Environmental education in the classroom: pilot study in Cabo Verde suggests differing impacts on local knowledge and environmental attitudes

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Abstract To execute environmental education effectively, the success and impacts of educational activities must be assessed. In areas of high biodiversity there is generally a lack of evaluation of the impact of environmental education. In this study we investigate the effect of a one-time classroom activity on student knowledge of local environmental issues, environmental attitudes and aspirations. The project was conducted on the island of Maio, Cabo Verde, a small, highly biodiverse island, as part of a classroom visit programme with the local environmental organization, Maio Biodiversity Foundation. We visited every fourth-grade class (i.e. students with an age range of 9–10 years) on the island (a total of 142 students) and delivered a half-day classroom activity. The results show that this activity did not influence environmental attitudes; however, it did significantly improve student knowledge and awareness of local environmental issues. This study shows that environmental education should not be assumed to improve attitudes and knowledge but requires individual evaluation for each type of activity. For environmental education to reach its full potential, activities should be planned in response to evaluation results.

Keywords Africa, attitudes, Cabo Verde, conservation, environmental education, evaluation, knowledge, Maio

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Introduction

Biodiversity is diminishing at an alarming rate. Since 2010, the IUCN has declared that > 160 species are extinct, and > 38,500 species are threatened with extinction (IUCN, 2021). Anthropogenic activities such as pollution, overexploitation of natural resources and habitat destruction are threatening the future of plant and animal species (Ramírez & Santana, 2019). The destructive practices that lead to environmental problems are often facilitated by a lack of knowledge and respect for the environment, which is ultimately caused by inadequate environmental education (Valderrama-Hernandez et al., 2017).

As advances in technology continue and global urbanization increases, exposure of children to the natural world has decreased. This has been referred to as the extinction of experience (Pyle, 1978). A study in the UK concluded that 12% of children participating in a survey spent 12 months without visiting a natural area (Hunt et al., 2016), and another study showed that although schoolchildren could only identify 40% of local species presented, they could identify 47% of exotic species, implying a disconnect from local biodiversity (Ballouard et al., 2011). The need to reconnect society with nature is apparent, and this is particularly important for children. Childhood is the optimal stage to undertake environmental education, with younger children being more receptive to environmental attitude changes than adults or even teenagers, as, once formed, it becomes increasingly difficult to influence environmental opinions (Kellert, 1985; Caro et al., 1994; Damerell et al., 2013; Liefländer & Bogner, 2014).

Implementing environmental education in schools is a way to increase pro-environmental behaviour in society. It is often assumed that parent–child teaching is unidirectional, with parents teaching their children the attitudes and knowledge they themselves possess; however, children can also influence the values and knowledge of their parents (Vaughan et al., 2003; Damerell et al., 2013). This bidirectional influence between adults and children gives environmental education the potential to be a powerful tool to increase knowledge and positive attitudes towards the environment across age groups.

Environmental education does not have one simple definition. It comprises a plethora of activities aimed at raising awareness of environmental issues, encouraging positive

attitudes towards nature, increasing knowledge both of and about the environment, and highlighting key problem-solving skills to facilitate the identification of solutions to environmental problems (Lucas, 1979; Edsand & Broich, 2020). This type of education is essential for slowing the loss of global biodiversity (Ruiz-Mallen et al., 2009). Biodiversity conservation is dependent on the understanding of threats to ecosystems and of the workings of ecosystems themselves (Kassas, 2002; Lanjouw, 2021). It is crucial that local communities become part of conservation efforts, and this starts with environmental and conservation education (Ardoin et al., 2020).

Environmental education is a powerful tool, with many effective projects having been undertaken (Ruiz-Mallen et al., 2009; Ortiz et al., 2018; White et al., 2018; Spooner et al., 2019; Karris et al., 2020). However, because of its many benefits, environmental education has sometimes been thought of as a general-purpose solution to many different environmental problems, without clearly defining goals or critically assessing the activities undertaken (Edsand & Broich, 2020). For environmental education to reach its full potential, its impact must be evaluated. An increased understanding of the impacts could improve the efficacy of the education itself and also help to increase the impacts of policies and programmes involving the environment, practices for sustainable development and the environmental career prospects of participants (Kassas, 2002). Changes in environmental attitudes, knowledge acquisition and even career trajectories should be monitored and assessed, and this has often been done using case studies focusing on particular environmental education programmes (Borchers et al., 2014). However, these evaluations have been predominantly in the USA and Europe (Stern et al., 2008; Kossack & Bogner, 2012; Koutromanos et al., 2018; Spooner et al., 2019).

