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Vasconcelos de Melo, Katarina; de Oliveira Fraga, Catarina Fernandes; Ferreira de
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The role of environmental education in changing school students' perceptions of and attitudes toward coral reefs in the Fernando de Noronha Archipelago, Brazil *

Fernanda Maria Duarte do Amaral^{@, a}; Maria de Fátima de Araújo Vieira Santos^a;
Katarina Vasconcelos de Melo^a; Catarina Fernandes de Oliveira Fraga^b;
Gilvaneide Ferreira de Oliveira^b; Andrea Quirino Steiner^c; Alexandre de Gusmão Pedrini^d

ABSTRACT

The objective of this study was to investigate attitudes regarding the conservation of reef environments at the Fernando de Noronha Archipelago. The project was conducted with students aged 10-18, in 2005, and included several educational activities, as well as the creation of a Reef Environment Museum at the local public school; questionnaires were administered in order to compare students' knowledge before and after these activities by using reference concepts of reefs, corals, environmental education and citizenship. We also analyzed students' views on the importance of corals, possible benefits brought about by reefs, changes in the marine environment, and their interest in participating in projects related to the conservation of reef environments. Initially, corals and reefs were perceived by students as valuable resources only when they generated economic advantages through tourism. After the educational interventions the students acquired concepts that were more aligned with environmental conservation per se; among the main results approximately 25% more students said they would agree to participate in educational projects to promote the conservation of reef environments after the interventions. However, due to the lack of interest in the project by several of what should have been key actors in the process, this study also showed that support from indirect actors (teachers, parents, school personnel) is just as important as the participation of the targeted group itself.

Keywords: citizenship; environmental perception; environmental education; coral reefs

RESUMO

O papel da educação ambiental na mudança das percepções e atitudes dos estudantes quanto aos recifes de coral no Arquipélago de Fernando de Noronha, Brasil

O objetivo deste estudo foi investigar atitudes relacionadas à conservação dos ambientes recifais no Arquipélago de Fernando de Noronha. O projeto foi conduzido com estudantes com idades entre 10 e 18 anos, em 2005, e incluiu diversas atividades educacionais, bem como a criação de um Museu de Ambientes Recifais na escolar pública local; questionários foram aplicados a fim de comparar o conhecimento dos alunos antes e após estas atividades, através do uso dos conceitos de referência de recifes, corais, educação ambiental e cidadania. Também se analisou a visão dos estudantes sobre a importância dos corais, os possíveis benefícios trazidos pelos recifes, as mudanças no ambiente marinho e o interesse na participação de projetos relacionados à conservação dos ambientes recifais. Inicialmente, os corais e os recifes foram percebidos pelos estudantes como recursos valiosos apenas quando geravam vantagens econômicas por meio do turismo.

[@] Corresponding author, to whom correspondence should be addressed.

^a Universidade Federal Rural de Pernambuco (UFRPE), Departamento de Biologia, Rua Dom Manoel de Medeiros, s/n – Dois Irmãos, Recife, PE, Brazil. e-mails: Amaral <fdamaral@db.ufrpe.br>; Santos <fatima.santos@db.ufrpe.br>; Melo <katyvmelo@ig.com.br>

^b Universidade Federal Rural de Pernambuco (UFRPE), Departamento de Educação, Recife, PE, Brazil. e-mails: Fraga <catarinafoga@gmail.com>; Oliveira <gil@ded.ufrpe.br>

^c Universidade Federal Rural de Pernambuco (UFRPE), Departamento de Ciência Política, Recife, PE, Brazil. e-mail: <ecodea@gmail.com>

^d Universidade do Estado do Rio de Janeiro (UERJ), Departamento de Biologia Vegetal, Rio de Janeiro, RJ, Brazil. e-mail: <pedrini@globo.com>

Após as intervenções educativas, os estudantes adquiriram conceitos que estavam mais alinhados com a conservação ambiental por si só; entre os resultados principais, aproximadamente 25% mais estudantes disseram que aceitariam participar de projetos educacionais para promover a conservação dos ambientes recifais após as intervenções. Entretanto, devido à falta de interesse de alguns dos que deveriam ter sido atores chave no processo, este estudo também mostrou que o apoio de atores indiretos (professores, pais, funcionários da escolar) é tão importante quanto à participação do grupo enfocado.

