EFFICACY OF DIFFERENT STRATEGIES IN ENVIRONMENTAL EDUCATION TEACHING: ASSOCIATION BETWEEN RESEARCH AND UNIVERSITY EXTENSION[1]

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Introduction

Environmental Education (EE) is widely considered the most appropriate tool with which to raise awareness concerning environmental problems and to promote changes in habits and behaviors that are detrimental to the environment (DIAS, 2004). The role of EE in general education is to provide a systematized structure capable of developing critical, participatory, transformative and emancipatory education that encourages, enables and empowers participating subjects to be responsible and have both the desire and wherewithall to promote environmental ethics and citizenship (BRASIL, 1998; 1999; CARVALHO, 2008; PROCOPIAK, 2010). In Brazil, the relevance of EE is legally established via a series of laws and educational guidelines, such as LDB (Brazilian Educational Bases and Guidelines Law), PNEA (Brazilian Environmental Education Program), PNE (Brazilian Education Plan) and Curricular Guidelines for Basic and Higher Education. Despite this, the application of EE in schools is still spotty and superficial, usually restricted to the disciplines of science, biology and geography, or to commemorative events such as "environment day."

In Brazil, the current approach to environmental issues within formal educational settings only incorporates purely ecological concepts and definitions, thus oversimplifying the meaning of the natural environment (REIGOTA, 1999; SAUVÉ, 2005; LEFF, 2007;

1. We thank the graduate and post-graduate students of the Laboratory of Population Ecology of Universidade Federal Rural do Semi-árido (UFERSA) for their help with field work. This work was supported by UFERSA-PROEC, CAPES and CNPq (ungraduate and post-graduate grants) and, CNPq, FAPERN and UFERSA-PROEC (research grants).

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MENDONÇA, 2007; LOUREIRO, 2012). This approach ends up positioning the human being as an element outside to the environment (REIGOTA, 1999; SAUVÉ, 2005; LEFF, 2007; MENDONÇA, 2007) and minimizing the active participation of the natural world in economic, social and cultural development (SATO and CARVALHO, 2005; SAUVÉ, 2005; CARVALHO, 2006). In such circumstances, it is often very hard for EE to promote the formation of the values, mind sets and attitudes necessary for the development of environmentally-sustainable solutions (DIAS, 2004; SATO and CARVALHO, 2005; CARVALHO, 2006; REIGOTA, 2010). To change this framework, several activities or methodological approaches have been suggested that would facilitate achieving the awareness and training objectives of EE.

Among the most commonly used methodologies for changing the inefficient framework by which EE is currently applied in Brazil are the conducting of *in situ* practical activities in natural environments (including scientific visits to Conservation Units, walks on ecological trails), and activities carried out in school environments (such as mini courses, workshops, creating vegetable gardens and recycling projects) (SOUZA and BRITO, 2012; SANTOS and BRÊTA, 2013; WEST, 2014; BAUR and HAASE, 2015). While such activities are extremely relevant to EE (SATO, 2002; GUIMARÃES, 2007), their they are often applied in a discontinuous way, or without an appropriate knowledge of biodiversity and sustainability, so that they become yet another informal educational activity that is trying to get beyond the school gates (SATO and CARVALHO, 2005; CARVALHO, 2006). Nevertheless, when EE activities are practiced in a systematized and appropriate way, it is considered that they can often be highly efficient, and that activities undertaken in natural areas are those with the greatest potential to promote knowledge and interest in environmental issues (NAVARRO-PEREZ and TIDBALL, 2012; STERN et al., 2014).

When such activities are combined with well-planned teaching, allow the student to imagine themselves as a key and integrated component of the natural environment, so altering their conceptions and perspectives in relation to the natural world (SATO and CARVALHO, 2005; STERN et al., 2014). Thus, the practical EE-linked activities, either within schools or in natural environments, constitute an important tool in the education-based formation of environmental knowledge (SATO and CARVALHO, 2005; CARVALHO, 2006). However, studies that aim to evaluate the efficiency of these alternatives through experimental comparison of the two activity types are infequent, yet a study that links the two approaches in the same investigation may be useful in evaluating the efficacy of these very different forms of EE.