In areas that contain high levels of biodiversity, such as West Africa, environmental education has rarely been evaluated (Kuhar et al., 2010; Borchers et al., 2014). Because of the increasing establishment of conservation foundations, predominantly NGOs, environmental education is increasing in Africa, but there have been few evaluations of these projects (but see McDuff, 2000; Carelton-Hug & Hug, 2010; Borchers et al., 2014; Leeds et al., 2017; Velempini et al., 2018). Additionally, differing cultures, social and educational systems and environmental circumstances have not necessarily been considered in the implementation of these educational activities. As a result of cultural and social differences, it cannot be assumed that similar environmental education strategies will have the same effects or be similarly applicable in Africa and Europe/North America (Bettinger et al., 2010; Borchers et al., 2014; Lanjouw, 2021).

Here we add to the limited research evaluating the impacts of environmental education in West Africa. We used the island of Maio, Cabo Verde, as a case study, evaluating the impacts of a one-time classroom intervention undertaken by the local conservation NGO Maio Biodiversity Foundation across all 10 fourth-grade classes on the island. We aimed to investigate whether and how a single exposure to environmental education in the classroom could influence attitudes towards the environment, knowledge acquisition regarding local environmental problems and aspirations regarding career and studies.

Study area

Cabo Verde is an archipelago comprising 10 islands c. 600 km west of the coast of Senegal, West Africa. The island of Maio is one of the smallest of the nine inhabited islands of Cabo Verde, with an area of 269 km² and a population of c. 6,980 inhabitants (Instituto Nacional de Estatística de Cabo Verde, 2015). Cabo Verde contains a great variety of endemic marine fauna and flora. The island of Maio is home to a wide range of this biodiversity, including some of the endemic bird taxa of Cabo Verde: the Iago sparrow *Passer iagoensis*, Bourne's heron *Ardea purpurea bournei*, Alexander's swift *Apus alexandri* and cream-coloured courser *Cursorius cursor exsul* (Rice et al., 2020). Maio is also home to the largest resident breeding population of Kentish plover *Charadrius alexandrinus* in the Macaronesian archipelagos (Engel et al., 2020; McDonald et al., 2020). Maio hosts a range of sea turtle species during the reproductive months of June–October, including olive ridley turtles *Lepidochelys olivacea* and green turtles *Chelonia mydas*, and it is one of three Cabo Verde islands with large nesting colonies of loggerhead turtles *Caretta caretta* (Lopes et al., 2016; Patino-Martinez et al., 2022). Maio comprises 13 distinct communities in four zones, with 11 primary schools. This study focused on fourth-grade students; i.e. the 142 students with an age range of 9–10 years old. Because of the small population size of some rural communities in Maio, fourth-grade students have been condensed into 10 classes distributed across eight schools. The content taught was relevant to the largest wetland on the island: Salinas do Porto Inglês. This is a Ramsar site of c. 535 ha (Oliveira, 2013; Pereira, 2016) containing saltmarsh, grassland and semi-desert habitats and is home to a variety of biodiversity, including endemic bird species and sea turtles.

Methods

Environmental education intervention

During 18–25 May 2021 we collaborated with Maio Biodiversity Foundation to visit all 10 fourth-grade classes on the island of Maio. At each school we (RR and HS) delivered a 2-h environmental education intervention. The

researchers took control of the session, but with the teacher remaining in the classroom to assist with any issues, such as with discipline. The topic of the intervention was ecosystems on Maio, and we used local examples to show the effects of human activities on ecosystems, both detrimental (threats such as litter and vehicles) and beneficial (conservation work such as turtle patrols and beach cleans).

Firstly, we introduced the topic of ecosystems in a 10 min presentation on the types of habitats on Maio and the species in each ecosystem. The focus was on the protected area Salinas do Porto Inglês. For this chosen ecosystem the class discussed what kinds of species are present and what the ecosystem comprises, including both biotic and abiotic components. For every organism suggested the class discussed what that organism depended on, allowing them to make links between ecosystem components. We then helped the students create an ecosystem network containing all the organisms that were suggested and all the connections discussed. We identified threats to the ecosystem, and we used five key examples for the activity: (1) quad bikes, (2) illegal sand extraction, (3) too many people, (4) litter and (5) hotel construction. We then recreated this ecosystem with the children. Every child represented part of the ecosystem (e.g. species of birds, turtles and plants, water and sand) by drawing cartoons on paper. The connections between ecosystem components were represented by holding a rope at each end. The threats to the ecosytem were also represented by cartoons on paper, and either a researcher or a researcher with a student would hold the cartoon to represent the threat, depending on classroom size. For each threat we discussed what kind of problems this threat generated for an organism or a connection. If a connection (rope) between the organisms (students) was broken by the threat (researcher or student), we placed the rope on the floor. We discussed all threats until all of the ropes were on the floor, indicating that the ecosystem was ruined. After the activity we held a group discussion to talk about the work of Maio Biodiversity Foundation and to discuss what everyone could do to stop these threats from destroying local ecosystems.