Palavras-chave: cidadania; percepção ambiental; educação ambiental; recifes de coral

1. Introduction

The Fernando de Noronha Archipelago (FN) is a district of the state of Pernambuco, Brazil, located 545 km from the capital, Recife. The archipelago is formed by 21 islands and islets of volcanic origin; the main island – the only one that is inhabited – occupies an area of approximately 17 km².

The first scientific expeditions to the archipelago were carried out by Charles Darwin in the 19th century on board of the H.M.S. Beagle (Amaral *et al.*, 2009; Laborel, 1970), yet anthropogenic impacts on the archipelago date back to the 18th century. At that time, most of the plant cover was removed to prevent fugitives from the local prison from hiding, and such modifications in the environment are still visible today. In spite of this, the beautiful and unique scenery that remains has potential for tourism related activities – the type of activity that maintains Fernando de Noronha's economy today.

The Fernando de Noronha National Park (PARNMAR-FN), created in 1988, includes 55% of the main island, all of the secondary islands and islets, and most of the adjacent waters up to depths of 50 m (FUNATURA, 1990). In 2001 UNESCO declared the archipelago a World Heritage Site.

Coral reefs, in turn, provide innumerable ecosystem services and carry social and economic importance. According to one estimate, reef environments are responsible for services and resources (tourism, coastal protection, food, etc.) that, if calculated in monetary terms, would be worth more than 375 billion dollars a year. Similarly, the destruction of one kilometer of coral reefs can bring about losses of up to US\$1.2 million (Bryant *et al.*, 1998). It is important to highlight, however, that such estimates are only for comparative educational purposes, as the true value of any given ecosystem is far beyond any amount of money.

There is a population of approximately 2,800 people on the main island, among whom there are social problems such as violence against the elderly (Araújo & Lobo Filho, 2009) and a rate of alcoholism that is much higher than in other regions of Brazil (Filizola *et al.*, 2008). The population also suffers from environmental problems related to its poorly conserved ecosystems, including its reef environments (Monteiro Filho &

Borges, 2003; Motta *et al.*, 1998; Castro, 2010). This directly affects the local food chain and fish stocks and, consequently, the local fish industry and economy. Overall, the conservation challenges faced by the Fernando de Noronha Archipelago are common to small islands in general, where it is especially hard to balance conservation and development (Calado *et al.*, 2014a; 2014b).

In Brazil, environmental education is regulated by law. On the federal level, according to the definition included in the National Environmental Education Policy, environmental education “can be understood as the processes through which individuals and collectivity construct social values, knowledge, abilities and attitudes regarding environmental conservation” (Presidência da República, 1999). This policy also states that environmental education must be present in all modalities of formal education, in a transversal manner.

However, Bizerril & Faria (2001) have highlighted that approaching environmental education from an interdisciplinary standpoint is complicated in the country because the inevitable team effort exposes (often insecure) teachers' pedagogical practices to colleagues and involves more need for studying in what is already a tight schedule. Similarly, Steele (2011) has discussed how embedding environmental education in the school curricula must be accompanied by strong professional development and confidence and leadership-boosting programs.

Education programs for school children and teenagers about coral reefs have been provided throughout the world, in locations such as Singapore (Chou & Goh, 1998), Mexico (Rodríguez-Martínez & Ortiz, 1999), the Marshall Islands (Bhandari & Abe, 2000), Tanzania (Howe, 2001), Panama (Goreau *et al.*, 2003), Australia (Stepath, 2004; Stepath, 2006), Trinidad and Tobago (Armstrong, 2005), the Philippines (Goreau & Goreau, 2007) and Brazil (Silva Júnior *et al.*, 2010).

Positive results were found in most of these studies. In Trinidad and Tobago, Armstrong (2005) successfully evaluated an eight-week pilot environmental education project focusing on coral reefs that was carried out in 15 primary schools. In Australia, Stepath (2004; 2006) applied and assessed a marine education program with 320 high school students of Queensland. Placed into

groups that were exposed to different educational interventions (class presentations and/or field trips), students who participated both in class presentations and field trips scored higher in terms of awareness and attitudes towards reef environments, and stated intentions to act.