In the semi-arid region of northeastern Brazil, there are few official programs to guide and inform the population about local environmental problems (TABARELLI and SILVA, 2003). A simple solution to this may be the creation of linkages between scientific research projects and university extension programs aimed at the development of EE initiatives. This could be especialy promissing since, as a result of research initiatives from public universities in the region, many scientific projects in ecology and environment are operating in semiarid Brazil. Once deployed, research projects can be used in university extension activities as a practical tool for an education-focused contact with nature by elements of the local po-

pulation. In the current study we used school environments and natural environments, as well as allying ourselves with an extension project from another scientific study to perform non-formal EE activities. We did this to test the following hypotheses: (1) the higher the degree of knowledge, the greater will be the interest in biodiversity and conservation, (2) activities conducted on-site in natural environment are more efficient in terms of the EE process than practical activities conducted away from the natural environment, and (3) the greater the level of involvement with the EE activity, the greater the level of knowledge assimilation and the growth of interest in nature conservation.

Methodology

Target Audience

A group of secondary school students from the Integrated Centro de Educação Integrada Professor Eliseu Viana, a school within the education network of Rio Grande do Norte state, with its catchment in the urban area of the municipality of Mossoró, were evaluated. Initially, we randomly selected 70 students to respond to a questionnaire, called a pre-test, which aimed to assess knowledge and interest in environmental issues prior to any EE intervention. Then, we randomly selected 90 students to participate in activities associated the current study (participants in which may or may not have also done the pre-test). The 90 students were divided into three groups of 30 participants (thoigh since during the actual participation not all attended, with the first group had 27 students, the second had 14 and the third had 20 participants).

The students of these groups had different levels of participation in the study activities. In the first group (the "high participation level" group), the students participated in all the proposed activities, including a series of lessons aimed at training, raising awareness and enhancing positive attitudes towards nature conservation. In the second group (the "medium participation level" group), students were involved only in the organization and execution of a workshop-type activity. These students did not participate *in situ* activities in the natural environment, and so received lower levels of formation and sensitization. Finally, in the third group (the "low participation level" group), the students were spectators of the workshop activity. These students participated passively in the activity, as listeners, and did not participate in the *in situ* activities in the natural environment.

Activities used to train and sensitize students

Participation in the research project (on-site activities in nature): Being involved in a scientific research project was one of the non-formal tools of EE teaching adopted for this study. This activity involved the active participation of the students from the "high participation level" group, in a research project called "Ecology and Conservation of Semiarid Birds". This was being carried out in an area of native Caatinga vegetation (dry forest) at the Rafael Fernandes Experimental Station (37°23'50.37"W and 5°3'17.57"S), belonging to the Federal Rural Semiarid University - UFERSA, located in a rural part of

the municipality of Mossoró, RN, Brazil. Students participated directly in the research activities for three consecutive days and on each visit three or four students were involved in the project's field activities. All the procedures relating to data collection, capture--marking-release processing of the birds, the field equipment and the scientific knowledge involved in the collection process, were all used to provide immersion teaching on the theme "valuing biodiversity".

Organization and presentation of a workshop: This, the other non-formal education tool adopted during the study was undertaken to allow two forms of student participation: 1) active participation, which involved the preparation and presentation of a workshop by the " medium participation level" group, with the help of the students of the " high participation level" group; and 2) passive participation, which included only listening at the workshop. This was undertaken by students from the "low participation level" group. The entire process was guided by the authors of this study and occurred on the premises of Centro de Educação Integrada Eliseu Viana school. Thus, it was non--formal, but was not an activity conducted within the natural ecosystem of the Caatinga. In preparing the workshop, students were divided into ten groups of four to five students, each with two or three members belonging to the "high participation level" and one or two members from the "medium participation level" groups. Each of the 10 groups was given a topic on the theme of "valuing biodiversity" and had about 15 hours of structured orientation on the theme. They were then asked to prepare demonstrations which were held in booths at the school; materials included posters and extra teaching materials, such as images, booklets, folders, seeds, natural products. The event entitled "Workshop on valuing Caatinga biodiversity" was open to all schools students and staff, took place in December 2014 and lasted 8 hours.

