Marine and coastal environmental education in the context of global climate changes - synthesis and subsidies for ReBentos (Coastal Benthic Habitats Monitoring Network)

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Abstract

As changes in coastal and marine environments are expected to negatively affect Brazilian ecosystems, the importance of Marine Environmental Education (MEE) comes to the fore. However, so far only 32 contributions related to this issue have been published in Brazil. The MEE workgroup of ReBentos aims at promoting EE and the communication of marine ecological research to the scholastic public as a whole, as well as to groups which exert an influence on general perception, such as the media, politicians, and scientists. This paper presents an overview of the initiatives of MEE in Brazil, with emphasis on the ReBentos projects and guidelines. The conceptual background of action is based on the Rio'92 Treaty on Environmental Education, thereby implying an MEE with Transdisciplinar, emancipatory and reflexive characteristics, directed to changes in values, principles and attitudes. During the period 2011 to 2015, 10 projects were developed from Alagoas to Santa Catarina States, involving the development, implementation and testing through scientific research of 16 MEE activity-models. The didactic material subsequently produced comprised three books and 21 book-chapters. A public of around 6,500 Conservation Unit visitors, 250 public school teachers and 800 high school students have been impacted to date. To act as monitors and multipliers, 250 undergraduate students and professionals were trained. Research project evaluation generated the publication of nine papers. As a further step, the need for protocol elaboration for each model is placed in evidence, in order to direct and facilitate future initiatives.

Descriptors: Marine environmental education, Climate changes, Marine biodiversity, Long-term monitoring.

Resumo

A importância da educação ambiental marinha (EAM) vem tomando relevância à medida que aumenta a expectativa de impactos nos ecossistemas brasileiros ocasionados por mudanças nos ambientes costeiros. Entretanto, apenas 32 contribuições sobre esse assunto foram publicadas no Brasil. O grupo de trabalho em EAM da ReBentos objetiva promover a comunicação da pesquisa ecológica marinha para o público escolar como um todo, bem como a grupos com influência na percepção comum, como a mídia, políticos e cientistas. Este trabalho apresenta uma visão das iniciativas em EAM no Brasil, com ênfase nos projetos e diretrizes da ReBentos. A base conceitual de ação é o Tratado de Educação Ambiental da Rio 92, implicando em um ensino com características transdisciplinares, reflexivas e emancipatórias, dirigidas a mudanças em valores, princípios e atitudes. Durante o período de 2011 a 2015, 10 modelos de atividade foram desenvolvidos, de Alagoas a Santa Catarina, envolvendo sua concepção, implementação e teste por meio de pesquisa científica. O material didático produzido compreendeu três livros e 21 capítulos de livros. Um público total ao redor de 5500 visitantes de UCs, 250 professores de escolas públicas e 800 estudantes foi impactado. Como monitores e multiplicadores, foram treinados 250 estudantes de graduação e profissionais. Projetos de avaliação de pesquisa geraram nove trabalhos científicos. Como uma próxima iniciativa, é salientada a necessidade de elaboração de protocolos para cada modelo, a fim de direcionar e facilitar futuras iniciativas.

Descritores: Educação ambiental marinha, Mudanças climáticas, Biodiversidade marinha, Monitoramento de longo prazo.

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INTRODUCTION

Environmental education: state of the art in Brazilian marine and coastal ecosystems

Although marine ecosystems comprise extremely rich natural resources and a fantastic germplasm bank of organisms, both of which must be preserved at all costs, Brazilian Environmental Education has been practically restricted to terrestrial environments alone.

Both abroad and in Brazil, Marine Environmental Education (MEE) is very little cited in specialized scientific journals. In a synthesis about the literature on Marine Environmental Education in Brazil (MEEB), PEDRINI (2010) selected 32 published contributions which represented the entire national literature. He also presented a typology with six types of MEEB approaches: a) by socio-environmental actors, viz., students in an elementary school near Fernando de Noronha National Marine Park (SILVA JR. et al., 2010); b) by ecosystems, such as urban mangroves within Florianópolis city (Santa Catarina State) (PANITZ, 2010); c) by iconic, flagship or charismatic species, such as dolphins along the Rio de Janeiro State coast (GURGEL et al., 2002); d) by aquariums and oceanariums, such as the Ubatuba Aquarium (Coast of São Paulo State) (GALLO NETO; BARBOSA, 2010); e) by marine biology classes, mainly as free courses directed to elementary or high school students; and f) by virtual environments (GUERRA, 2002).

It is also possible to find research on the evaluation of negative ecological impacts caused by divers, tourists and vessels in marine and coastal environments (CREED; AMADO FILHO, 1999; GHILARDI-LOPES et al., 2015; HAWKINS; ROBERTS, 1993; HAWKINS et al., 1999; PEDRINI et al., 2007; PLATHONG et al., 2000; ROUPHAEL; INGLIS, 2001; SILVA; SILVA JR., 2002; SILVA et al., 2012a; SILVA; GHILARDI-LOPES, 2012; TUNALA et al., 2013), as well as that regarding the efficiency of MEE from an educational perspective, and on the reduction of these impacts (BARKER; ROBERTS, 2004; BERCHEZ et al., 2005; CORREIA; SOVIERZOSKI, 2009; 2010; KATON et al., 2013; LUNA et al., 2009; MEDIO et al., 1997; PEDRINI, 2010; PEDRINI et al., 2008; SALM, 1985; TOWATA et al., 2013; TOWSEND, 2000; URSI et al., 2013; WALTERS; SAMWAYS, 2001; WORACHANANANTA et al., 2008).

EE activities that contemplated marine ecosystems and that have already been developed in Brazil, although equally rare (BERCHEZ et al., 2005; PEDRINI, 2010; WEGNER et al., 2006), were extremely important for the development of a mindset for their conservation. Although with a poorly defined conceptual and methodological structure, and basically involving the simple observation of local ecosystems together with technical learning, activities enthusiastically carried out since the 80's by diving schools can be cited as an example, through the consequential and substantial reduction in sport submarine-fishing, and the increase of the spirit for conserving these environments and their organisms.

Examples of conservation activities with well-defined objectives and structures include that of marine chelonians (Tamar/IBAMA Project), marine mammals along the Rio de Janeiro State coast (GURGEL et al., 2002), the northeastern Brazil marine reefs (OLIVEIRA; CORREIA, 2013b; SILVA et al., 2013b), the Abrolhos Marine Park, (MELO et al., 2005) and, finally, southeastern Brazil rocky-coasts (BERCHEZ et al., 2007; PEDRINI et al., 2011). In São Paulo State, and within the Subaquatic Trail Project (BERCHEZ et al., 2007; GHILARDI; BERCHEZ, 2010; URSI et al., 2010; URSI et al., 2009), environmental education-activities models based on interpretative trails, have been developed, applied and afterwards tested through specific research projects.

Other conservation activities can be indirectly related to EE, as is the case of the Alcatrazes Project, mainly dedicated to protection of the Archipelago of the same name (São Paulo State), whose ecosystems are threatened through target practice by the Brazilian Navy (CAMPOS, 2008).

MEE activities related to marine trails are cited by WEGNER et al. (2006) on the northern coast of Santa Catarina State, BERCHEZ et al. (2007) on Anchieta Island rocky shores, HADEL and BERCHEZ (2005) within the CEBIMar-USP monitored visitation Program at Segredo Beach (São Sebastião, São Paulo State), and PEDRINI et al. (2011) with the Ecoturismar Project in Rio de Janeiro State.

Most of the accumulated experience has neither been published in specialized journals, nor have the results been scientifically tested. The little data available has been reported in the form of these or other means of publication, with only limited scope of disclosure.

Due, among other factors, to the lack of data, it is possible to observe differences in the structural patterns of MEE activities, both between those which are well-informed and planned, and those which are only empirical and inconstant in time. In many cases their potential

is underrated, due to conceptual and operational mistakes. In other cases, attempts have even resulted in negative action, with immediate negative impacts on nature, and the possible assimilation of behaviors contrary to those desired. The opening of protected areas to exorbitant, irresponsible, impacting and excessively commercial tourism can be cited as an example (REUSS-STRENGEL et al., 1997).

The creation of models with well-defined conceptual and philosophic bases and structures, and their testing by means of parallel scientific studies, is thus of great importance in the management of marine-protected areas, or even of areas which encompass coastal and marine environments and organisms, and where the implementation of activities adapted to local conditions should be encouraged.

Environmental education in the context of climate changes

The Intergovernmental Panel on Climate Change (IPCC) reports that global changes, besides occurring at a faster rate than at any other period in time over the last 25 million years, are already causing innumerable impacts in marine environments (BELLARD et al., 2012; IPCC, 2014). Nowadays, there is a consensus among scientists as to anthropogenic influence on global climate changes (DORAN; ZIMMERMAN, 2009). Furthermore, ROCKSTROM et al. (2009) also pointed out climate changes as being one of the planetary boundaries that have already been crossed by human activities, thereby possibly leading to "the risk of irreversible and abrupt environmental changes".

The expected changes in coastal and marine environments, such as the average rise in sea levels, changes in both local and global marine currents, and rises in temperatures and seawater-acidification (BERCHEZ et al., 2008), can negatively affect many Latin American ecosystems (TURRA et al., 2013), many of which, besides being unique, constitute biodiversity hotspots (MILOSLAVICH et al., 2011), such as the kelp forests in the Cape Horn Biosphere Reserve (ROZZI et al., 2012), the extensive rhodolith beds in the Southwest Tropical Atlantic (BERCHEZ et al., 2009), and the highly biodiverse coral reefs of the Tropical Atlantic, with their high number of endemic species (CORREIA; SOVIERZOSKI, 2012; LEÃO et al., 2003). Thus, not only is concern for the protection of these environments essential, but also critical discussion capable of presenting the complexity of the problem, and improving changes in social structure.

Although the effects of climate change on coastal and marine environments can be expected, and in a certain way, understood, in scientific and academic environments, a large part of the population is not only ignorant of or has no access to this information, but knows absolutely nothing about these ecosystems and their intrinsic value. Since any posture-change in relation to the environment, which is directed towards minimizing and possibly reverting the anthropogenic influence on global-climate changes, is not only a government responsibility, but also of concern to each citizen, we are facing a great challenge, for there is clear detachment between comprehension of climate change phenomena and everybody's 'day-to-day' existence (TAMAIO, 2010; 2013). As an example, few people are conscious that fundamental economic activities, such as fisheries and coastal and marine ecotourism, depend on the quality of marine environments, and that any alteration thereof will have a consequential and detrimental impact. New research has demonstrated that people generally overestimate how common their own opinion is, and in doing so, they are less likely to change their views on climate changes (LEVISTON et al., 2013).

Perception that long-term climate trends are related to human causes has been shown to be dependent on scientific consensus (LEWANDOWSKY et al., 2013). Moreover, political group consensus on anthropogenic global warming has proved to be a primary factor in social-perception (BRECHIN, 2012). Without this, even scientific agreement on climate change may have a limited impact.

In this context, Environmental Education (EE) figures as the base for accomplishing a transformative and critical approach to the theme, thereby making it possible, in the near future, to amplify mobilization efforts and intensify civil-society action, in such a way as to alert world leaders on their role in guiding this emergent challenge. It is clear that, besides the general and scholastic public, EE focusing on the media, politicians, and even scientists themselves, would clarify the importance of these groups in overall public perception.

Environmental education is conceivably a permanent educational activity, through which the community becomes conscious of both reality and the novel relationships that mankind has established with nature, and consequently, of the problems derived from this relationship and their profound causes. From this awareness, attitudes and values that could capacitate a surpassing transformation of this same reality are possible (GONZÁLEZ GAUDIANO, 2005) (Figures 1 and 2).