Questionnaires

We designed a questionnaire to evaluate the environmental attitudes, aspirations and knowledge of local environmental issues of the students before and after the environmental education intervention (Supplementary Materials 1 & 2). The questionnaire comprised 14 statements, with responses to be provided on a 1–5 Likert scale (1, strongly disagree to 5, strongly agree) and three open-ended questions, categorized into five groups: (1) science, (2) animals, (3) litter, (4) aspirations and (5) knowledge of local environmental issues. We developed the questionnaire in English and then translated it into Portuguese, and the final editing of the questionnaire

was undertaken by a Cape Verdean with experience in schools (JA), to ensure the questions and language were appropriate and understandable. We applied the questionnaires immediately before the intervention and 1 week after the intervention. In total, 131 students filled out at least one questionnaire. Nine students were absent for one of the two applications and therefore we analysed only the response of the 122 students who filled out both pre- and post-activity questionnaires. We anonymized student identities by using a numbering system.

Analysis

The open-ended questions were interpreted by one author (RR) and converted into a score of 1–5. The highest score of 5 represented a complete answer showing full comprehension of the question. The lowest score of 1 represented no useful answer, an incorrect answer or no understanding of the question. Two of the statements implied a negative attitude: (1) 'I find science boring' and (2) 'I leave my litter on the floor'; therefore, the scores for these were reversed for the analysis. For each group of statements (science, animals, litter, aspirations and knowledge of local environmental issues) we applied a multivariate mixed model analysis to assess the effect of the intervention. We investigated the relationships between the dependent variables (scores of questions) and three fixed independent variables (school, gender, intervention), with the student number used as a random effect. To determine the effect of gender and school on student learning, we calculated the difference in scores before and after the intervention, and we conducted a two-way multivariate analysis of variance on these differences. Gender and school type were the independent variables and differences in scores per question were the dependent variables.

We performed all statistical analyses using *R 4.1.3* (R Core Team, 2020). For modelling we used the package *lme4* (Bates et al., 2015) in *R*.

Results

Exposure to the environmental education intervention (variable Intervention) was the most influential in the questionnaire outputs (Table 1). The scores of 11 of 17 statements and questions significantly differed before and after the intervention, and the scores of nine statements varied between schools. Responses did not vary between genders.

Opinions regarding science

The statement 'I like science lessons' was significantly affected by both Intervention and School. The students stated that they liked science lessons less after the intervention;

Table 1 Multivariate mixed model output testing the effects of Intervention (before or after) and School (Polivalente, Liceu, Morro, Calheta, Morrinho, Pilão Cão, Barreiro, Figueira) on scores of statements regarding Science, Animals, Litter, Aspirations and Local environmental issues amongst fourth-grade schoolchildren (9–10 years old) on the island of Maio, Cabo Verde, with corresponding significant variables, estimates, t-values and P-values (the corresponding degrees of freedom are 548, 995, 542, 514 and 548, respectively). We removed the non-significant variable Gender from the models.