Theme used in non-formal education: The theme "Defining and valuing Caatinga biodiversity" (based on PRIMACK et al., 2001) was the main subject of the EE activity. Within this theme, the following topics were addressed: valuing direct consumption (hunting, firewood, extractivism), valuing direct trade (genetic resources, pharmacological drugs, biological control), valuing indirect uses (ecosystem functions, nutrient cycling, recreational use), option values (keep species alive for the future) and valuing existence (ethical feelings of the existence of life). The themes were introduced in the form of specific questions and systematized during the whole of the research project data collection procedure, and during the preparation and presentation of the workshop. Captured birds, plants visible alongside the tracks of the data collection area, and ecological processes that benefited humans and could be observed during the data collection activity were used as examples. Workshop preparation activities occurred using periodic meetings, during which all students involved in this phase gained knowledge through dialogue exchange and study of material provided by the interlocutor.

Evaluation tools

We used questionnaires and audio recordings of informal conversations as instruments of extension action evaluation. These were aimed at evaluating the effectiveness

of the study activities for the formation, sensitization and motivation of the students. The questionnaire was based on ideas of Hagenbuch et al. (2009) concerning active learning methods in biodiversity conservation. This questionnaire contained 12 questions, grouped into two categories: (1) knowledge of biodiversity, and (2) interest in nature conservation. Issues related to the "knowledge" category addressed the issues: biodiversity concepts and their importance to human quality of life, effects of biodiversity reduction on the environment and human beings, and current major threats to biodiversity. Content of the "interest" category addressed: changes in views and policies and changes in habits and attitudes, both with a view to conserving nature. The "knowledge" category was investigated with multiple choice questions, while the "interest" category was investigated by priority ranking of the issues.

Evaluation was carried out in two stages. In the first stage, called the pre-test, 70 questionnaires were given before the study activities started, though the students already knew what the questionnaire theme would be. The questions were designed to evaluate the target audience according to their extent and nature of their knowledge and interest prior to the study. In the second stage, immediately after their special activity had taken place, the same questionnaire was given to the 61 students who had all been part of the study, although at different participation levels (high, medium and low). That is, the 27 students in the "high participation" group answered the questionnaire after the field activities, while the other students answered the questionnaire after the workshop. This test aimed to evaluate immediate retention of what had been made availaible during the special activity. We used the comparison between the responses to the pre- and post--test to assay the effect of the special activity on the level of knowledge and interest in biodiversity conservation.

Ethical and legal procedures for data collection

The research project operated with all required legal authorizations. These were granted by CEMAVE (National Center for Research and Conservation of Wild Birds) and ICMBio (Chico Mendes Biodiversity Institute). The school, through its administration and teachers, signed an institutional consent agreement permitting the activities in the school to occur. Before *in situ* activities in natural habitats with interested students took place, we obtained the consent of the person legally responsible for each student. This person signed a consent form provided by the ethics committee in researches with human beings. Additionally, all the students who participated in the research signed an informed consent form-TCLE.

Data analysis

In the evaluation test, questions relating to "knowledge" were grouped into three themes: concept of, threats to and importance of biodiversity. These questions were composed of five alternative responses, five of which were environmentally correct, differing only by the proportion of importance given to biodiversity conservation. Thus for the

analyzes, these alternatives were grouped and considered correct. We summed the number of correct and incorrect answers for the pre-test questionnaires and for each of the three levels of intervention. We statistically compared the pre-test with each level of intervention using the chi-square test (X^2), using a 5% significance level ($\alpha = 0.05$). Thus, we evaluated the degree of homogeneity between responses before and after the EE intervention.