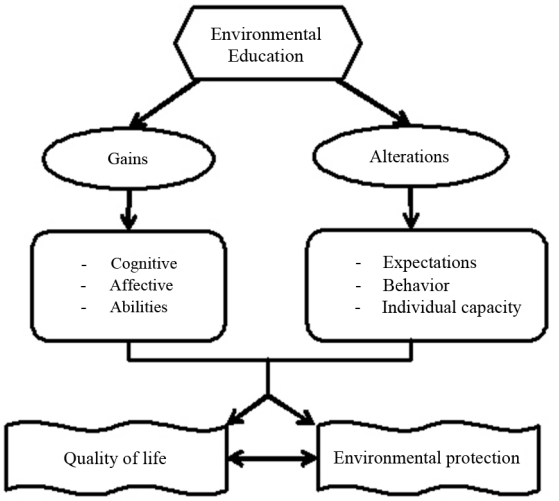

Figure 1. Holistic environmental education.

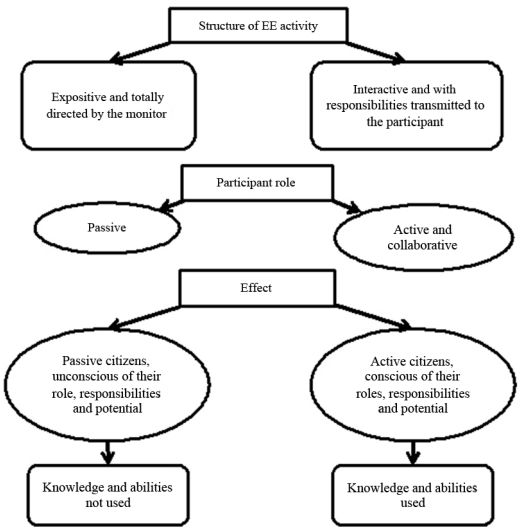

Figure 2. Expected effects of the different approaches of environmental education activities.

These concepts, drawn from pedagogic assumptions and embodied in the *Tbilisi Declaration on Environmental Education,* and also expressed in the Rio-92 *Treaty on Environmental Education for Sustainable Societies and Global Responsibility* (PEDRINI; BRITO, 2006), have been adopted by the Brazilian National Environmental Education Program (BRASIL, 2005). Table 1 shows some of the conceptual indicators of the treaty (BERCHEZ et al., 2007), which, in spite of the inherent premise fundamentality and favorable credibility sustaining further MEE action, have not been considered in numerous projects.

PEDRINI and SABA (2008) report a new approach to the global environmental changes (GECs) theme. It employs the movie "An inconvenient truth" (produced by Al Gore to make the issue of global warming a recognized problem worldwide), as a strategy for teaching English among public high school students.

Table 1. Short description of some conceptual EE indicators.

Indicator (EE)	Indicator description
Transforming	Facilitates changes in attitudes for the development of sustainable societies.
Participative	Encourages participation in collective mobilization
Embracing	Involves all the various social groups
Permanent	Performed as a continuous activity (or continued EE)
Contextualized	Acts directly on the reality of the activity and on achieving global dimensions
Ethical	Respect for human beings and all life-forms
Interdisciplinary	Integrates various forms of knowledge
Holistic	Aims at transforming the individual, e.g. values and ethical concepts
Multiplying	Aims at expanding activities through the formation of multipliers

Although there are some EE initiatives related to climate changes in Brazil, a clearer relationship between day-to-day actions, their synergies (e.g. locomotion, over-consumption, housing, feeding, land-use, deforestation, river-silting, desert-formation) and the increase in greenhouse-gas emission (TAMAIO, 2010; 2013), is still necessary. EE programs and actions should also be conceived in an accessible language, compatible with the different publics, for effective population-awareness of the causes and impacts due to climate change (MONZONI, 2009), thereby promoting systemic comprehension, and holistic and contextualized thinking about the complexity of the problem.

METHODS

Initial REBENTOS guidelines for marine environmental education

The aims of the MEE workgroup of the Coastal Benthic Habitats ReBentos Monitoring Network (MCT/ CNPq/ MEC/ CAPES/ FNDCT – Ação Transversal/FAPs, FAPESP process nº 10/52323-0), is to incite environmental education and scientific communication of marine ecological research to the public, as a whole. An initial protocol, based on conceptual issues, as well as the previous experience of the participants, was proposed to serve as a general basis for MEE workgroup projects.

Conceptual issues should be based on the Rio-92 *Treaty on Environmental Education for Sustainable Societies and Global Responsibility*, which serves as a base for Brazilian EE legislation (Law n° 9.795, April, 1999) and the National EE Program (ProNEA). This implies a holistic vision of EE, mainly directed to changes in values, principles and attitudes (LA TROBE; ACOTT, 2000) of a multi, trans-discipline emancipatory and reflexive character, capable of facilitating movement towards individual emancipation and more sustainable societies. This vision is not antagonist, but encompasses that which visualizes EE as a form of biological, ecological or social education. Artistic, physical and philosophic disciplines, among others, become instruments and fall under the EE wing.

Public – The main goals of ReBentos EE action and materials are to reach opinion and policy-makers, with the aim of maximizing and spreading efforts. Once again, this is not antagonist, but complementary to more conventional approaches, such as those that deal with elementary and high school students, or local communities.

Lines of action – Based on preliminary ReBentos experience, the EE-ReBentos projects should be related to (1) the production of educational material, (2) the development of environmental educational models, (3) education evaluation, and (4) long-term evaluation of the perception of basic GEC concepts, and their consequential effects.

On incorporating the question of marine GECs, education material and methods would acquire a direct approach towards cognitive gains, with the application of indirect strategies directed to affective gains or the development of specific skills. In the latter case, the conceptual relationship with GECs would be clearly shown, both in the project, and to those that will make use of the resource. Explicit reference to ReBentos should appear in the products and projects, and during EE activities and staff-training courses.

RESULTS

Projects, actions and results from 2011 to 2015

1. Subaquatic Trail

Coordinator: Flávio Berchez, IB-USP

Objectives

The Subaquatic Trail Project was begun in 2001 in Anchieta Island State Park (Ubatuba City, São Paulo State, Brazil), with the proposal of an innovative environmental education approach towards marine environments, based on the creation, implementation and scientific evaluation (both educational and ecological) of models.

Description and Conceptual background:

The general structure, common to all models, is based on guided interpretative trails (COSTA; COSTA, 2000), in which the participants stop at pre-defined spots, where certain issues are discussed with the monitor(s). Each spot corresponds to a stage in an activity with specific educational objectives involving a holist relationship with the marine environment.

Although greater emphasis is given to the rocky-shore ecosystem, since this is the team's main focus, other models have been developed in other coastal environments. The models have been applied mainly in the counties of Ubatuba and São Sebastião, São Paulo State.

Model-structuring was based on the holistic environmental education concept (Figure 1) adopted by the Brazilian National Environmental Education Program (BRASIL, 2005). The aim is individual transformation and evolution, along with an understanding of natural phenomena in an integral way (WEIL, 1991), thereby leading to behavioral, ethical and value changes acquired through cognitive, skill and emotional gains related to the ecosystems visited (HEIMLICH, 2002).

Apart from model-elaboration, the main aim is to prepare college educators, capable of spreading information and concepts. Operational structure involves not only the activities themselves, but also mainstays, such as personal training and security. The evaluation of both educational outcome, based on EE research techniques, and the negative ecological impacts of the activities within the environment, is complementary.

Furthermore, the activities present a multidisciplinary approach to interpretation of the environment (Table 2), through relating the functional aspects of ecosystems with biotic and abiotic factors, and organism adaptation, as well as furthering discussion of conservation and the main anthropogenic impacts on marine and coastal environments. As regards diving, integration is centered on specific diving equipment techniques and performance, and on the action of factors, such as water temperature and human-body pressure, on anatomy, physiology, physical conditioning and health.

Activities are always carried out in groups, with the number of participants per model varying in accordance to security and conservational aspects. Interaction among the elements of the group is incited by the monitor, through quizzes and educational activities aimed at stimulating participative behavior (Table 1 and Figure 2).

Preliminary Results

Protocol - Creation of standard procedures, including (1) chronological teaching sequence, (2) minimum-knowledge base that models should encompass, and (3) intended cognitive, affective and ability gains, and the didactic posture needed for their achievement. So far, eight models have complied: underwater trail outside the water, free diving trail, SCUBA diving trail, natural aquarium trail, ecosystem trail, vertical trail, kayak trail, lectures about marine ecosystems.

Didactic material support - books (BERCHEZ et al., under preparation; GHILARDI-LOPES et al., 2012; MARQUES; PEREIRA FILHO, 2013), websites (sites–www.ib.usp.br/ecosteiros2 – and distance education tools (video-classes based on the Moodle Platform).

Monitor training and formation – 250 environmental monitors have been prepared to apply the protocol, this comprising students, professionals in the areas of biology, oceanography, geology and education, protected area technicians and managers from several states of the Brazilian southeastern, southern and eastern regions. The training consisted of participation as extension or undergraduate Univ. of São Paulo students (BIB-0529 - Teoria e prática de educação ambiental em UCs marinhas) in (1) a blended learning theoretical course, followed by one week of practical monitoring in one of the model activities.

Implementation of models – the models were applied to the general public visiting protected areas (7,805 visitors), to the recycling of public school teachers (24), and to correspondent students of technical (tourism) schools (110, 14 with visual or hearing deficiencies). In the case of teachers, special certified capability was related to the use of active diving, as a centralizing theme for promoting school-discipline transversal integration. Preparation was also extended to student monitoring.

Evaluation of activities – efficiency and change in perception as regards climate changes and the marine environment, was evaluated through research projects. Evaluation of the ecological impacts related to the absence of visiting protocols in the region of the natural aquarium trail, was through a master's degree monograph (SPELTA, 2011). This was extended to public perception of global climate changes, with emphasis on expected alterations to and impacts on the marine environment (GHILARDI-LOPES et al., 2013b; GHILARDI-LOPES et al., 2015). Following the extension of the concepts and models to Chile, a comprehensive review about integrated approaches between ecology and education in South America Marine Protected Areas was prepared (BERCHEZ et al., 2015).

2. Games about Climate Changes and their effects on Marine and Coastal Environments Project

Coordinator: Natalia Pirani Ghilardi-Lopes, UFABC)

Objective

The main aim of the project is to develop, apply and test two educational web-based games with elementary

Table 2. Main fields of knowledge presented during the activities of the Subaquatic Trail Project.

Field of knowledge	Discussed aspects
Biology, ecology and environment conservation	Most important or attractive organisms - nutrition, behavior and ecological and economic importance.
	Organism ecological interactions - predation, competition, epiphytes, succession.
	Community ecology - diversity and community structure;
	Conservation and protection of marine ecosystems, rules of minimal impact.
	Rules, function and importance of marine protected areas (Brazilian conservation units).
	Global climate changes and their effects on marine and coastal ecosystems.
Chemistry and Physics	Salinity, nutrients, temperature, hydro-dynamism and radiation, and their importance for living beings.
	Pressure related to diving (embolism, narcosis, organic compression).
	Physics related to diving equipment.
Geology	Consolidated and unconsolidated substrates - kinds and origin.
	Erosion and weathering.
Physical Education and the human body	The importance of physical activities.
	The correct practice of physical activities - stretching and heating, free and SCUBA diving techniques.
	Physiology and anatomy of the human body in relation to diving;
	Body consciousness.

school students and their teachers, and also, to promote continuing education for teachers.

Description and Conceptual background

The idea of the project came from the easy access to information through technology, and from people nowadays being active agents of their own knowledge-construction process. When properly done, i.e. through reliable sources of information, this behavior can result in significant learning, in which the newly acquired information is anchored on relevant concepts already present in the cognitive structure of the apprentice, and on new concepts constructed in an interconnected way and with a real meaning (AUSUBEL et al., 1980). In accordance with this tendency, the use of communication and information technologies is more and more encouraged and prompted in formal educational systems (DEANEY et al., 2003; LIM et al., 2005).