Similarly, Howe (2001) analyzed the effects of a marine educational program in southern Tanzania that was carried out with 198 children in 14 schools. A preliminary evaluation showed that the program was important to expand the local knowledge base and to help the community become more active in managing coastal resources.

According to Freire (2002, 2013), teaching practices must consider personal, ethical, social, and cultural dimensions and must be approached both from individual and collective standpoints. When students in coral reef education programs become aware of local problems, they also become potential multipliers of possible local solutions. It is therefore very important that these educational activities take local socio-economic realities into consideration (Dal Pian, 1992), as well as previous knowledge and relationships with nature.

The design of this study focused on referential concepts of corals and reefs and their importance, environmental conservation, and citizenship awareness. All of these concepts are profoundly related to the archipelago's social and environmental well-being, and most especially to the population's main source of income: tourism.

Thus, this study aimed to investigate attitudes towards the conservation of reef environments in Fernando de Noronha Archipelago before and after a series of environmental education interventions with the purpose of increasing knowledge of these ecosystems, promoting citizenship and environmental awareness, and contributing to the conservation of the reef environments.

In addition to presenting findings related to students' attitudes towards conservation of local reef environments, the article follows up by discussing difficulties in the process, possible result distortions, and lessons learned.

2. Methods

The study was undertaken in 2005 at the archipelago's public school (Escola Arquipelago)– the only school in the island of Fernando de Noronha, Pernambuco State, Brazil (Figure 1) at the time – and focused on students from 5th to 8th grade (aged 10-18)¹. The first step was to carry out a sensibilization activity to which practically all of the island's organizations were invited (school teachers and staff, NGOs, churches, staff of

the day care unit, etc.). Approximately 200 people participated – almost 10% of the island's population at the time (2005).

Educational activities were developed around the following reference concepts: corals, reefs and their importance; environmental conservation; and environmental education and citizenship. The school already approached environmental education as a transversal issue.

2.1. Environmental Awareness Strategies

The educational activities included videos, photograph presentations and the display of preserved specimens and/or skeletons of corals and other components of the reef fauna. Such materials were exhibited and also used in talks by the professors from the Federal Rural University of Pernambuco (UFRPE) and some local monitors who participated in the project. Field trips involving group dynamics and guided tours were carried out², including diving in the local reef environments (Figure 2a-f)³. Although teachers did not participate actively, they were present and followed the educational activities.

In order to create a public and permanent visitation area and to promote continuous construction and dissemination of knowledge, the Reef Environment Museum (Museu do Ambiente Recifal – MAR) was installed inside the school. The material used included posters and photographs of Fernando de Noronha's reef environment, as well as preserved specimens of the reef fauna and flora. The museum was opened by the project team on June 10th, 2005, with the presence of local authorities and the school community.

2.2. Data sampling

A questionnaire completed by the archipelago's school students included 13 questions. The first five provided a profile of the students (age, gender, grade and time living on the island). The eight remaining questions were open-ended and evaluated the progress of the construction of the referential concepts while inquiring about corals and reefs and their importance; environmental conservation; environmental education; and

¹ Although presently Brazilian educational law does not use the grade format to classify class levels (former “séries” are now “anos”), this was not the case at the time of the study.

² See studies such as those by Ballantyne & Packer (2002), Morag *et al.* (2013) and Behrendt & Franklin (2013) for the benefits of field trips and outdoor educational programs for students.

³ As an activity complementary to the project, in September of 2005, two students who participated in the project were selected to receive financial aid (SESU/ MEC) and to visit the research team's laboratory at the UFRPE, as well as reef environments in several beaches of the states of Pernambuco and Alagoas. These students were taught to observe, analyze and compare the biotic and abiotic components of both the continental and the archipelago reef ecosystems and were trained to become ecotourism guides. The initial idea was to train all of the students participating.