Issues related to the theme "interest" were placed in two groups: changes in points of view and policies and changes in habits and attitudes, both from the point of view of nature conservation. Each issue had five options grading from alternatives highly degradatory to nature to those which were fully conservationist. For each question students were instructed to give priority rank scores to these alternatives, with the value 'one' representing lowest priority and value 'five' being top priority. To facilitate statistical testing, we then grouped the two issues on the theme of interest in nature conservation so that the tested score varied from 2 to 10. We calculated the average score of the most environmentally appropriate alternative, based on the student-made rankings. To assay for significant difference between the mean scores of the groups, pre-test results were compared with each intervention level by means of a t-test for independent samples, using a 5% significance level ($\alpha = 0.05$).

Audio recordings were used to supplement the answers of the questionnaires. From these we extracted qualitative information about pre-intervention and post-intervention concepts about the Caatinga biome held by the students from the groups participating in the EE interventions at the "high" and "medium" levels.

Results

In all, 131 questionnaires were answered, 70 during the pre-test and 61 in the post-test. The latter were distributed among the three groups of participants in the activities (see material and methods). A total of was 195 responses was obtained in the "knowledge of biodiversity" category and 150 in the category "interest in nature conservation".

The pre-test showed a relatively high percentage (47 to 69%) of correct answers in the category "knowledge of biodiversity" (Figure 1). During the post-test, this percentage rose to 70-93% correct responses from the "high participation level" group (Figure 1). For both groups above-mentioned (pre-test and post-test of the high level of participation), degree of knowledge was highest for those questions regarding the definition of biodiversity. For the themes "threat" and "importance", the percentage of correct answers for the pre-test was 50 and 47%, respectively, and 76 and 69% post-test for the "high participation level" group (Figure 1).

Comparison between the pre-test and the "high participation level" group responses showed a statistically significant increase in the three themes of the "knowledge" category ($p < 0.05$, Table 1). However, the results were not statistically significant for the comparison between pre-test and "middle" and "low participation levels" ($p > 0.05$, Table 1). Between the pre-test and the "high participation level" group there was an addition of 24 percentage points for biodiversity issues, 19 percentage points for issues related to threats and 29 points for the importance of biodiversity (Figure 1).

Figure 1 – Percentage of correct answers for biodiversity topics in the category "knowledge", highlighting pre-test and post-test scores of the three "participation levels" (high, medium and low) of student groups. Source: Data obtained by the author (2014)

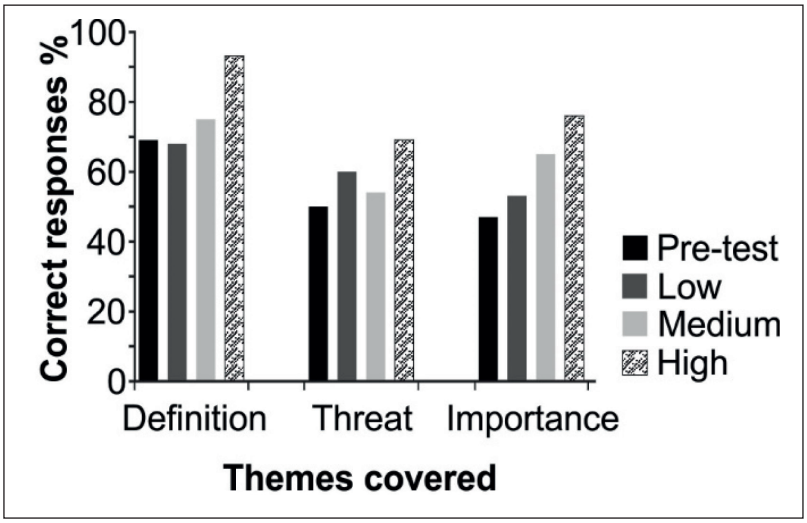


Table 1 - Statistical comparison of responses of tests pre-EE and post-EE exposure for the three "participation levels" (high, medium and low) for biodiversity knowledge related topics.