In this context, educational games of free access in the web, or available for restricted classroom use, when adapted to the general public, can serve as powerful tools in the process of disseminating scientific information, and for facilitating its apprehension and comprehension, this beyond the direct and experiential interaction of the knowledgeable apprentice, thereby changing behavior and inciting active participation, with the consequential improvements in socio-environmental quality, (Table 1, Figures 1 and 2).

When playing, a person simulates and creates realities, within certain mutually accepted rules, roles, conditions and premises, thence taking the place of somebody else, and so developing an understanding of why people act in certain ways. Thus, the players learn how to act and make mistakes, without negative consequences to the real world, since certain realities can be simulated, played out, manipulated and experimented, and the possible consequences felt. If these are negative, things that should not be done are learned, thereby making it possible to plan alternative approaches or objectives. The players can also share their experiences, develop their collaborative spirit, and use the game for self-knowledge, thence understanding their own attitudes, values and thinking processes better, as well as comprehending and feeling their very limitations and possibilities of promoting changes. Moreover, games, besides generally being fun and pleasurable, afford a way of intensifying the emotional bond between the player and the subject of the game.

Systemic games comprise a category specifically aimed at showing the players how complex systems function. These games are extremely interesting in the context of global climate changes that result from of the interaction of diverse components of ecological systems. Systemic games facilitate seeing, feeling and experimenting several aspects of the system's behavior that are important in the transformation of reality and in the context of "feeling part of a larger picture". The player, although able to influence the system, cannot always direct it in a desirable way, which means that attempts must be made to understand the way things work and find other ways of promoting the required changes, such as identifying the crucial points involved in its functioning (DIELEMAN; HUISINGH, 2006).

Preliminary results

The two games developed in the project were:

Game-book "Challenge in Apicum" (GHILARDI-LOPES, 2014) – based on RPG (Role Playing Games) solo adventures, in which the participant will play the role of a student, who must discover the causes of the changes that are occurring in the surroundings of Apicum City (a fictional coastal city specially created for the game). For this, the participant will have to carry out quizzes, puzzles and activities (GHILARDI-LOPES et al., 2013a; SILVA et al., 2013a). The game is under test. It was applied to 135 elementary school children, who filled in questionnaires before and after playing, which are being analyzed. The game-book can be accessed at the following link: http://professor.ufabc.edu.br/~natalia.lopes/jogosmarinhos/index.php/material-de-apoio-2/16-livro-jogo

"Apicum" game – this game basically presents the same story as the gamebook, but in a more interactive interface. The educative game was developed in GameMaker® software. One important step in its development was to produce the Game Design Document (GDD), which includes a description of the story, objectives, rules, and all the characters and items of the game, as well as the Level Design Document (LDD), which includes a description of the scenarios, levels of the game (Table 3), the conditions of entrance and exit of each level, and the flow conditions at each level (what the main character can and cannot do). Both documents for the game are already finished, and the game is now being tested. It can be accessed at the following link: http://professor.ufabc.edu.br/~natalia.lopes/jogosmarinhos/index.php/prototipos-2. A page on facebook has also been developed (https://www.facebook.com/apicumgame). Subsequently, it will be applied to elementary and high school students, and evaluated in terms of educational efficiency.

Another result of the project was the Extension course for elementary and high-school teachers recycling (GHILARDI-LOPES et al., 2014a). Many teachers say they feel uncomfortable when addressing the subject of global environmental changes in their classrooms, since they know little about it. Taking this into account, an extension course on global changes and their effects on marine and coastal environments was given to 15 elementary and high school teachers. During the course, they prepared and applied a didactic sequence. At the end, they presented and discussed the results. All didactic sequences, as well as theoretical information on the subject of the course can be accessed at the following link (GHILARDI-LOPES et al., 2014b): http://professor.ufabc.edu.br/~natalia.lopes/jogos-marinhos/index.php/material-de-apoio-2/17-e-book.

3. Learning with the Sea Project

Coordinators: Benjamim Teixeira, Laura Pioli Kremer and Renata Costella Acauan, IFSC

Objectives

The main goal is to stimulate the introduction of marine knowledge into school activities, thereby contributing to the implementation of marine-environmental education activities in elementary and high schools.

Description and Conceptual Background

The project "Learning with the Sea" was initiated in mid 2012 in Santa Catarina State, and is under way. Santa Catarina, with a long coastline (531 kilometers), has an appreciable population closely related to the marine environment. However, knowledge of marine ecosystems is slight, and subjects related with this environment are rarely present in school activities. One way to develop marine-environmental education is to stimulate the introduction and integration of this theme into the school curriculum. With this in mind, and by using the marine environment as a starting point to teach the concepts of various subjects across the curriculum, the project comprises a means of developing marine-environmental awareness, and generating the understanding of marine processes, and how they are linked to local problems.

Project execution is through workshops for students and teachers, the latter as prospective multipliers, and procedures according to conceptual EE indicators (Table 1), with the constant stimulation of interdisciplinary dialogues between marine knowledge and daily school activities. The educational objectives of specific-workshop content are related with and linked to school curriculum disciplines. The basic knowledge content deals with marine biology, oceanography, human culture linked to the sea, the value of marine processes and resources, and global anthropogenic impacts on the marine environment.

Table 3. Levels of the educational game on global climate changes and their effects on marine and coastal ecosystems, with the objectives proposed for each one.

Level	Objective(s)
Introduction	Help people who have passed through a heavy storm
	Talk with marine ecologists
School	Learn about marine ecosystems and global climate changes
Individuals' homes	Make their homes more sustainable against greenhouse-gas emissions
Coral reef	Visit a coral reef, and measure environmental variables in order to understand why the corals are bleached
Store	Purchase diving equipment
Library	Learn about the issues dealt with in the game
University	Talk with a marine researcher and obtain help to understand the problems with the coral reef
Laboratory	Learn about equipment to measure environmental variables
City Hall	Choose a candidate to take care of the three dimensions of sustainability

Preliminary results

Implementation of models: with the participation of 1.253 students, 74 teachers and 20 monitors.

Evaluation of activities: the results were presented in three scientific events (ACAUAN et al., 2014; ACAUAN et al., 2012; KREMER et al., 2013).

Based on this project, a postgraduate course on Marine Sciences, as applied to Teaching (Ciências Marinhas Aplicadas ao Ensino) was created. This is an interdisciplinary course with 400 hours, which was initiated in 2014 at the 'Instituto Federal de Santa Catarina' Campus at Itajaí. Until now 35 students have participated. It is designed for pre-school, elementary and high school teachers from several fields of knowledge, such as science, social studies, languages and arts. The main goals are:

Facilitate the application of marine-science insights to learning environments.

Enhance students' knowledge of marine environmental sciences.

Integrate marine environmental learning within all the subjects at the pre-, elementary and high school levels.

Stimulate new possibilities of interdisciplinary knowledge-construction in schools.

Support educators by facilitating learning experience in the marine environment outside the classroom.

Provide students with opportunities to experience and investigate teaching practice.

4. Marvelous Brazilian Mangroves Program

Coordinators: Renato de Almeida, UFRB; Clemente Coelho Junior, UPE; Yara Schaeffer-Novelli, USP

Objectives

Support formal education programs in marine protected areas. The specific objective is to provide an educational tool to help teachers and community members to interpret coastal and estuarine systems. In this way, the 'Marvelous Mangroves' contributes towards implementing a National Communication Strategy and environmental education in protected areas.

Description and Conceptual background

'Marvelous Mangroves' is a curriculum guide that is formally introduced and presented to elementary school teachers (ALMEIDA et al., 2008). During the 16–hour-course, teachers are instructed on classroom and field use. The proposals for practical activities in coastal zone and marine ecosystems involve aspects of climate-change in the context of science and environmental education. After classroom activities, teachers are encouraged to develop projects covering an eight to ten month period. As these activities occupy about 84 hours, the duration of the whole course comes to 100 hours. Participants receive their certificates on termination. A system of training and evaluation, with the use of forms for teachers and students alike, facilitates monthly monitoring of all the teachers and schools involved. This strategy eliminates the punctual approach, common in educational projects. In Brazil, this program is coordinated by the Instituto Bioma Brasil (IBB), associated to the Mangrove Action Project (MAP), a US Non-Governmental Organization. To date, the Marvelous Mangrove curriculum guide has been applied in the towns of Cariacica and Fundão (Espírito Santo State), Maragojipe (Bahia State), Porto de Pedras (Alagoas State), and Tamandaré (Pernambuco State).

Preliminary Results

Records from circumstantial experience with curriculum guides in Brazil has shown that, besides reproducing the proposed exercises, teachers also used these guides for motivating activities not dealt with therein. Non-course-participants were also involved with the projects developed in their own schools.

Incentives by the Brazilian Ministry of Environment (MMA) for the use of the curriculum guide in interpretative programs in protected marine and coastal areas. Models were implemented in Cariacica (48 teachers, 19 schools), Fundão (61 teachers, 11 schools), Maragojipe (69 teachers, 14 schools), Porto de Pedras (30 teachers, 11 schools), and Tamandaré (30 teachers, 12 schools).

Dissemination of the curriculum guide in Brazil with support from MMA, local councils and other partner organizations. The Ministry of Education (MEC) also gave support to an extension project of the Federal University of Bahia Recôncavo (UFRB).

Human-resource training and studies presented in domestic scientific events (ALMEIDA et al., 2010; SILVA et al., 2012b).

Evaluation system strengthening and recognizing the potential, as well as educational and administrative limitations. Noteworthy is the participation of students and teachers in a discussion forum and Educators Collective, besides the production of a video and interactive blog.

5. Investing in new talent from the public education network for social inclusion and development of scientific culture

Coordinators: Monica Dorigo Correia and Hilda Helena Sovierzoski, UFAL

Objectives

Develop and improve the scientific and technological culture of teachers and students alike, in elementary and high schools of the Alagoas State public network, by conducting educational activities in the natural sciences area, aimed at encouraging the construction of new academic activities and teaching activities from a contextualized theoretical and experimental viewpoint, in order to awaken and broaden the vision of natural and scientific phenomena, as a strategy for the discovery of vocations and new talent.

Description and Conceptual background

This Project was begun in 2011, with three stages involving professors and students from public schools and undergraduate Biological Science courses, with grants from the Scientific Initiation Program (CAPES/UFAL). It also involved students from the Undergraduate Program

of the Teaching of Science and Mathematics (PPGECIM/UFAL). All the students and both professors are associated with the Sector of Benthic Communities of the Federal University of Alagoas.

Information on biodiversity and the preservation of Alagoas coastal ecosystems is still little divulged in the media or presented in the state elementary and high schools. The need is known for expanding and improving human resources directed to increasing studies on biodiversity and the preservation of coastal ecosystems in the state of Alagoas, as well as the training of students and teachers in elementary schools. The methodology used in this context is based on three steps:

a) Development of experimental and pedagogical kits with the participation of basic education teachers, students of the Undergraduate Program in Science Education and Mathematics of UFAL (PPGECIM) and teacher-researchers of UFAL, thereby targeting the use of alternative educational and innovative material to be used in activities in stages 2 and 3 in this sub-project. In the future, these will be made available for use by other teachers in basic education.

b) Education courses and the updating of teachers in the area of Natural Sciences from the public basic-education network, in order to improve the teaching-learning process.

c) Implementation of the program "Saturdays at the Plant Science" consisting of regular visits by public school students and teachers, thereby facilitating access to and operation of our educational collection composed of scientific experiments and audiovisual resources, and thus fostering interaction among students of education, basic researchers and teachers, all graduate students from the Program in Science Education and Mathematics (PPGECIM/UFAL).

Results

Studies of the biological sciences and environmental education were developed, as a means of integrating students from the various undergraduate courses at UFAL, in particular those related to promoting improvements in academic performance, and encouraging elementary and high school students to work in future related professions.