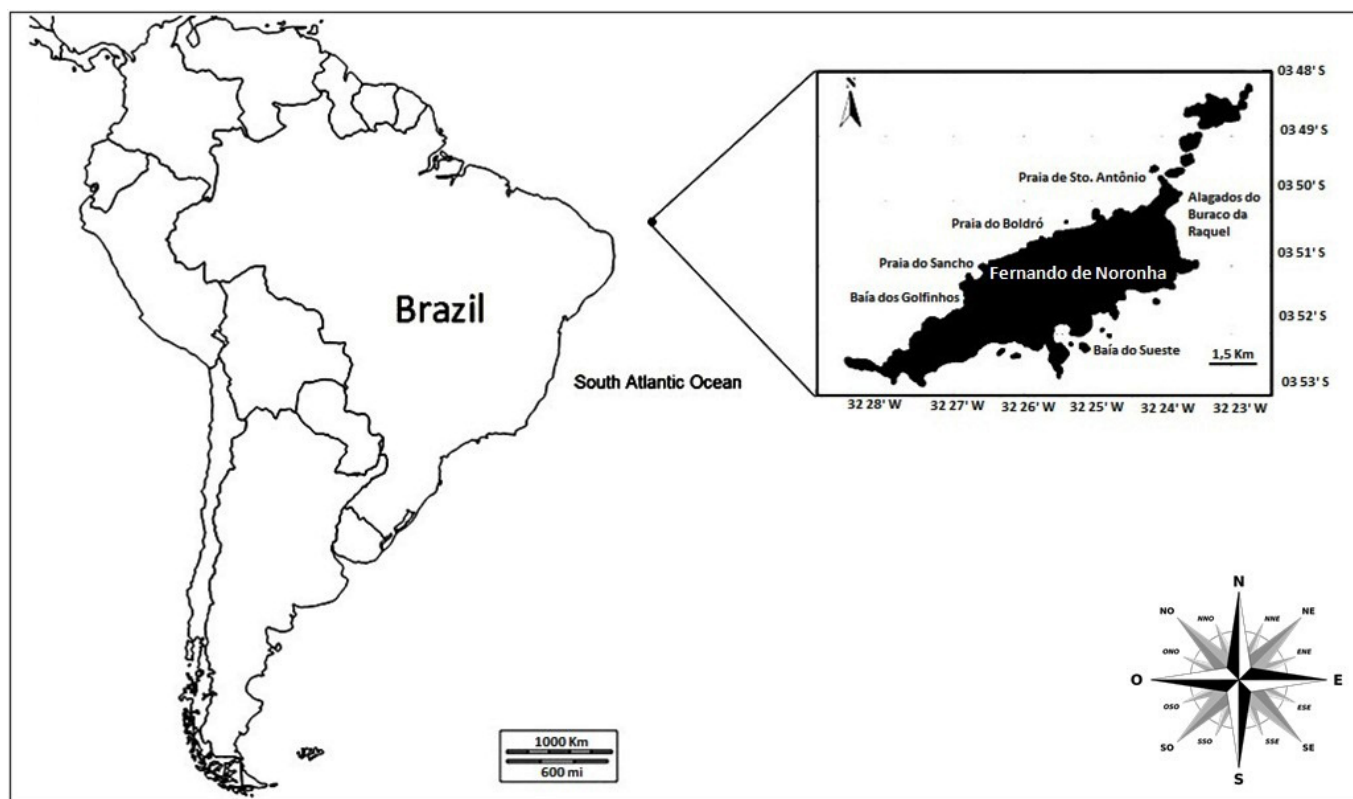


Figure 1 - Location of the Fernando de Noronha Archipelago

Figura 1 – Localização do Arquipélago de Fernando de Noronha.

citizenship awareness. It was also asked that the students list the marine animals they knew inhabited the archipelago's waters.

The questionnaires were applied three times over the 2005 school year (in February, March and June). The first happened before the educational interventions and diagnosed the students' existing perceptions and knowledge about the referential concepts. The other two questionnaires were applied after the interventions and served to evaluate changes in these concepts after the educational activities.

The first interventions took place between February 28th and March 7th, 2005, and included lectures, workshops, group dynamics, guided tours, diving and observation of fauna and flora. The second intervention took place between June 6th and 10th and included similar activities⁴.

The group who filled in the questionnaire before any intervention was made up of 30 students from the (approximately 10% of the total student population) – these being from 5th through 8th grades. The sex ratio was approximately the same (52% male and 48% fe

male). Age ranged between 12 and 18. Students had lived between one and 17 years on the island – an average of 12.2 years (half had lived there between 12 and 13 years). After the first intervention, a total of 38 students – 50% male and 50% female, aged 10 to 15 – answered the questionnaire; these students had lived an average of eight years on the island. The results of the third questionnaire will not be considered in the analysis, as explained in the next section. The majority of the students that carried out the educational activities and responded to the questionnaires were the same throughout the project.