Theme	Pre-Test vs High level (χ^2, p)	Pre-Test vs Medium level (χ^2, p)	Pre-Test vs Low level (χ^2, p)
Concepts and definitions	3.689; < 0.05	0.106; 0.74	0.027; 0.86
Principle threats	6.332; < 0.01	0.153; 0.69	2.262; 0.13
Importance of biodiversity	6.368; < 0.01	2.088; 0.14	0.557; 0.45

Source: Data obtained by the author (2014)

Responses to questions on "interest in biodiversity conservation" showed that level of increase in interest varied with level of student participation in the intervention. Compared with the pre-test, the score means were significantly different for the groups

that had "high" and "medium" participation levels, but not for the "low" level (Table 2). Students of the "high participation level" group showed the highest ranking for questions concerning "interest in environmental conservation" (Figure 2). On a scale ranging from 2 to 10, this group had a 2.3-point increase in the ranking levels given to issues related to changes in point of view and policies (Figure 2A), and 2.0 points for questions concerning interest in changing environmental habits and attitudes (Figure 2B). Responses from the students in the "meadium participation level" group indicated a lower increase in interest in the conservation of the biodiversity, an important aspect for the thematic concerning changes in the point of view and policies (2.1 points), as well as that relating to interest in the change of habits and environmental attitudes (1.4 points).

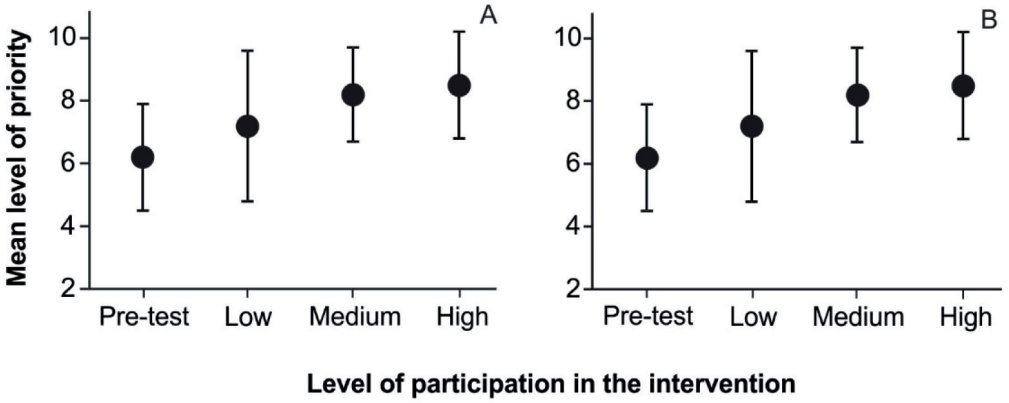
Table 2 - Statistical comparison of responses of tests pre-EE and post-EE exposure for the three "participation levels" (high, medium and low) for topics related to interest in environmental conservation

Themes	Pre-Test vs High level (t, gl, p)	Pre-Test vs Medium level (t, gl, p)	Pre-Test vs Low level (t, gl, p)
Changes in point of view and politics	5.38; 65; < 0.001	4.23; 52; < 0.003	1.59; 58; 0.12
Changes in habits and environmental attitudes	5.29; 73; < 0.001	2.90; 60; < 0.007	0.21; 65; 0.82

Source: Data obtained by the author (2014)

Students responses (Table 1) regarding environmental concepts, specifically in the Caatinga biome, showed significant changes after the EE action interventions. Students of the "high and medium participation levels" began to associate the biome with broader concepts, changes the factually-incorrect and narrow view concerning the Caatinga. After the intervention, the students began to talk about characteristics of the biome using terms and concepts previously unknown to them, such as the high biodiversity of the Caatinga, the use of environmental resources by society and the benefits of the harmonious relationship between man and nature.

Figure 2 – Mean level and standard deviations of priorities established by the students participating in the research. (A) Questions concerning change in point of view and policies aimed at environmental conservation. (B) Questions concerning changes in environmental habits and attitudes. Source: Data obtained by the author (2014).



Block 1 – Opinions about the Caatinga biome given by the students of "high and medium participation levels" in EE interventions during the study.