The results were reproduced in several articles on science teaching practice (ARAÚJO et al., 2011; OLIVEIRA et al., 2011; SOUZA et al., 2011), biodiversity (LIMA JÚNIOR et al., 2012; SOUZA et al., 2013), and youth and adult education (SOUZA et al., 2011; SOVIERZOSKI et al., 2014). The aspects of science education and marine biodiversity of Alagoas, including conservation and environmental education, directed to basic education, and produced by the research group on Benthic Communities of UFAL are available on the site (http://www.icbs.ufal.br/grupopesquisa/comunidadesbentonicas).

6. What we know about the biodiversity of coastal ecosystems on Alagoas

Coordinators: Monica Dorigo Correia and Hilda Helena Sovierzoski, UFAL

Objectives

The aims were to increase knowledge of biodiversity in the coastal ecosystems of Alagoas State, and spread scientific information on the conservation of reefs, estuaries, mangroves and beaches by the general public, with emphasis on teachers and students in public schools.

Description and Conceptual background

This Project, which was initiated in 2012, in Alagoas State, was based on extension activities that concentrated efforts towards the transmission of knowledge about biodiversity in Alagoas coastal ecosystems.

Marine biodiversity calls for the conservation of Alagoas State coastal ecosystems, which are poorly understood and rarely reported on in elementary and high schools. The information generated and gathered by the Research Group on Benthic Communities served as the base for divulging knowledge and activities in environmental education, as directed to coastal conservation. This project involved undergraduate students from Biological Science courses with grants by CNPq/PIBIC, as well as undergraduate students from the programs of Teaching Science and Mathematics (PPGECIM), and Biological Diversity and Conservation in the Tropics (PPGDIBICT), all associated to the Sector of Benthic Communities of the Federal University of Alagoas.

Results

Studies were in the field and the laboratory, with the qualitative and quantitative analysis of the biodiversity and environmental education of the Alagoas coast. It was concentrated on undergraduate and graduate courses at UFAL, in particular those related to marine biology. The aim was to promote improvements in academic performance, and encourage basic and high school students to consider marine science as a future work-option.

Scientific results were divulged in several papers on the biodiversity and coastal ecosystems of Alagoas State, and included topics such as reefs (OLIVEIRA; CORREIA, 2013a; OLIVEIRA et al., 2014; SILVA et al., 2013b), mangroves (OLIVEIRA et al., 2012; SOVIERZOSKI et al., 2014), and environmental education (PEDRINI et al., 2014b). Information on aspects related to the conservation of coastal ecosystems and biodiversity of the Alagoas coast, including several new and endemic species, as well as publications on environmental protection that have been produced by this research group, are available on the site (http://www.icbs.ufal.br/grupopesquisa/comunidadesbentonicas).

7. The Emancipatory Environmental Education by Marine Ecotourism - EcoTourisMar Project

Coordinator: Alexandre de Gusmão Pedrini, IBRAG / UERJ

Objectives

The main objective of this Emancipatory Environmental Education (EEE) project is to offer tourism products with environmental and economic sustainability. Focus is placed on: a) environmental managers and analysts from government agencies that grant licenses to enterprises operating in protected areas of sustainable use; b) tourism and ecotourism entrepreneurs involved in developing economic activities with social and environmental sustainability; c) educators seeking alternative work activities, other than the present that negatively impact the environment.

Description and Conceptual Background

Economic activity derived from Brazilian tourism is mostly a repetition of the wild-capitalist model (unfair and oppressive). This typical model of mass tourism concentrates income among entrepreneurs, while leaving only crumbs, in the form of jobs, to the employees. These are often seasonal and deprived of social security and labor rights (LOUREIRO, 2006). It falls to the underemployed community of disproportionately low income, the option of acquiring tourist products that are in no way socially or financially mitigatory. Beyond incoming taxes, the local government apportions the entire positive income of the receiving infrastructure. Concomitantly, when appropriating both marine and coastal resources, tourists usually generate disastrous social and environmental effects, with a consequential and overwhelming impact on coastal and marine biodiversity (PEDRINI et al., 2007; SILVA; GHILARDI-LOPES, 2012; TUNALA et al., 2013). Thus, Emancipation Environmental Education (EEE) is indispensable as a structuring strategy for promoting drastic changes in the behavior and attitudes of active coastal-tourism enterprises (PEDRINI et al., 2011; PEDRINI et al., 2013b; RHORMENS; PEDRINI, 2015). The facile availability of ecotourism products with features directed to the marine environment (GARROD; WILSON, 2004; GARROD et al., 2002; GARROD et al., 2003) undoubtedly enhance the circumstances of those politicians and financiers alike, involved in activities that devastate the sea (PEDRINI et al., 2011.

The conceptual and operational paradigm of EEE (PEDRINI; BRITO, 2006; PEDRINI et al., 2015a; PEDRINI et al., 2013a; PEDRINI et al., 2011; PEDRINI et al., 2012; PEDRINI et al., 2010; PEDRINI et al., 2014b; RHORMENS, 2013; RHORMENS; PEDRINI, 2015) has been discussed by several authors. They propose that environment education be considered as EEE by marine ecotourism, and that it be characterized as: a) emancipatory; by facilitating the transformation of social actors from illegal citizens into productive ones, thereby involving them in the ecotourism product, and generating their partial financial or overall independence, for example, as entrepreneurs or guides; b) transformative; by allowing those involved in the application of the product to acquire knowledge and skills through experience, thus enabling them to face, solve and prevent environmental problems, including those from the region of the ecotourism route; c) comprehensive; by placing all or most of the social actors in the area under the influence of product application; d) globalizing, addressing the environment to its various local, regional, national and global scales; e) contextualizing; in which the action is based on knowledge of local reality in which there is ecotourist activity; f) interdisciplinary; since, as environmental issues evolve over time, they are essential for the aggregation of knowledge in problem solving and improvements; g) ethics; with respect for all planetary life-forms, especially those in the ecotourism route region; h) permanent; since episodic action leads to disruption of the instructional process, and disengagement of the citizens involved; i) participatory; in that citizens, on acquiring knowledge about the entire product creation process, can opine from experience and so contribute towards product-improvement.

This model will generate compatibility between political action and survival, thus giving rise to a unique ecotourism product that presents the following characteristics: a) limitation to 10 participants (PEDRINI et al., 2011); b) equitable sharing of the financial benefits thereby generated; c) occurrence in a natural environment involving the local community; d) inducing discussion on contextual socio-environmental subjects (environmental performance); e) entire social and environmental protection as the end result (PEDRINI et al., 2011). Thus, a marine ecotourism product could be a feasible substitute for massive and predatory tourism in the marine environment (GARROD; WILSON, 2004; GARROD et al., 2002; GARROD et al., 2003).

Results

Table 4 presents the adopted methodological model with its main steps (PEDRINI et al., 2011).

Although two products were formulated on a research scale, the only one appropriately tested as a possible commercial product was snorkel-diving. Both products attract tourists worldwide. The first was launched in the Marine Environmental Protection Area of Buzios (APAMAB), Rio de Janeiro State. The town of Buzios includes a seaside resort with very beautiful beaches. However, of late the town has been receiving visitors from ocean-going cruisers that disembark thousands of passengers, just to spend the day on the beach. As meals are aboard ship, little use is made of local resources, and the town only receives by-products from such a massive and socially exclusive tourism. Fishermen have sold their instalations, and gone to live on the outskirts. Thus, involvement of the local community has not been possible as was desired. However, the local state school has formed tour guides recognized by the Ministry of Tourism and the project has become a discipline in the course (PEDRINI et al., 2011; PEDRINI et al., 2012).

The second Ecoturismar product was developed in the Environmental Protection Area of Tinharé and Boipeba Islands (EPATB), Cairu county, Bahia State. There, mass tourism occurs mainly in the form of coral-reef visits, resulting in clearly noticeable adverse effects. The test results were: a) selection of Tassimirim beach, with variated marine geobiodiversity, for deploying an underwater trail 320 meters long; b) product testing with 28 participants: 89% rated the product as excellent; c) 76% of the tourists are agreeable to paying $ 17.00 to $ 33.00 for the product; d) 80% of the residents classified the product as excellent; e) 91% would like to get involved with the product; f) 88% of local entrepreneurs rate the initiative as excellent; g) 55% of these would divulge the product; h) The price of the product is now $ 16.00. Income from the product applied during 10 days generated $ 433.00. If association holds, around 50% of the income would go to pay the diver and project technical coordinator, with almost 100% profit.

Table 4. Main steps of the model which facilitates the development of Emancipatory Environmental Education through Marine ecotourism.

Steps	Model subtopics
1	Characterization of negative public use of marine ecosystems, by quantifying them through comparative studies or direct observation
2	Characterization of marine geobiodiversity and design of a trophic contextual web
3	Creation of a network of partners interested in supporting or owning the product after its formulation, with agreement on ways of collaboration
4	Product formulation, including an underwater trail with interpretative areas
5	Product efficacy assessment generated by the university
6	Training courses offered to divers and micro-entrepreneurs from the local community
7	Dissemination of results to the scientific community, and the procedure towards a network of local partners.

8. Project PEAPP: Perception and Environmental Education in a Public Square, as a strategy to face Sea Global Warming

Coordinator: Alexandre Gusmão Pedrini, IBRAG / UERJ

General objective

Develop a methodology for keen perception, as an environmental and educational form of applying extension activities of UERJ, with the context of a material detachment event that occurs in a public square denominated Edmundo Rego in the city of Rio de Janeiro.

Specifics objectives

Environmental perception

The main objectives are: a) identify perception of climate change, especially global warming (GW) at sea, among children, teenagers and adults; b) test the hypothesis whether visitors to the square and the material

detachment event have a higher level of socio-environmental knowledge than mere bypassers; c) check the level of understanding of the real significance of certain selected key-concepts, viz., the environment, the marine environment, Global Climate Change (GCC), the effects of sea global-warming, and the causes of GW; d) evaluate which media are important as sources of information on the studied subjects; e) check whether the subjects know who is responsible for GCC; f) learn whether visitors assume a participating attitude and adaptation to GCC.

Environmental Education

The main objectives are: a) develop a methodology for promoting environmental education to face global warming in a marine environment within the context 'Climate Change', among teens and adults who are visiting a public square; b) due to contextual difficulties, through 'Participatory Planning' select which are the appropriate methodological strategies for environmental education action in the place chosen; c) test each of the chosen strategies, as to suitability and performance; d) present the composition of the marine environment, its importance and synergy, and the negative effects of Global Warming; e) Encourage and discuss, what each can do, both individually and collectively, to address the negative effects of GW at sea.

Description and Conceptual Background

Environmental education, as a strategy for coping with GCC, more specifically those arising from Global Warming, and their impact on the sea, is in the very beginning. Vasconcelos and TAMAIO (2010) strongly criticized the National Climate Change Plan developed by the Ministry of the Environment, for encouraging improvements in education in this area. The federal government subsequently published an interesting book on the subject written by TAMAIO (2013). This very preliminary work presents several guidelines on the way the environmental educator should address GCC. One is to provide scientific information on identifying the phenomenon and its anthropogenic causes. He selected certain authors and sites identified with the EE chain defended by him. Unfortunately, in the process such works as those by PEDRINI (2008) and PEDRINI and SABA (2008) among others, and as presented in this article, were excluded.

In fact, in Brazil there is the lack of a comprehensive synthesis of convergence between EE and GCC. The practical character of the process is presented by VIEIRA and BAZZO (2007), DEBONI (2007) and PEDRINI and SABA (2008). The first reports on a case of EE with GW in the classroom, showing scientific methodology with a strong epistemological component. The second is that by PEDRINI and SABA (2008), originally written in English. They proposed a methodology for addressing the main problem arising from GCC, i.e., Global Warming (GW). Work was carried out in three steps, in six classes directed to the first and second years of High School. It was the basis of research for the film "An Inconvenient Truth" presented by the former USA Vice President Al Gore. The third, by DEBONI (2007), presented reflections on issues arising from global change (also centered in GW) and EE. This involved a series of conjectures on EE and the media, thereby proposing that environmental educators go deeper into the subject in theoretical and conceptual terms, and not be limited to a repetition of what has been seen on TV or in films, such as "An Inconvenient Truth", with its plainly visible characteristics of self-promotion.