2.3. Questionnaire Evaluation

When examining the responses we focused on the knowledge building process in order to analyze students' cognitive stage in relation to each concept in question. In this manner, it was possible to identify which concepts were under-developed (when incomplete answers were provided), which were not developed at all (when the answers were very far from the reference concept) and which were fully developed (when answers satisfactorily covered the main elements of the reference concept) (Vasconcelos *et al.*, 2008).

These criteria were based on the evaluation system and terminology adopted by the Department of Education of the State of Pernambuco at the time, to which the island school is bound:

⁴ The short amount of time between the interventions and questionnaire evaluations was due to limitations related to funding, as it was required that the entire project be carried out within one year.



Figure 2 - a. Material used in the lectures for students at the Archipelago Public School, Fernando de Noronha. b. Illustration panels showing reef animals, as used at the Archipelago Public School, Fernando de Noronha. c. Guided tour at Atalaia Beach for students of the Archipelago Public School, Fernando de Noronha. d. Preparing for free diving at the reefs of Atalaia Beach, Fernando de Noronha. e. Activity on citizenship for students of the Archipelago Public School, Fernando de Noronha. f. Five-senses workshop carried out with students of the Archipelago Public School, Fernando de Noronha. Photographs by Fátima Santos.

Figure 2 - a. Material utilizado nas palestras para estudantes da Escola Pública do Arquipélago de Fernando de Noronha. b. Painéis de ilustrações utilizados na Escola Pública de Fernando de Noronha mostrando animais dos recifes. c. Turnê guiada à Praia de Atalaia para os alunos da Escola Pública do Arquipélago. d. Preparação para o mergulho livre nos recifes da Praia de Atalaia, Fernando de Noronha. e. Atividade sobre a cidadania para os alunos da Escola Pública do Arquipélago de Fernando de Noronha. f. Oficina dos Cinco Sentidos realizada com os alunos da Escola Pública de Fernando de Noronha. Fotografias de Fátima Santos.

- a. Constructed (C) – complete or almost complete answers, which include the main elements of the referential concepts;
- b. Under construction (UC) – partial answers, lacking important elements of the referential concept;
- c. Not constructed (NC) – questions left unanswered or completely incorrect which do not include any of the elements of the referential concepts.

When the third questionnaire was distributed, the project team observed that one of the teachers openly told students to rush through the questionnaire in order for class to continue, a fact that undoubtedly distorted these

results. Thus, in our analysis we will only consider the results of the first and second questionnaires.

3. Results

Although this was not used as part of the evaluation, it is important to mention that students easily located and identified several organisms during the guided tours to the local beaches, such as corals, mollusks, shrimp, polychaetes, fish, starfish, sea urchins, algae, etc. They also showed that they had understood the activities carried out by enthusiastically pointing out movement, structures and relationships between these organisms.

Table 1 – Evaluated responses of the questionnaires answered by students of the Archipelago Public School (Fernando de Noronha, Brazil). Data collected during the 2005 school year before the intervention (February) and after the 1st intervention (March). Classification criteria terminology followed that adopted by the Department of Education of the State of Pernambuco/Brazil at the time of the study: not constructed (NC), under construction (UC) and constructed knowledge (C).

Tabela 1 – Avaliação das respostas aos questionários dadas pelos alunos da Escola Pública do Arquipélago (Fernando de Noronha, Brasil). Os dados foram coletados durante o ano letivo de 2005, antes da intervenção (fevereiro) e após a primeira intervenção (março). A terminologia dos critérios de classificação seguiu a adotada pela Secretaria de Educação do Estado de Pernambuco na época do estudo: não construído (NC), em construção (UC) e conhecimento construído (C).