Before the intervention
• "Vegetation with no life". • "Lifeless dryland". • "Its all just dryness, there are only lizards". • "Almost no animals". • "Its just low dry vegetation, and useless to people". • "Bioma totally poor in nature".
After the interventions
• "I never imagined that the Caatinga could have so many animals and plants". • "The Caatinga has a huge number of plants, birds, insects, reptiles and mammals". • "Even though the vegetation is dry and there is little rain, it has high biodiversity". • "A rich biome, which brings many benefits, such as medicinal plants, fruitys and primary products". • "The Caatinga is very useful to people, huge numbers of useful products can be ontained from its vegetation". • "The Caatinga is important for the natural environment and for humanity".

Source: Data obtained in informal audio recordings made by the authors themselves (2014). Quoted phrases minimally adapted to the written standards of the Portuguese language.

Discussion

Students evaluated during the pre-test showed the same pattern of behavior and knowledge as reported in the literature (FISCHER and YOUNG, 2007; FONSECA, 2007; BEZERRA et al., 2008; CASTOLDI et al., 2009; MALAFAIA and RODRI-

GUES, 2009; SANTOS and BRÊTA, 2013, BEZERRA et al., 2014). Before any EE intervention, their knowledge of environmental issues was confined to the general concepts of biodiversity, such as the variety of animal and plant species. There were two ways in which the naturalistic view of biodiversity (REIGOTA, 1999; SAUVÉ, 2005) was present in the results of the current study; focussing on the concept-threat--importance tripod and the choice for simplistic definitions of biodiversity: we observed a lower level of knowledge regarding "threat and importance of biodiversity" (<50% of correct answers in the pre-test). For the second aspect, most biodiversity definitions responses did not consider the human dimension or considered the current threats to biodiversity to be minor issues.

In this simplistic view of natural systems, students did not address the role of the environment in the maintenance of social, cultural, and economic issues, which define human existence as we know it, and considered nature as an external element (REIGOTA, 1999; SAUVÉ, 2005). Similar results have been reported in studies from other regions of Brazil (FONSECA, 2007; MALAFAIA and RODRIGUES, 2009; SANTOS and BRÊTA, 2013). A poorly developed and circumscribed definition of biodiversity was held by both students and teachers in public schools in Pará (FONSECA, 2007), and by groups of young and adult students in Minas Gerais (MALAFAIA and RODRIGUES, 2009). These views are sometimes related to the limited use of textbooks (FONSECA, 2007). Such a restricted form understanding is one reason why many students, and society as a whole, avoids responsibility for environmental problems and shows a lack of commitment to solving them (AMORIM et al., 2011). This point of view often makes EE's goals difficult to achieve.

In the current study, the practical activities in natural environments associated with non-formal teaching in biodiversity valuation (high participation level group) resulted in both increased knowledge and interest in biodiversity conservation, showing that these tools are effective for teaching EE. Students came to understand the different meanings of biodiversity and its importance to humans and, in addition, developed an interest in attitudes that prioritized nature conservation. Therefore, activities that bring humans and the natural environment physically together were able to mitigate, at least in part, the known effect of fragmentation on knowledge within formal education, and thereby generate understanding and stimulate student interest (DILLON et al., 2006; RAMADOSS and POYYAMOLI, 2011; PESSOA and BRAGA, 2012; SHWARTZ et al., 2012; 2014; SILVA et al., 2014; SOUZA, 2014). In studies developed in Brazil, the practical approach to enhanching awareness about natural environments occurred, for example, through visiting ecological trails (SOUZA, 2014) and monitoring sea turtle research (*e.g.* TAMAR Project, SILVA et al., 2014). Studies designed for other cultural realities, have achieved similar results, for example, via an association of theoretical classroom teaching and non-formal activities in natural environments (India, RAMADOSS and POYYAMOLI, 2011), and through student contact with the biodiversity of urban centers (France, SHWARTZ et al., 2012, 2014). In addition, the inclusion of practical activities involving nature during EE sessions is widely recognised as an efficient and motivating practice, and can make EE a transformative experience and so achieve the recommen-

dations proposed during the Tbilisi conference in 1997 (DIAS, 2004; DILLON et al., 2006; NAVARRO-PEREZ and TIDBALL, 2012; STERN et al., 2014).