In fact, DEBONI (2007), besides undertaking research in the field, incited government officials to assume their responsibilities for more in depth studies of this delicate problem within the context of Brazilian environmental education, whence the subject requires the comprehensive training of the public, teachers, politicians, public authorities, etc. The contribution of this project arises from reaching the public that congregates at a material detachment event in a public square. Thus, this extension work addresses GCC to a congregation in a public space, as understood from the Habermas perspective (HABERMAS, 1984), viz., a *locus* for collective claims, both by adults and teenagers.

Results

For PEDRINI et al. (2014a) and from preliminary results, it was shown that most people (75%) correctly comprehend the concepts Marine Environment (ME), Global Climate Change (GCC) and Global Warming (GW). On the other hand, Environmental Education (EE) is only understood as a change in behavior (59%). The understanding is that humanity is the social-actor responsible for GCC (72%). People believe that they help to improve the environment, a) by becoming aware of the problem, and aiding in conservation (23% each), and b) by practicing the three Rs (17%). In the case of 22%, there was no response. The fact that 1/5 stated that nothing should be done requires investigation. The results of diagnosis imply an in-depth approach to the subject of the consequences of GW on the sea.

As to responsibility for GCC, Pedrini et al. (PEDRINI et al., 2015c) verified whether respondents attributed this to humanity as a whole. However, it is important to point out that there are more important social actors to be highlighted, apart from those indicated in this naïve answer. These are unscrupulous entrepreneurs and selfish investors, who only think about constantly increasing their profit. In general, these groups attempt to cheat environmental control systems, and have no scruples about worsening the environmental health of cities and their outskirts. Assign the deterioration of environmental quality by GCC to mankind as a whole could, to a certain extent, be a form of accommodation on the part of respondents, as also a translation of the consumerist-capitalist-media maneuvers that crown our contemporary society. Another alternative is a way of attributing responsibilities to nobody in particular, and thus conceal the real and mainly responsible culprits, in other words, the rich industrial countries.

Some believe that only individual change would suffice for confrontation with GCC (GHILARDI-LOPES et al., 2014a; GHILARDI-LOPES et al., 2015). However, it has been shown that the simple acquisition of fresh knowledge is insufficient to generate these changes (TAMAIO, 2013). PEDRINI et al. (PEDRINI et al., 2015b; PEDRINI et al., 2015c) showed that there are no daily individual attitudes. The general belief was that collective efficacy would only be attained through the implementation of mediating, public policies. Neither do they know that government planning is more concerned with plans for adjustments to the situation, and less to facing and situating changes. Furthermore, the existence of federal, state and municipal policies in the City of Rio de Janeiro is unknown, and there is no assessment of their efficacy. This accommodation, even among environmentalists, is worrying. A possible explanation could be discredit in a government official who might be the leading figure in formulating laws derived from policies. The sources of information about GCC is one more topic of concern. The predominant ones are Internet (32%) and cable TV (21%). It is widely known that, to a large extent, data from both are either wrongly divulged or outdated. Nonetheless, the hypothesis about GCC tested by environmentalists in the square having an adequate information level, has been statistically proven. However, on coping with GCC, this information-set cannot be translated into terms of attitudes in the daily lives of individuals.

The method on how individuals could face and contribute towards solving the adverse effects of GCC presented relative dispersion. Thus, it can be deduced that the public in general knows nothing about what and how to act. The belief (reinforced by the concept of EE being merely behavioral, see PEDRINI et al., 2015b) is that only the adoption of essentially behavorial action of the three Rs, or eventual simple action, are adequate.

9. Diving in Seropedica's education

Coordinator: Valéria Marques, UFRRJ, Guilherme Henrique Pereira Filho, UNIFESP

Objectives:

This Project was started during 2011, with an interdisciplinary and interdepartmental character integrating teachers and students belonging to several fields of knowledge, notably biology and psychology. It was afterwards split into two sub-projects "Diving, the connection between Seropedica and UFRRJ: the use of narration in environmental education" (SILVA; MARQUES, 2012; VERAS et al., 2012; VINHAES et al., 2012) and "Dive and ideas, innovation and ideals" (MARQUES et al., 2013). Within the overall aim of linking high school students to the university scientific environment, thereby favoring new possibilities in knowledge construction, the first was directed towards collaboration with teachers, by enriching practical pedagogy through diving experience, and evaluating narration as a methodological tool. The second was aimed at evaluating the use of underwater trails, as an educational activity in high schools (CIEP 155 Maria Joaquina de Oliveira Seropédica/RJ). It was developed in two phases, viz., the training of environmental monitors/multipliers, and the evaluation of the diving experience of students (Ilha Grande, RJ), through questionnaires and interviews.

Results

1. Development of protocols and implementation of 3 trails: "In loco" Ilha Grande terrestrial and underwater trails; Itinerant trail, in which the marine environment was discussed through comic strips in 10 panels; Virtual electronic track (under development).
2. Development of supporting didatic material (MARQUES; PEREIRA FILHO, 2013; MARQUES et al., 2013).
3. Monitor training and formation –6 high school teachers and 11 monitors were formed.
4. Model implementation – application to 25 high school students (2011-2012) and 75 students (2012-2013).

5. Evaluation of activities – the discussion and activity evaluation were published as abstracts (MARQUES et al., 2013; SILVA; MARQUES, 2012; VERAS et al., 2012), and as an undergraduate dissertation (VERAS, 2014). A master dissertation is also in preparation.

10. Mussels: Evaluating and stimulating community integration coupled to mussel farming at Jurujuba, Niterói – Rio de Janeiro

Coordinators: Daniel Shimada Brotto, Marcia Esteves Capello, Lucilia Ramos Tristão, UVA; Marli Cigagna Wiefels, UFF)

Objectives

The main goal is to evaluate socio-environment perception, and various forms of production of those directly and indirectly involved in mussel farming, prior to implementing advisory action aimed at optimizing both activities and social emancipation.

Description and Conceptual Background

Although handicraft fishing, tourism and sea farming can be considered as natural local vocations, there have been many problems since the end of the 70's, evidently brought about by the lack of understanding on the part of government authorities. The formerly traditional fishing community is now a decadent and disorderly town district, composed of seafood restaurants, and decrepit sardine canning industries, commercial fishing docks, yachting marinas and mussel farms, in other words, a diversified human community mainly composed of lower income citizens (RITTER, 2007).

Since the end of the 80's, mussel farming emerged as a profitable and economic activity in the region, nowadays this being the main source of income that sustains many families, independent of the questionable water conditions, the lack of organization, and the technological gap among local entrepreneurs.

Project approach is quite in accordance with the precepts of Environmental Education for Sustainable Societies (PEDRINI; BRITO, 2006), by aiming at self-emancipation and the integration of individuals by permanent participation in the solution of on-the-spot environmental questions.

Preliminary results

As they belonged to families of mussel farmers and fishermen, the primary focus was centered on a group of school students in the region. At the end of 2011, and after a first contact with teachers and the director of the CEFEM (Colégio Estadual Fernando de Magalhães), students were invited by their teachers to participate in environmental education activities, specifically beach surveys and rapid assessment protocols, carried out in the neighborhood, and also to attend extra school lectures, when they were asked to respond to questionnaires, to so evaluate perception and the efficacy of the specific activity. Those directly involved in mussel farming were informally interviewed and observed *in situ* during working hours.

Results from the aforementioned approaches should be considered, when planning instructive activities focusing the optimization of mussel farming at Jurujuba, and of the use of discarded shells in handcraft and the arts. The implicit aim is to foment critical perception of the world, as well as community integration, focusing on a certain charismatic living marine resource, since in Brazil the word mexilhão (mussel) can be used to define, not only an inquisitive and restless person, but also another important aspect of the cultivated mussel species, *Perna perna*, a very resilient invasive species that was accidentally brought to South America in slave ships from Africa, as were the ancestors of most of the people living in Jurujuba.

CONCLUSIONS

Marine and coastal environment-education activities in Brazil are still scarce and need to receive effective support from such integrated networks as ReBentos, which unite researchers from various regions of the country, thereby facilitating the creation of sub-networks and the exchange of information, data and results. There are several models of Marine Environmental Education under way. They differ mainly as to the theoretical approach (PEDRINI, 2008; PEDRINI, 2013), as for example, being in accordance with the theory of Popular Education by Paulo Freire, or with Critical Environmental Education. They also vary in the methodological strategies selected to obtain data or their analysis (PEDRINI, 2007) such as the selection of action research, interviews, life histories, questionnaires, and content or speech analysis, among others. What can be standardized over short-term are data-analysis methods in the context of a quantitative paradigm, since within the qualitative, standardization would only be possible after numerous actions and projects have been completed. Only in this way is it possible to think of establishing standardized procedures based on a solid conceptual framework.

So far, the ReBentos environment education

work-group is dealing with activities and projects that still do not use the biologic results from the other groups of the network (estuaries, beaches, submersed vegetated bottoms, reefs and rocky shores, mangroves and salt marshes). The aim is to increase the use and exchange of these data in the future. Actions should be expanded to public schools, as well as to other states within the country. EE approaches with the specific goal of impacting decision-makers and media are also considered fundamental.

ReBentos Directives for Marine-Environment Education

Climate change is an excellent pedagogical opportunity for inducing desirable outcomes in environmental education. It serves as a means for teaching the science of complex systems, and comprises a teaching opportunity for meaningful learning, through being ideal for debating the application of the precautionary principle. Nonetheless, the complexity and global nature of the phenomenon, associated with the difficulty of modifying human behavior, complicates the choice of efficient strategies in climate-change education. Therefore, the evaluation of medium and long-term education intervention is crucial. Besides the number of participants or events, evaluation should be based on achievement of specific environmental education indicators.

As a further step, definite protocols should be elaborated for each EE model, to so serve as supports for newcomers to the area, and for direct action within the network, thereby facilitating the exchange of experience and material among ReBentos groups.

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REFERENCES

ACAUAN, R.; KREMER, L. P.; TEIXEIRA, B.; PILOTTO, A. L. S. Aprendendo com o Mar: subsídios ao desenvolvimento da educação ambiental marinha no ensino básico. Congresso Brasileiro de Oceanografia. Itajaí, 2014.

ACAUAN, R. C.; KREMER, L. P.; TEIXEIRA, B.; ZIPPER, G.; GONÇALVES, I.; LIM, M. D. S. D. Aprendendo com o Mar: inserção da mentalidade marítima no ensino fundamental, Itajaí, SC. IV Encontro Nacional dos Núcleos de Pesquisa Aplicada em Pesca e Aquicultura. Itajaí, 2012.

ALMEIDA, R.; FRAGA, R. A.; DEMONER, A. R.; FERRAZ, V. Quando a educação não formal encontra a escola. Projeto povos e mangues: 20 meses de monitoramento. Rev. SBENBio., v. 3, p. 2486-2497, 2010.

ALMEIDA, R.; COELHO JÚNIOR, C.; CORETS, E. Os Maravilhosos Manguezais do Brasil. Cariacica: Papagaia, 2008. 266 p.

ARAÚJO, E. S. A.; OLIVEIRA, A. P. L.; MORAIS, J. P. S.; SOVIERZOSKI, H. H.; CORREIA, M. D. Trabalho prático aplicado ao ensino de ciências naturais. I Encontro Luso-Brasileiro sobre Trabalho Docente: Maceió, 2011 p. 145-150.

AUSUBEL, D. P.; NOVAK, J. D.; HANESIAN, H. Psicologia educacional. 2. ed. Rio de Janeiro: Interamericana, 1980. 626 p.