Criteria/ Question	Before the intervention			After the 1 st intervention		
	NC %	UC %	C %	NC %	UC %	C %
“Cite examples of marine animals that you know.”	33	27	40	13	47	40
“What do you know about corals? And reefs?”	63	37	0	24	74	2
“Are corals important to you and to your community? Why?”	90	10	0	48	50	2
“Do reefs provide any benefits to you and to your community? Explain.”	83	17	0	65	31	2
“Have you observed any kind of difference or change in the marine environment throughout time? Describe it.”	77	20	3	61	39	0
“What is your understanding of environmental education?”	73	27	0	53	39	8
“Would you be interested in participating in an environmental education project related to the protection of corals and reef environments?”	80	0	20	66	24	10
“To you, what does it mean to practice citizenship?”	83	17	0	47	42	11

Students paradoxically fared worse in the third questionnaire, even though at that point they had received more information and undergone both theoretical and practical activities both in the classroom and in the field. As described previously, in this case the project team observed that one of the teachers openly told students to rush through the questionnaire in order for class to continue, a fact that undoubtedly distorted these results. The way teachers and staff treated the project might also have negatively affected the results by giving students the wrong idea that reef conservation is not that important.

In relation to the number of marine animals known before the interventions, 40% of students cited more than seven animals (thus their knowledge was considered to be constructed). The average number of animals cited amongst all students was seven, when considering the entire group. Of the 207 citations, the animals most mentioned were dolphins (13%), sharks (12%), turtles (8%), and moray eels (8%). After the first intervention, again, 40% of the students cited more than seven animals, but the general average number cited rose to eight. Out of a total of 144 citations, the animals most mentioned were sharks, fish, and rays (9% each), and corals, turtles, and dolphins (8% each).

The knowledge on corals and reefs was considered not constructed for 63% of the students before the first intervention. Among the remaining 37% (who showed knowledge under construction) responses for corals were limited to concepts such as “fragile live beings” and “barriers to contain the ocean”, or “home to several marine organisms”. After this first intervention the rate of responses with knowledge considered to be under construction rose to 74%, with respect to the same content as that used before the intervention. Overall, most students had trouble distinguishing the terms “reef” and “coral”, which were often used interchangeably, even after the two interventions. Some considered reefs and corals a physical threat to surfers and tourists, while others saw them as ornaments that “should be softer so that tourists and surfers could take better advantage of them”. Nevertheless, some students clearly absorbed new concepts and complemented their answers by citing coral symbiosis with zooxanthellae, for instance.

Regarding the importance of corals, before any intervention, most students (90%) cited solely the generation of income from tourist visitation. Only 10% listed these organisms' ecological importance. However, after the first intervention 50% of the responses mentioned at

least one kind of importance unrelated to economic profit, such as food and shelter for other marine organisms (knowledge under construction). Only 2% cited more than one kind of ecological importance, which was considered to be constructed knowledge.

Eighty-three percent of the students who answered the initial questionnaires did not see any possible benefits brought about by reefs (with the exception of the financial benefit of attracting tourists cited in some responses). As mentioned previously, many considered reefs to be an obstacle for surfers, with no advantages whatsoever. The remaining 17% (whose knowledge was considered to be under construction) cited only one service or benefit aside from profit, either as protection against the sea or as a source of food for the community. After the first intervention the number of responses with non-constructed knowledge decreased to 66%, which now included profits for the diving industry. Only 3% of the students had noticed at least one type of change in the marine environment over the past few years. Most (77%) did not answer or did not believe that the environment was being impacted in any way, which also included answers such as “corals and reefs are always being preserved in order to decorate the ocean”. Twenty percent, however, demonstrated knowledge under construction by citing general problems they believed to be affecting the local marine ecosystems, such as pollution (as that recorded by Sul *et al.*, 2009, for instance), and species extinction (there are no records of recent extinctions in the archipelago). After the first intervention the rate of responses that showed non-constructed knowledge decreased to 61%, yet out-of-place comments like “new species are appearing” or “corals are reproducing themselves more and more lately” were still common.

Before any intervention, most students (73%) presented non-constructed knowledge about environmental education; the remaining students (27%) had a partial concept that “we must bring about awareness in order to preserve the environment”. However, after the first intervention 8% of the responses showed constructed knowledge, while 39% showed knowledge under construction (which included responses such as “not stepping on corals” and “not removing corals from the sea”) and 53% showed non-constructed knowledge.