We found that non-formal teaching using workshop activities, even without direct experience of nature, also resulted in an increased interest in nature conservation, though, with less impact on the level of environmental awareness of students (medium level of participation). In this group, we did not find an increase in biodiversity knowledge. Other studies that did not include direct contact with the natural environment have also shown such practices to be effective environmental teaching-learning processes. In these such studies, successful lessons have included elements of theatre and role play and doing practical classroom-based projects (SANTOS and BRÊTA, 2013), while video-based lessons, and classes centered around the creation of videos exhibiting the main threats to biodiversity were used as tools by Souza and Brito, (2012), and practical actions within the school environment related to waste treatment and recycling by Baur and Haase (2015).

We have not found any previous scientific reports of EE efeciency evaluations that included in the sensitization actions different levels of participation. This approach allowed us to quantitatively assess the effects of the presence/absence of *in situ* activities in nature during the EE intervention. In general, actions that allow the use of creative approaches to knowledge exploration and/or activities that provide a new way of seeing the natural environment, even without the direct influence of this environment, are also considered valuable for student environmental education (SATO, 2002; DIAS, 2004; GUIMARÃES, 2007). Our comparative evaluation showed the natural environment-based activity to be the most effective. However, activities lacking direct natural environment contact also had impact. This suggests that approaches lacking on-site activities should be encouraged in situations where practical experiences with nature are not feasible, providing that they include active involvement of the participants in the learning process.

Evaluation of students who formed the "low participation level" group, i.e. the spectators of the workshop event, showed that some non-formal teaching activities, such as the use of presentations on specific topics, may have little or no impact on the generation of knowledge and interest in nature conservation. In such activities, students did not actively participate in knowledge construction, and even if such construction occurred in an environment conducive to teaching-learning, it did have positive effects on knowledge and interest. Other studies have highlighted this aspect showing the need to link other activities to the information made available, since information alone is insufficient to bring about a transformation in the way of thinking and acting of the human being (FISCHER and YOUNG, 2007).

In the current study, the presence of different levels of participation in the intervention, showed that the "knowledge" associated to the students' involvement in EE activities was closely related to the generation of "interest" for the nature conservation. Existing literature indicates that the greater the stimulus given to the individual (contact with the natural environment, practical activities concerning sustainable use of resources, collective activities such as themed fairs, shows and festivals) the greater will be the retention of knowledge concerning the environment and the effectiveness of sustainablility programmes (SANTOS and SATO, 2001; ABÍLIO et al., 2010). It is this interactive and

dynamic types of processes that will facilitate a true and profound understanding of the indispensable association between the biotic and the social-human systems (SANTOS and SATO, 2001; DILLON et al., 2006, ABÍLIO et al., 2010; NAVARRO-PEREZ and TIDBALL, 2012; STERN et al., 2014).

One important aspect of the current study was the use of scientific research as a non-formal EE teaching tool. It appears that linking scientific research to an extension activity has not been a very common practice. This can be clearly shown with an evaluation of literature reviews from other countries that have collated results of programs and studies with successful approaches to EE. A study that critically analyzed publications addressing the importance of outdoor activities in the United Kingdom (DILLON et al., 2006) and other studies that investigated strategies and programs of EE developed in the United States, showed the main success and failure of methodologies proposed to promote EE (NAVARRO-PEREZ and TIDBALL, 2012; STERN et al., 2014). In Brazil, one of the few exceptions observed was the TAMAR Project, which develops scientific research with sea turtles and promotes EE by uses this to enhance environmental awareness in local fishing communities (SILVA et al., 2014). In a recent survey of university extension activities in the Brazilian semi-arid region, 35% of extension projects were focused on environmental issues (ABÍLIO et al., 2010). However, there were no reports of participation in scientific research being as an EE teaching tool.