BARKER, N. H. L.; ROBERTS, C. M. Scuba diver behaviour and the management of diving impacts on coral reefs. Biol. Conserv., v. 120, n. 4, p. 481-489, 2004.

BELLARD, C.; BERTELSMEIER, C.; LEADLEY, P.; THUILLER, W.; COURCHAMP, F. Effects of climate change on the future of biodiversity. Ecol. Lett., v. 15, n. 4, p. 365-377, 2012.

BERCHEZ, F.; GHILARDI, N.; ROBIM, M. J.; PEDRINI, A. G.; HADEL, V. F.; FLUCKIGER, G.; SIMÕES, M.; MAZZARO, R.; KLAUSENER, C.; SANCHES, C.; BESPALEC, P. Projeto Trilha Subaquática: sugestão de diretrizes para a criação de modelos de educação ambiental em unidades de conservação ligadas a ecossistemas marinhos. OLAM – Ciênc. Tecnol., v. 7, n. 3, p. 181-209, 2007.

BERCHEZ, F.; MANSILLA, A.; GHILARDI-LOPES, N. P.; SHWINDT, E.; LEITE, K.; ROZZI, R. Ecology and Education in Marine Protected Areas: Insights from Brazil and South America. In: ROZZI, R.; CHAPIN III, F. S.; CALLICOTT, J. B.; PICKETT, S. T. A.; POWER, M. E.; ARMESTO, J. J., MAY JÚNIOR, R. H. (Eds.). Earth Stewardship: Linking Ecology and Ethics in Theory and Practice. Cham: Springer International Publishing, 2015. v. 2, 2015. p. 351-366.

BERCHEZ, F. A. S.; CARVALHAL, F.; ROBIM, M. J. Underwater interpretative trail: guidance to improve education and decrease ecological damage. Int. J. Environ. Sust. Devel., v. 4, n. 2, p. 128-139, 2005.

BERCHEZ, F. A. S.; OLIVEIRA FILHO, E. C.; AMÂNCIO, C. E.; GHILARDI, N. P. Possíveis impactos das mudanças climáticas globais nas comunidades de organismos marinhos bentônicos da costa brasileira. In: BUCKERIDGE, M. (Ed.). Biologia & Mudanças Climáticas no Brasil. São Carlos: RiMa, 2008. p.167-180.

BERCHEZ, F. A. S.; TIAGO, C. G.; ROSSO, S.; DIAS, G.; OLIVEIRA, E. C. Structure of a coralline algal bed on southeastern Brazil. Braz. J. Biol., v. 13, p. 49-57, 2009.

BRASIL. Ministério do Meio Ambiente e Ministério da Educação. Programa Nacional de Educação Ambiental. 3. ed. Brasília: MMA e MEC, 2005. 102 p.

BRECHIN, S. R. Sociology: Shaping US climate opinion. Nat. Clim. Chang., v. 2, p. 236-237, 2012.

CAMPOS, F. P. Em defesa de Alcatrazes. 2008. Acesso em: 08 de janeiro de 2008.

Disponível em: < http://www.alcatrazes.org.br/home/textos/defesa/defesaAlcatrazes.htm >.

CORREIA, M. D.; SOVIERZOSKI, H. H. Ecossistemas Costeiros de Alagoas - Brasil. Rio de Janeiro: Technical Books, 2009. 144 p.

CORREIA, M. D. Macrobenthic diversity reaction to human impacts on Maceió coral reefs, Alagoas, Brazil. 11th International Coral Reef Symposium. Fort Lauderlade. International Society for Reef Studies, 2010. p. 1083-1087.

CORREIA, M. D. Endemic Macrobenthic Fauna on the Brazilian Reef Ecosystems. 12th International Coral Reef Symposium. Cairns: International Society for Reef Studies, 2012. p. 9-13.

COSTA, V. C.; COSTA, N. M. C. O desafio do ecoturismo em unidades de conservação. Rev. Geo. UERJ, v. 8, p. 55-66, 2000.

CREED, J. C.; AMADO-FILHO, G. M. Disturbance and recovery of the macroflora of a seagrass (*Halodule wrightii* Ascherson) meadow in the Abrolhos Marine National Park, Brazil: an experimental evaluation of anchor damage. J. Exp. Mar. Biol. Ecol., v. 235, n. 2, p. 285-306, 1999.

DEANEY, R.; RUTHVEN, K.; HENNESSY, S. Pupil perspectives on the contribution of information and communication technology to teaching and learning in the secondary school. Res. Papers. Educ., v. 18, n. 2, p. 141-165, 2003.

DEBONI, F. E. A Educação Ambiental frente às mudanças climáticas: organizar ou desorganizar? Brasil: Notícias da América Latina e Caribe, 2007.

DIELEMAN, H.; HUISINGH, D. Games by which to learn and teach about sustainable development: exploring the relevance of games and experiential learning for sustainability. J. Clean. Prod., v. 14, p. 837-847, 2006.

DORAN, P. T.; ZIMMERMAN, M. K. Examining the Scientific Consensus on Climate Change. Eos Trans. Am. Geop. Union., v. 90, n. 3, p. 22-23, 2009.

GALLO NETO, H.; BARBOSA, C. B. Educação Ambiental em aquários de visitação pública: a experiência do Aquário de Ubatuba. In: PEDRINI, A. D. G. (Ed.). Educação ambiental marinha e costeira no Brasil. Rio de Janeiro: EDUERJ, 2010. p. 227-242.

GARROD, B.; WILSON, J. C. Nature on the Edge? Marine ecotourism in peripheral coastal areas. J. Sust. Tou., v. 12, n. 2, p. 95-120, 2004.

GARROD, B.; WILSON, J. C.; BRUCE, D. M. Ecoturismo Marino Genuinamente Sostenible en el Área Atlântica de La UE: Guia de Buenas Prácticas. Bristol: University of the West of England, 2002.

GARROD, B.; WILSON, J. C.; BRUCE, D. M. Defining Marine ecotourism: a Delphi Study. In: GARROD, B.; WILSON, J. C. (Eds.). Marine ecotourism: Issues and experiences. Clevedon: Channel View Publications, 2003.

GHILARDI-LOPES, N. P. Desafio em Apicum. Santo André: UFABC, 2014. 112 p. Disponível em: < http://professor.ufabc.edu.br/~natalia.lopes/jogosmarinhos/index.php/material-de-apoio-2/16-livro-jogo >.

GHILARDI-LOPES, N. P.; BRAGA, J. C.; SILVA, L.; FREITAS, S. R. D.; SILVA, R. L. F.; RIBEIRO, T.; SIMÕES, E.; PINHATA, E. Environmental education through an online game about global environmental changes and their effects on coastal and marine ecosystems. Proceedings of SBGames. São Paulo: Sociedade Brasileira de Computação, 2013a. p. 469-474.

GHILARDI-LOPES, N. P.; TURRA, A.; BUCKERIDGE, M.; OLIVEIRA, V. M. D.; SILVA, A. C.; BERCHEZ, F. A. D. S. Perceptions and conceptions of tourists about climate changes: case study during the subaquatic trail project (Ubatuba, northern São Paulo State coast, Brazil). 7th World Environmental Education Congress. Ubatuba: Marrakech. WEEC Permanent Secretariat, 2013b.

GHILARDI-LOPES, N. P.; HADEL, V. F.; BERCHEZ, F. Guia para Educação Ambiental em Costões Rochosos. Porto Alegre: Artmed, 2012. 200 p.

GHILARDI-LOPES, N. P.; KAWABE, L. A.; SLOMPO, C. S. Formação continuada em mudanças climáticas globais e seus efeitos nos ambientes marinhos e costeiros: um relato de experiência de curso de extensão na Universidade Federal do ABC (UFABC, Santo André, Brasil). Revista da SBEnBIO, v. 7, p. 5935-5946, 2014a. Disponível em: < http://www.sbenbio.org.br/wordpress/wp-content/uploads/2014/11/R0107-1.pdf >.

GHILARDI-LOPES, N. P.; KAWABE, L. D. A.; SLOMPO, C. S. Formação Continuada: Mudanças Climáticas Globais e seus Efeitos nos Ambientes Marinhos e Costeiros. Santo André: UFABC, 2014b. 71 p.

GHILARDI-LOPES, N. P.; TURRA, A.; BUCKERIDGE, M. S.; SILVA, A. C.; BERCHEZ, F. A. D. S.; OLIVEIRA, V. M. D. On the perceptions and conceptions of tourists with regard to global environmental changes and their consequences for coastal and marine environments: A case study of the northern São Paulo State coast, Brazil. Mar. Policy, v. 57, p. 85-92, 2015.

GHILARDI-LOPES, N. P.; BERCHEZ, F. Projeto Trilha Subaquática - modelos de educação ambiental marinha para o grande público. In: PEDRINI, A. G. (Ed.). Educação ambiental marinha e costeira no Brasil. Rio de Janeiro: EdUERJ, 2010. p. 71-91.

GONZÁLEZ GAUDIANO, E. Interdisciplinaridade e educação ambiental: explorando novos territórios epistêmicos. In: SATO, M.; CARVALHO, I. M. (Eds.). Educação ambiental: pesquisa e desafios. Porto Alegre: Artmed, 2005. p. 119-133.

GUERRA, A. F. S. Educação Ambiental em áreas costeiras: o aprender e o ensinar usando a Internet. In: PEDRINI, A. G. (Ed.). O Contrato Social da Ciência, unindo saberes na Educação Ambiental. Petrópolis: Vozes, 2002. p. 45-55.

GURGEL, I. M. G. N.; PEREIRA, M. B.; FRAGOSO, A. B. L.; LAILSON-BRITO, J.; AZEVEDO, A. D. F. Educação Ambiental para a preservação de mamíferos aquáticos. In: PEDRINI, A. G. (Ed.). O Contrato Social da Ciência unindo saberes na Educação Ambiental. Petrópolis: Vozes, 2002. p. 233-254.

HABERMAS, J. Mudança estrutural da esfera pública: investigações quanto a uma categoria da sociedade burguesa. Rio de Janeiro: Tempo Brasileiro, 1984.

HADEL, V. F.; BERCHEZ, F. S. A biologia marinha ao alcance de todos: programas de visitas monitoradas ao CEBIMar. Rev. Cult. Ext. USP., v. 1, p. 50-61, 2005.

HAWKINS, J. P.; ROBERTS, C. M. Effects of recreational scuba diving on coral reefs: trampling on reef-flat communities. J. Appl. Ecol., v. 30, n. 1, p. 25-30, 1993.

HAWKINS, J. P.; ROBERTS, C. M.; T VAN'T HOF, K.; MEYER, K.; TRATALOS, J.; ALDAM, C. Effects of recreational scuba diving on caribbean coral and fish communities. Conserv. Biol., v. 13, n. 4, p. 888-897, 1999.

HEIMLICH, J. E. Environmental Education: A Resource Handbook. Bloomington: Phi Delta Kappa Educational Foundation, 2002. 193 p.

IPCC. Climate Change: Impacts, Adaptation, and Vulnerability. Cambridge, and New York, 2014.

KATON, G. F.; TOWATA, N.; BERCHEZ, F. A. S.; OLIVEIRA, V. M.; URSI, S. Percepção de estudantes que vivem distantes do litoral sobre o Ambiente Marinho. Enseñs. Cienc., v. extra, p. 3554-3559, 2013.

KREMER, L. P.; ACAUAN, R. C.; TEIXEIRA, B. A extensão e o desenvolvimento da mentalidade marítima brasileira. 31º Seminário de Extensão Universitária da Região Sul. Universidade Federal de Santa Catarina, 2013.

LA TROBE, H. L.; ACOTT, T. G. A modified NEP/DSP environmental attitudes scale. J. Environ. Educ., v. 32, n. 1, p. 12-20, 2000.

LEÃO, Z. M. A. N.; KIKUCHI, R. K. P.; TESTA, V. Corals and coral reefs of Brazil. In: CORTES, J. (Ed.). Latin American Coral Reefs. Amsterdam: Elsevier; 2003. p. 9-52.