Before the interventions, only 20% of students said they would agree to participate in an educational project to preserve coral reefs and reef environments. The other 80% either answered incoherently or openly said they would not participate (classified as non-constructed knowledge). After the first intervention, 10% thought it was important to participate (constructed knowledge) and 24% said they would participate but also showed they did not really understand the practical meaning of such participation.

Regarding the concept of citizenship, 83% of the students initially demonstrated non-constructed knowledge and responded incoherently. Even after the first intervention, 47% still showed non-constructed knowledge, with answers such as “a way for teachers to evaluate students”.

4. Discussion

This project was received with enthusiasm by students and parents, who openly demonstrated their appreciation in learning more about their island's marine ecosystems and organisms. However, it did not receive the same support from the school staff. One clear example was the Reef Environments Museum. Created with the participation of the students to be a lasting educational tool inside the school, it was deliberately removed by staff before the end of the project. Unfortunately, coral reef museums directed at children are rare. In fact, Goreau & Goreau (2007) have stated that the Museo Sang Bata Sa Negros, in the Philippines, is believed to be the only children's coral reef museum in the world.

Parlo & Butler (2007) in an evaluation of participants of a coastal marine teacher workshop in the state of Georgia (USA), revealed that teachers found it difficult to apply what was learned in the workshop because they felt compelled to follow the standard curriculum. Additionally, teachers thought it was important to focus on preparation for standardized tests.

As mentioned previously, students paradoxically fared worse in the third questionnaire despite the fact that at that point they had received more information and undergone more.

A previous study carried out in 2002 at the same school also investigated students' conservation attitudes and knowledge of corals and reefs. Steiner *et al.* (2004) studied the environmental perception of students from grades 6-9 and found different results. In that study, almost half of the students interviewed gave correct definitions of corals, while roughly one-quarter gave incorrect or partially correct answers; most also cited the importance of corals in the food chain. Regarding reefs, most students defined these structures as groups of corals.

Similarly, a study that also involved educational interventions and before and after questionnaires filled in by the students, obtained excellent results in changing the attitudes of 6th and 9th grade students of six schools located in the Metropolitan Area of Recife, also in the state of Pernambuco (Vasconcelos *et al.*, 2008). Additionally, the number of animals cited by the students of this study before the interventions was higher (40) than that found by Steiner *et al.* (2004), where only 21 organisms were listed. Both studies found similar difficulty among students regarding the distinction between

the concepts of reefs and corals. Oigman-Pszczol *et al.* (2007) encountered confusion in conceptual knowledge as well in the difference between algae and corals in a coastal tourist town in southeastern Brazil.

In Fernando de Noronha, despite the fact that many students had been born or lived on the island for several years, most of the changes observed in the marine environment were not specific to the island, but rather general responses such as “species extinction” or “marine pollution”.

The fact that most students related the importance of reef environments and corals to profit is not surprising, as tourism is probably the main source of income for many of their parents. Nevertheless, the low rate of responses that included references to the ecological or intrinsic importance of the reefs is worrisome. These results were similar to those of Rodriguez-Martínez & Ortiz (1999), who in a study with primary and secondary students of Quintana Roo, a coastal state in southeastern Mexico, found that the children had little awareness of coral reefs and their importance.

Likewise, the concept of citizenship was not familiar among the students in Fernando de Noronha and had probably never been mentioned in school, as was clear in students' accounts during the interventions and in the results even after these activities.

Kaza (1995) has stated that “While traditional education programs are often aimed at school children, in its first years a marine protected area may need to direct its programs towards local leaders, government officials or influential community members”. Unfortunately there was a complete lack of interest in the project by key

community leaders. . Future educational projects in the area might benefit if accompanied by professional development programs directed at the school teachers, such as the one described by Rivera *et al.* (2013).

Aside from its initial intention, this study also showed that support from indirect actors (teachers, parents, etc.) is just as important as the participation of the targeted group itself (see also Sauv  , 2005). With the benefit of hindsight, our project may have been more effective if an initial phase had been dedicated exclusively to school teachers and staff.

Additionally, it is important that future programs reflect not only what is thought to be right by external perceptions (such as those of researchers), but also that of the local community. Projects that inform the social and environmental importance of the island’s ecosystems but also reflect how locals value reef environments will certainly make a difference in the long run.

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