University extension is a tool for transmitting the knowledge generated in the universities, using it to construct an informed citizenary and transform thought, including that relating to environmental actions (DEMO, 2006; 2008; ABÍLIO, 2011). The sharing in school-based education of experiences and activities based on scientific research projects has been shown to be a great potential tool for EE, operating in this context as a synergystic, dynamic, interactive and transformative action for EE teaching. New studies that combine research and university extension would assist in evaluating the potential of this tool, and help consolidate this practice as an innovative and effective tool for teaching EE.

Final considerations

The present study corroborated the three hypotheses initially proposed, finding that students who had a higher degree of participation in EE activities, be they *in situ* or involving the preparation of the workshop, were more sensitized and showed greater interest in biodiversity conservation. It also showed the importance of the extent of knowledge in awakening an interest in conservation, and that contact with the natural environment is a key part of the success of environmental education and biodiversity conservation programs. These responses were obtained thanks to an innovative use in the experimental design of different levels of participation in the learning process, which allowed quantification the scope and success of each type of action. We suggest that the use of scientific research by extension projects, as a practical tool for contact with nature, is an effective way to integrate knowledge-interest and consolidation of EE in Brazilian schools.

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Submitted on: 04/11/2015
Accepted on: 10/12/2016
http://dx.doi.org/10.1590/1809-4422ASOC228R1V2022017

EFFICACY OF DIFFERENT STRATEGIES IN ENVIRONMENTAL EDUCATION TEACHING: ASSOCIATION BETWEEN RESEARCH AND UNIVERSITY EXTENSION

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***Abstract*:** We evaluated three aspects of an environmental education (EE) process: relationship between level of knowledge and level of interest in the conservation of biodiversity, EE efficiency in activities *in situ* versus *ex situ* in nature and relationship between level of personal involvement and increase in knowledge-interest in conservation. For this, high school students from a public school in the RN were divided in groups with different levels of participation (high, medium and low) on activities carried out *in situ* and *ex situ* in nature. We observe the direct relationship between level of knowledge and level of interest for nature conservation. We found that practical activities with or without the presence of the natural environment were effective for EE; however, the activities *in situ* were more effective. Finally, students with higher levels of participation in the proposed activities were more stimulated by the action.

Keywords: Biodiversity. Environmental education. Schools. Semiarid. Valuate.

***Resumo*:** Neste estudo avaliamos três aspectos de um processo de Educação Ambiental (EA): relação entre grau de conhecimento e grau de interesse pela conservação da biodiversidade, eficiência da EA em atividades *in loco* versus *ex loco* na natureza e relação entre nível de envolvimento pessoal e aumento no conhecimento-interesse pela conservação. Para isso, estudantes do ensino médio de uma escola pública do RN foram divididos em grupos com diferentes níveis de participação (alto, médio e baixo) em atividades realizadas *in loco* e *ex loco* na natureza. Observamos a relação direta entre grau de conhecimento e nível de interesse pela conservação da natureza. Constatamos que atividades práticas com ou sem a presença do ambiente natural foram eficientes para a EA, porém sendo as atividades *in loco* mais efetivas. Por fim, estudantes com maior grau de participação nas atividades propostas foram mais sensibilizados pela ação.

Palavras-chave: Biodiversidade. Educação Ambiental. Escolas. Semiárido. Valoração.

Resumen: En este estudio se evaluaron tres aspectos de un proceso de educación ambiental (EA): relación entre el nivel de conocimiento y el grado de interés en conservación de la biodiversidad, eficacia de la EA a través de actividades *in loco* versus *ex situ* en la naturaleza y la relación entre el nivel de implicación personal y el aumento de conocimiento-interés por la conservación. Para ello, estudiantes de secundaria de una escuela pública de RN fueron divididos en grupos con diferentes niveles de participación (alta, media y baja) para las actividades realizadas. Observamos una relación directa entre el nivel de conocimiento y el nivel de interés por la conservación de la naturaleza. Constatamos que ambas actividades prácticas fueron eficaces para EA, entretanto, fueron las actividades *in loco* aún más eficaces. Finalmente, los estudiantes con niveles más altos de participación en las actividades propuestas se sensibilizaron más por la acción.

Palabras clave: Biodiversidad. Educación Ambiental. Escuelas. Semiáridas. Valoración.