LEVISTON, Z.; WALKER, I.; MORWINSKI, S. Your opinion on climate change might not be as common as you think. Nat. Clim. Chang., v. 3, n. 4, p. 334-337, 2013.

LEWANDOWSKY, S.; GIGNAC, G. E.; VAUGHAN, S. The pivotal role of perceived scientific consensus in acceptance of science. Nat. Clim. Chang., v. 3, n. 4, p. 399-404, 2013.

LIM, C. P.; PEK, M. S.; CHAI, C. S. Classroom management issues in information and communication technology (ICT)-mediated learning environments: back to the basics. J. Educ. Mult. Hyper., v. 14, n. 4, p. 391-414, 2005.

LIMA JÚNIOR, R. L. S.; CORREIA, M. D.; SOVIERZOSKI, H. H. Apresentação dos invertebrados marinhos em livros de biologia do ensino médio utilizadas em Alagoas, Brasil. III Encontro Nacional de Ensino de Ciências da Saúde e do Ambiente. Niterói, 2012. 12 p.

LOUREIRO, C. F. B. Trajetórias e Fundamentos da Educação Ambiental. São Paulo: Cortez, 2006.

LUNA, B.; PÉREZ, C. V.; SÁNCHEZ-LIZASO, J. L. Benthic impacts of recreational divers in a Mediterranean Marine Protected Area. ICES J. Mar. Sci., v. 66, p. 517-523, 2009.

MARQUES, V.; PEREIRA-FILHO, G. H. Mergulho: uma nova ferramenta educacional. Rio de Janeiro: Seropédica/ Ed. da UFRJ, 2013. 128 p.

MARQUES, V.; PEREIRA FILHO, G. H.; VERAS, P. C. Mergulho Ideias, Inovações e Ideais. In: VIII Simpósio Pedagógico e Pesquisas em Educação. Resende, 2013.

MEDIO, D.; ORMOND, R. F. G.; PEARSON, M. Effect of briefings on rates of damage to corals by scuba divers. Biol. Conserv., v. 79, n. 1, p. 91-95, 1997.

MELO, R. S.; CRISPIM, M. C.; LIMA, E. R. V. O turismo em ambientes recifais: em busca da transição para a sustentabilidade. Cad. Virt. Turis., v. 5, n. 4, p. 34-42, 2005.

MILOSLAVICH, P.; KLEIN, E.; DÍAZ, J. M.; HERNÁNDEZ, C. E.; BIGATTI, G.; CAMPOS, L.; ARTIGAS, F.; CASTILLO, J.; PENCHASZADEH, P. E.; NEILL, P. E.; CARRANZA, A.; RETANA, M. V.; ASTARLOA, J. M. D. D.; LEWIS, M.; YORIO, P.; PIRIZ, M. L.; RODRÍGUEZ, D.; YONESHIGUE-VALENTIN, Y.; GAMBOA, L.; MARTÍN, A. Marine Biodiversity in the Atlantic and Pacific Coasts of South America: Knowledge and Gaps. PLoS ONE, v. 6, n. 1, p. e14631, 2011.

MONZONI, M. Diretrizes para a formulação de políticas públicas em mudanças climáticas no Brasil. São Paulo: GVces, 2009. 94 p.

OLIVEIRA, A. P. L.; ARAÚJO, E. S. A.; MORAIS, J. P. S.; SOVIERZOSKI, H. H.; CORREIA, M. D. Atividades Práticas como Recurso Didático para a Disciplina de Biologia no Ensino Médio em Alagoas. I Encontro Luso-Brasileiro sobre Trabalho Docente. Maceió, 2011. p. 20-35.

OLIVEIRA, A. P. L.; CORREIA, M. D. Aula de Campo como Mecanismo Facilitador do Ensino-Aprendizagem sobre os Ecossistemas Recifais em Alagoas. Alexandria, v. 6, n. 2, p. 163-190, 2013a. Disponível em: < http://alexandria.ppgect.ufsc.br/publicacoes-2013/volume-6-numero-2-junho-2013/ >.

OLIVEIRA, A. P. L. Aula de campo como mecanismo facilitador do Ensino-Aprendizagem sobre os ecossistemas Recifais em Alagoas. Alexandria, Rev. Educ. Ciênc. Tecnol., v. 6, n. 2, p. 163-190, 2013b.

OLIVEIRA, A. P. L.; CORREIA, M. D.; SOVIERZOSKI, H. H. Análise da Exposição sobre as Atividades das Aulas de Campo nos Ecossistemas Recifais. Rev. Educ. Amb. Ação, v. 49, p. 1-16, 2014.

OLIVEIRA, A. P. L.; MORAIS, J. P. S.; SOVIERZOSKI, H. H.; CORREIA, M. D. Avaliação do conhecimento dos alunos de uma escola pública sobre o ecossistema manguezal no litoral norte do município de Maceió. Alagoas. III Encontro Nacional de Ensino de Ciências da Saúde e do Ambiente. Niterói, 2012. 13 p.

PANITZ, C. M. N. Projeto de Oficinas Ecológicas em Ecossistemas Costeiros: Uma Proposta De Educação Ambiental Costeira. In: PEDRINI, A. G. (Ed.). Educação ambiental marinha e costeira no Brasil. Rio de Janeiro: EdUERJ, 2010. p. 160-176.

PEDRINI, A. G. Metodologias em Educação Ambiental. In: PEDRINI, A. G. (Org.) Metodologias em Educação Ambiental. Petrópolis: Vozes, 2007, p. 23-51.

PEDRINI, A. G. Mudanças globais e a educação ambiental para a construção de sociedades sustentáveis. In: Conferência da Terra. João Pessoa, 2008.

PEDRINI, A. G. Educação Ambiental Marinha e Costeira no Brasil. In: PEDRINI, A.G. (Org.). Educação Ambiental Marinha e Costeira no Brasil. Rio de Janeiro: EdUERJ, 2010, 272 p.

PEDRINI, A. G. A Inserção Contemporânea da Educação Ambiental no Ensino de Graduação em Instituições de Ensino Superior nos Estados do Rio de Janeiro e Espírito Santo. In: SEABRA, G. (Ed.). Educação Ambiental; conceitos e aplicações. João Pessoa: EdUFPB, 2013. p. 172-186.

PEDRINI, A. G.; BRITO, M. I. M. S. Educação Ambiental para o desenvolvimento ou sociedade sustentável? Uma breve reflexão para a América Latina. Rev. Educ. Amb. Ação, v. 5, n. 17, p. 20, 2006.

PEDRINI, A. G.; BROTTO, D. S.; GHILARDI-LOPES, N. P.; LOPES, M. C.; FERREIRA, L. P. Environmental education and ecotourism concepts in Marine Protected Area of Armação de Búzios, Rio de Janeiro, Brazil: reflections for the adoption of coastal ecotourism. Rev. Bras. Ecotur., v. 8, n. 1, p. 59-73, 2015a.

PEDRINI, A. G.; LIMA, L.; SANTOS, T. V.; NUNES, R. M.; BROTTO, D. S. Environmental Education in Public Square as a facing strategy of Global Warming On Sea: Participatory Planning with visitors for pedagogical action. 8th World Environmental Education Congress. Gothemburg, 2015b.

PEDRINI, A. G.; LIMA, L.; VIANA, T.; NUNES, R. M.; BROTTO, D. S. Percepção ambiental pública sobre atitudes e responsabilidades frente às mudanças climáticas globais por frequentadores de uma praça urbana na cidade do Rio de Janeiro (RJ, Brasil) e o papel das fontes de informação. 7º Encontro Nacional de Programas de Pós-Graduação e Pesquisa em Ambiente e Sociedade (ENAMPPAS). Brasília: Universidade Nacional de Brasília, 2015c.

PEDRINI, A. G.; BROTTO, D. S.; LOPES, M. C.; FERREIRA, L. P.; GHILARDI-LOPES, N. P. Percepções sobre meio ambiente e o mar por interessados em ecoturismo marinho na Area de Proteção Ambiental Marinha de Armação de Búzios, estado do Rio de Janeiro, RJ, Brasil. Pesqui. Educ. Amb., v. 8, n. 2, p. 59-75, 2013a.

PEDRINI, A. G.; BROTTO, D. S.; PIMENTEL, D. S.; BEHRENDS, E.; SOARES, A. A. J.; LOPES, M. C.; RUA, M. B. Ecoturismar project: Efficacy evaluation of an experimental ecotouristic product at marine Environmental Protection Area of Armação de Búzios (APAMAB), state of Rio de Janeiro, Brazil. Arraial do Cabo: BIOINC, 2013b. 5 p.

PEDRINI, A. G.; BROTTO, D. S.; LOPES, M. C.; MESSAS, T. P. Gestão de áreas protegidas com educação ambiental emancipatória pelo ecoturismo marinho: a proposta do Projeto Ecoturismar. OLAM – Ciênc. Tecnol., v. 10, n. 3, especial, p. 6-81, 2011. Disponível em: < http://www.periodicos.rc.biblioteca.unesp.br/index.php/olam/index >.

PEDRINI, A. G.; BROTTO, D. S.; MESSAS, T. P. Avaliação de aproveitamento no I curso de atualização em EA para o turismo marinho e costeiro (I CEAM). Rev. Eletr. Mestr. Educ. Amb. (REMEA), v. 28, p. 133-147, 2012.

PEDRINI, A. G.; COSTA, C.; NEWTON, T.; MANESCHY, F. S.; SILVA, V. G.; BERCHEZ, F.; SPELTA, L.; GHILARDI, N. P.; ROBIM, M. J. Efeitos ambientais da visitação turística em áreas protegidas marinhas: estudo de caso na Piscina Natural Marinha, Parque Estadual da Ilha Anchieta, Ubatuba, São Paulo, Brasil. OLAM – Ciênc. Tecnol., v. 7, n. 1, p. 678-696, 2007.

PEDRINI, A. G.; DUTRA, D.; ROBIM, M. J.; MARTINS, S. L. Gestão de áreas protegidas e avaliação da educação ambiental no ecoturismo: estudo de caso com o Projeto Trilha Subaquática – educação ambiental nos ecossistemas marinhos – no Parque Estadual da Ilha Anchieta, Ubatuba, São Paulo, Brasil. OLAM – Ciênc. Tecnol., v. 8, n. 2, p. 31-55, 2008.

PEDRINI, A. G.; LIMA, L.; VIANA, T. Educação Ambiental em praça pública como estratégia para enfrentamento do aquecimento Global do mar: percepção dos visitantes sobre a problemática. 4º Fórum brasileiro de educação ambiental. Belém, 2014a.

PEDRINI, A. G.; URSI, S.; BERCHEZ, F.; CORREIA, M. D.; SOVIERZOSKI, H. H.; MOCHEL, F. R. Metodologia em Educação Ambiental para a Conservação Socioambiental dos Ecossistemas Marinhos. In: PEDRINI, A. G.; SAITO, C. H. (Eds.). Paradigmas Metodológicos em Educação Ambiental. Petrópolis: Vozes, 2014b. p. 132- 151.

PEDRINI, A. G.; MESSAS, T. P.; PEREIRA, E. S.; GHILARDI-LOPES, N. P.; BERCHEZ, F. A. Educação Ambiental pelo Ecoturismo numa trilha marinha no Parque Estadual da Ilha Anchieta, Ubatuba (SP). Rev. Bras. Ecotur., v. 3, n. 3, p. 428-459, 2010.

PEDRINI, A. G.; SABA, M. G. Educação ambiental e mudanças ambientais globais: um relato de experiência com o documentário "Uma verdade inconveniente" como estratégia no ensino de inglês numa escola pública. Conferência da Terra. João Pessoa: Anais da Conferência da Terra, 2008. p.101-105.

PLATHONG, K.; INGLIS, J.; HUBER, M. E. Effects of Self-Guided Snorkeling Trails on Corals in a Tropical Marine Park. Conserv. Biol., v. 14, n. 6, p. 1821-1830, 2000.

