by semantic criteria and classified according to a common meaning.

Students' answers	Number of answers
Amount of water (relative to land), properties (density), depth, extent, salinity, and chemical composition.	65
Has not learned or forgotten.	62
Environmental issues (conservation, pollution, treatment)	55
About life in the oceans (algae, fish, reefs, and others)	46
That there are many seas and oceans (name some sea or ocean)	30
Human activities (leisure, transportation, utility, economy, food)	15
That is still largely unknown	13
Point out differences between sea and oceans	8
Tsunamis, dangers of the sea	8
About the moon's influence on the tides	3
Other	17
<b>TOTAL</b>	<b>322</b>

Besides the devaluation of oceanic culture in Brazilian curricula, we can cite other reasons for the elimination of the subject in the classroom. Among them, the lack of teaching materials and insecure teachers were pointed out by Araújo and Aparecida Santos Alitto (2021). This was one of the conclusions obtained through the analysis of questionnaires administered to 147 teachers in Brazil in 2020.

The lack of teaching materials does not reflect Brazilian research, which has been growing in recent years. As an example, results obtained under the BIOTA-FAPESP Program are available for other studies in basic education. However, it is difficult for the school community to access and work with this data with their students. For this reason, groups of researchers have been striving to produce teaching materials that can be used in basic education. For example, the didactic sequence 'Is Araçá Bay dead?' was produced using data from the Biota-FAPESP Araçá thematic project 'Biodiversity and functioning of a subtropical coastal ecosystem: subsidies for integrated management' (Amaral et al. 2016). The didactic sequence is available at <https://biota.fe.usp.br/and> and published by Alitto et al. (2021).

By increasing the number and quality of teaching materials and providing more continuing education for teachers, we believe that it will be possible to achieve a higher level of ocean literacy among students and help achieve the Sustainable Development Goals (SDG). Among the 17 SDGs, SDG 14 (Life Below Water) that aims to 'conserve and sustainably use the oceans, seas and marine resources for sustainable development' is, without a doubt, the most related to ocean literacy.

However, the promotion of ocean literacy is not limited to SDG 14 alone. Recent studies (Asikin et al. 2023; Mokos, Realdon, and Zubak Čizmek 2020) listed 5 other SDGs that can be achieved by improving young people's ocean literacy, such as: SDG 4 (Quality Education) by providing knowledge about marine ecosystems that can be integrated into education; SDG 6 (Clean Water and Sanitation) by the understanding of seawater quality; SDG 7 (Affordable and Clean Energy) by using the marine energy potential; SDG 13 (Climate Action) as the ocean plays a crucial role when it comes to climate change mitigation and SDG 17 (Partnerships for the Goals) to achieve SDGs through cross-sector and cross-country cooperation. Thus, ocean literacy can help promote a better understanding of the ocean and shapes concrete actions to protect and utilise marine resources sustainably, supporting the larger SDG agenda.

## Conclusions

This study aimed to analyse the initial perception of middle school students from two schools in the state of São Paulo about the marine environment and its relationship with their daily lives. To this end, we used a questionnaire with three open questions (in the Google Forms platform). This was administered to 299 middle school students from two Brazilian public schools.

The analyses revealed that most students were unable to relate their daily lives to the marine environment. The most common justification provided by the students was the physical distance from the sea. Although some students acknowledged the importance of preservation by relating the marine environment to their daily lives, effective actions for conservation/preservation depend on the knowledge of the ecosystems. We observed that the students have limited knowledge on this topic, and that is primarily related to the subject of geography. A few points were mentioned about other subjects, such as ocean biodiversity.

Another highlight was the presence of the anthropocentric worldview, in which the environment is considered as the set of natural elements at man's disposal (Flores and González Gaudio 2008). This understanding may reveal the perspective that human beings do not see themselves as part of nature, but rather as individuals who are present to enjoy it. In these terms, humans, as subjects, perceive nature as an object capable of providing them with power and wealth for their domination. Furthermore, they constantly interact with the environment to satisfy their desires and needs (Bezerra and Aparecida Cajueiro Gonçalves 2007).



In this context, we advocate for teaching practices that incorporate Marine and Coastal Environmental Education as a pedagogical alternative to increase the population's knowledge about marine ecosystems, their preservation, and their impact on people's quality of life, even for those who live far from coastal areas. Through Environmental Education, it is possible to foster greater student engagement with maritime issues. By feeling connected to the planet that they inhabit, students will be better equipped to make political decisions for the protection of animal life and its habitat. This connection will also help them progress towards developing greater awareness and adopting critical citizen attitudes.

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## ORCID

Grace V. B. C. L. Alves  <http://orcid.org/0000-0002-2764-5170>  
 Renata Aparecida Alitto  <http://orcid.org/0000-0001-9732-4877>  
 Thiago Antunes-Souza  <http://orcid.org/0000-0002-5881-8855>  
 Simone A. A. Martorano  <http://orcid.org/0000-0002-7115-0933>

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