REUSS-STRENGEL, G.; ASMUS, M.; CHLUDINSKI, A. P. Avaliação do impacto causado pelo turismo marinho na Reserva Biológica Marinha do Arvoredo, Santa Catarina, Brasil, utilizando um modelo ecológico de simulação. I Congresso Brasileiro de Unidades de Conservação. Curitiba: Rede Pró-UC, 1997. p. 528-541.

RHORMENS, M. S.; PEDRINI, A. G. Educação Ambiental Emancipatória pelo Ecoturismo Marinho de Base Comunitária nos Ecossistemas Recifais da Área de Proteção Ambiental das Ilhas de Tinharé e Boipeba, município de Cairu, Bahia, Brasil. 3º Congresso internacional de países e comunidades de língua portuguesa, 2015. Torreira, Portugal.

RITTER, P. D. Da Roça ao Mar: estudo de uma comunidade de marisqueiros em Jurujuba. 2007. 242 f. Dissertação (doutorado). Rio de Janeiro: Instituto de Psicologia, 2007.

ROCKSTROM, J.; STEFFEN, W.; NOONE, K.; PERSSON, A.; CHAPIN, F. S., 3RD; LAMBIN, E. F.; LENTON, T. M.; SCHEFFER, M.; FOLKE, C.; SCHELLNHUBER, H. J.; NYKVIST, B.; DE WIT, C. A.; HUGHES, T.; VAN DER LEEUW, S.; RODHE, H.; SORLIN, S.; SNYDER, P. K.; COSTANZA, R.; SVEDIN, U.; FALKENMARK, M.; KARLBERG, L.; CORELL, R. W.; FABRY, V. J.; HANSEN, J.; WALKER, B.; LIVERMAN, D.; RICHARDSON, K.; CRUTZEN, P.; FOLEY, J. A. A safe operating space for humanity. Nature, v. 461, n. 7263, p. 472-5, 2009.

ROUPHAEL, A. B.; INGLIS, G. J. Take only photographs and leave only footprints? An experimental study of the impacts of underwater photographers on coral reef dive sites. Biol. Conserv., v. 100, n. 3, p. 281-287, 2001.

ROZZI, R.; ARMESTO, J. J.; GUTIÉRREZ, J. R.; MASSARDO, F.; LIKENS, G. E.; ANDERSON, C. B.; POOLE, A.; MOSES, K. P.; HARGROVE, E.; MANSILLA, A. O.; KENNEDY, J. H.; WILLSON, M.; JAX, K.; JONES, C. G.; CALLICOTT, J. B.; ARROYO, M. T. K. Integrating Ecology and Environmental Ethics: Earth Stewardship in the Southern End of the Americas. BioScience, v. 62, n. 3, p. 226-236, 2012.

SALM, R. V. Integrating marine conservation and tourism. Int. J. Environ. Stud., v. 25, n. 4, p. 229-238, 1985.

SILVA, E. L.; MARQUES, V. O uso do questionário na interação pessoa-ambiente como instrumento de avaliação da percepção ambiental. VII Fórum da Pós-Graduação da UFRRJ, 2012.

SILVA, F. J. L.; SILVA JR., J. M. Incremento do turismo e implicações na conservação dos golfinhos rotadores no Parque Nacional Marinho de Fernando de Noronha. III Congresso Brasileiro de Unidades de Conservação. Rede Nacional Pró-Unidades de Conservação/Fundação O Boticário de Proteção à Natureza. Fortaleza. 2002. p. 135-144

SILVA, I. B.; FUJII, M. T.; MARINHO-SORIANO, E. Influence of tourist activity on the diversity of seaweed from reefs in Maracajaú, Atlantic Ocean, Northeast Brazil. Braz. J. Pharmacogn., v. 22, n. 4, p. 889-893, 2012.

SILVA, J. N.; GHILARDI-LOPES, N. P. Indicators of the impacts of tourism on hard-bottom benthic communities of Ilha do Cardoso State Park (Cananéia) and Sonho Beach (Itanhaém), two southern coastal areas of São Paulo State (Brazil). Ocean. Coast. Manag., v. 58, p. 1-8, 2012.

SILVA JR., J. M.; GERLING, C.; VENTURI, E.; ARAUJO, L. L.; SILVA, F. J. L. Férias Ecológicas: um programa de educação ambiental marinha em Fernando de Noronha. In: PEDRINI, A. D. G. (Ed.). Educação Ambiental Marinha e Costeira no Brasil. Rio de Janeiro: EdUERJ, 2010. p. 201-226.

SILVA, L.; BRAGA, J. C.; GHILARDI-LOPES, N. P.; PINHATA, E.; SIMÕES, E.; RIBEIRO, T.; RIBEIRO, E. Q.; SHINOHARA, B. Educational game on global environmental changes: Collaborative design using a social network. Proceedings of SBGames. São Paulo: Sociedade Brasileira de Computação, 2013a. p. 520-523.

SILVA, L. M.; CORREIA, M. D.; SOVIERZOSKI, H. H. Percepção Ambiental Sobre os Ecossistemas Recifais em duas diferentes Áreas do Litoral Nordeste do Brasil. Rev. Educ. Amb. Ação., v. 45, p. 1-13, 2013b. Disponível em: < http://www.revistaea.org/artigo.php?idartigo=1590&class=02 >.

SILVA, M. S.; RIBEIRO, A. C. V.; LADISLAU JÚNIOR, R.; DELGADO-MENDEZ, J. M.; ALMEIDA, R. O Uso do Guia Didático Os Maravilhosos Manguezais do Brasil no contexto da Reserva Extrativista Marinha Baía do Iguape. Maragojipe: Seminário Universidade e Sociedade Semana Kirimurê, 2012.

SOUZA, N. N. F.; CORREIA, M. D.; SOVIERZOSKI, H. H. Atitudes Ambientais entre os Alunos da Educação de Jovens e Adultos em Maceió, Alagoas. II Congresso Nacional de Educação Ambiental. João Pessoa, 2011. p.1210-1215.

SOUZA, V. W.; CORREIA, M. D.; SOVIERZOSKI, H. H. Um Pé De Quê, Uma Proposta Pedagógica para Aulas de Botânica. 65ª Reunião Anual da SBPC, Ciências Biológicas, 2013. 3 p.

SOVIERZOSKI, H. H.; SANTOS, L. M.; CORREIA, M. D. A Construção do Pensamento Ecológico a partir da Visão do Manguezal nos Desenhos de Alunos do Ensino Fundamental. IV Encontro Nacional de Ensino de Ciências da Saúde e do Ambiente. Niterói, 2014. p. 1-12.

SPELTA, L. Avaliação das alterações na estrutura da comunidade bentônica relacionadas à visitação pública na piscina natural do Parque Estadual de Ilha Anchieta, Ubatuba. 2011. 122 f. Dissertação (Mestrado). Instituto de Biociências, Universidade de São Paulo, São Paulo, 2011.

TAMAIO, I. Uma proposta de política pública: Parâmetros e Diretrizes para a Educação Ambiental no contexto das Mudanças Climáticas causadas pela ação humana MMA. Brasília: Ministério do Meio Ambiente: 105 p. 2010.

TOWATA, N.; KATON, G. F.; BERCHEZ, F. A. S.; URSI, S. Ambiente marinho, sua preservação e relação com o cotidiano: influência de uma exposição interativa sobre as concepções de estudantes do Ensino Fundamental. Enseñ. Cienc., v. extra, p. 1342-1347, 2013.

TOWSEND, C. The Effects of Environmental Education on the Behaviour of SCUBA Divers: A Case Study from British Virgin Island. 2000. 118. F. Thesis (Tourism). Conservation and Sustainable Development, University of Greenwich, London, 2000.

TUNALA, L. P.; BITTAR, V. T.; PEDRINI, A. D. G. Efeitos ambientais negativos de mergulhadores em apnéia (com 'snorkel') na Praia de João Fernandes, Área de Proteção Ambiental Marinha de Armação dos Búzios, Rio de Janeiro, Brasil. XI Congresso de Ecologia do Brasil. Porto Seguro, 2013. p.1-3.

TURRA, A.; CRÓQUER, A.; CARRANZA, A.; MANSILLA, A.; ARECES, A.; WERLINGER, C.; BAYÓN, C.; NASSAR, C.; PLASTINO, E.; SCHWINDT, E.; SCARABINO, F.; HO, F. F. C.; FIGUEROA, F. L.; BERCHEZ, F.; HALL-SPENCER, J.; SOTO, L.; BUCKERIDGE, M. S.; COPERTINO, M.; SZÉCHY, M. T.; GHILARDI-LOPES, N.; HORTA, P.; COUTINHO, R.; FRASCHETTI, S.; LEÃO, Z. Global environmental changes: setting priorities for Latin American coastal habitats. Glob. Change Biol., v. 19, n. 7, p. 1965-1969, 2013.

URSI, S.; GHILARDI-LOPES, N. P.; AMÂNCIO, C. E.; RIBEIRO, H. L.; TOWATA, N.; BERCHEZ, F. Projeto "Trilha Subaquática Virtual nas Escolas": proposta de uma atividade didática sobre o ambiente marinho e sua biodiversidade. Rev. SBEnBio., v. 3, p. 3821-3829, 2010.

URSI, S.; TOWATA, N.; BERCHEZ, F. A. S.; GHILARDI-LOPES, N. P. Concepções sobre educação ambiental em curso de formação para monitores do Projeto Ecossistemas Costeiros (Parque Estadual da Ilha Anchieta, SP). VII ENPEC. Florianópolis. 2009.

URSI, S.; TOWATA, N.; KATON, G. F.; BERCHEZ, F. A. S. Influência de exposição interativa sobre ambiente marinho e sua biodiversidade nas concepções de "meio ambiente" de estudantes do Ensino Fundamental. Enseñ. Cienc., v. extra, p. 3575-3580, 2013.

VERAS, P. C. Mergulhando na educação: percepção de discentes do ensino médio de uma escola pública do município de Seropédica/RJ a respeito da educação não formal e interdisciplinar. 2014. (Monografia de graduação). Instituto de Biologia, Universidade Federal Rural do Rio de Janeiro, 2014.

VERAS, P. C.; VINHAES, I. R. M.; PEREIRA FILHO, G. H.; MARQUES, V. O uso da interdisciplinaridade no ensino médio: sugestões de atividades. VII SIMPED. Resende, 2012.

VIEIRA, K. R. C. F.; BAZZO, W. A. Discussões acerca do Aquecimento Global: uma proposta CTS para abordar esse tema controverso em sala de aula. Ciên. Ens., v. 1, p. 1-12, 2007.

VINHAES, I. R. M.; VERAS, P. C.; MARQUES, V.; PEREIRA FILHO, G. H. Sensibilização e envolvimento de professores do ensino médio de escola pública para a utilização da prática de mergulho como ferramenta educacional. VII SIMPED. Resende, 2012.

WALTERS, R. D. M.; SAMWAYS, M. J. Sustainable dive ecotourism on a South African coral reef. Biodivers. Conserv., v. 10, n. 12, p. 2167-2179, 2001.

WEGNER, E.; TONIOLI, F. C.; CABRAL, D. Q. Underwater-Trails: a New Possibility of Marine Tourism. J. Coast. Res., v. 39, p. 990-993, 2006.

WEIL, P. O novo paradigma holístico: ondas à procura do mar. In: BRANDÃO, D.; CREMA, R. (Eds.). O novo paradigma holístico: ciência, filosofia e mística. São Paulo: Summus, 1991. p. 14-38.

WORACHANANANTA, S.; CARTERB, R. W. B.; HOCKING-SC, M.; REOPANICHKULD, P. Managing the Impacts of SCUBA Divers on Thailand's Coral Reefs. J. Sust. Tour., v. 16, n. 6, p. 645-663, 2008.