Statement/question	Variable	Estimate	t	P
Science				
I like science lessons	Intervention (after)	−0.219	−2.098	0.036
	School (Morro)	1.015	2.453	0.015
I want more science lessons at school	Intervention (after)	0.307	2.356	0.019
I find science boring	School (Figueira)	0.906	2.458	0.014
	School (Calheta)	0.645	2.116	0.035
	School (Liceu)	0.668	2.294	0.022
Animals				
I like animals	No significant variables			
I want to learn more about animals	School (Morro)	−0.578	−2.060	0.040
I like seeing different animals on TV & in books	School (Pilão Cão)	−1.155	−2.979	0.003
	School (Morrinho)	−0.892	−2.475	0.014
Animals are important	Intervention (after)	0.500	3.202	0.001
It is important to protect animals in Cabo Verde	No significant variables			
Litter				
I always put my litter in the bin	Intervention (after)	−0.281	−2.250	0.025
	School (Morro)	0.840	2.486	0.013
I feel sad when I see litter in the street or on the beach	Intervention (after)	0.395	2.785	0.005
I leave my litter on the floor	Intervention (after)	−0.385	−3.191	0.002
	School (Pilão Cão)	1.452	3.241	0.001
	School (Morrinho)	1.217	2.957	0.003
	School (Liceu)	0.649	2.107	0.036
	School (Figueira)	0.838	2.092	0.037
	School (Polivalente)	0.690	1.979	0.048
Aspirations				
I want to continue to study science	No significant variables			
I want to work with the environment	Intervention (after)	0.405	3.003	0.003
I would like to volunteer with Maio Biodiversity Foundation one day	Intervention (after)	4.674	4.674	0.000
	School (Morro)	0.805	2.054	0.040
Local environmental issues				
What are the environmental problems in Maio?	Intervention (after)	1.583	14.035	< 0.001
	School (Figueira)	1.312	4.693	< 0.001
	School (Morrinho)	1.137	3.839	< 0.001
	School (Calheta)	0.839	3.656	< 0.001
	School (Pilão Cão)	1.104	3.549	< 0.001
	School (Morro)	0.747	2.412	0.016
How can we help the environment every day?	Intervention (after)	0.644	7.492	< 0.001
	School (Morrinho)	0.980	3.999	< 0.001
	School (Figueira)	0.596	2.561	0.011
	School (Calheta)	0.420	2.205	0.028
Who is responsible for taking care of the environment?	Intervention (after)	1.356	8.699	< 0.001

however, students from the school Morro scored this statement significantly higher compared to other schools. Students scored higher for the statement 'I want more science lessons at school' after the intervention (Supplementary Fig. 1). The intervention did not affect student scores for 'I find science boring', although students from the schools Figueira and Calheta scored this statement significantly higher in comparison to the other schools (Table 1).

Opinions about animals

Of the five statements regarding opinions towards animals, only one, 'Animals are important', was positively affected by Intervention or School (Supplementary Fig. 2). The statement 'I want to learn more about animals' scored higher in the school Morro, and the statement 'I like seeing different animals on TV and in books' scored higher in two schools (Pilão Cão and Morrinho; Table 1).

Opinions about litter

All three statements regarding litter were affected by Intervention and two statements were affected by School. The statements concerning litter dropping 'I always put my litter in the bin' and 'I leave my litter on the floor' were both negatively affected by Intervention, with students admitting to dropping litter more after the intervention (Supplementary Fig. 3). These two statements were also affected by School, with 'I always put my litter in the bin' scoring higher in two schools and 'I leave my litter on the floor' scoring higher in five schools. However, students also admitted to feelings of sadness when they saw litter in the street or on the beach after the intervention (Table 1).

Opinions about aspirations

The two statements related to becoming involved with conservation activities 'I want to work with the environment' and 'I would like to volunteer with Maio Biodiversity Foundation one day' were both positively affected by the intervention (Supplementary Fig. 4). The statement 'I would like to volunteer with Maio Biodiversity Foundation one day' was affected by School, with one school (Morro) having overall higher scores compared to the other schools (Table 1).

Knowledge of local environmental issues

Scores for all three questions about local environmental issues significantly increased after the intervention (Supplementary Fig. 5). Additionally, two of the questions were affected by School, with the schools Morrinho, Figueira and Calheta showing higher scores than the other schools (Table 1).

School

Overall environmental opinions and knowledge differed between schools; for nine of the 17 questions responses significantly varied between certain schools. For five of these nine questions the school Morro had significantly higher scores. The only school that did not show significantly higher or lower scores for any question was Barreiro. The other schools all showed significantly higher or lower scores for at least one question.

The two-way multivariate analysis of variance indicated a statistically significant difference in student learning between schools (Wilks' $\Lambda = 0.0496$, $F = 1.33$, $P = 0.0295$), but we observed no differences between genders. Specifically, three of the 17 questions showed a significant difference in learning between schools: 'I always put my litter in the bin' ($F = 2.989$, $P = 0.0098$), 'I like animals' ($F = 2.395$, $P = 0.0324$) and 'What are the environmental problems in Maio?' ($F = 2.805$, $P = 0.0142$).

Discussion

This study provides four main findings. Firstly, the scores of most statements regarding environmental attitudes and actions were not improved by the one-time exposure to the environmental classroom activity. Secondly, questionnaire responses suggested that after the intervention students were more willing to be involved with environmental activities. Thirdly, the intervention significantly increased student knowledge of local environmental issues. Fourthly, student attitudes and learning were dependent on the school they attended. Overall, we conclude that this study highlights the necessity of evaluations of environmental education and suggests that environmental education cannot be assumed to be a general solution but rather is a tool that requires careful planning, much like any other conservation action.

With respect to the first finding, the majority of statements regarding attitudes towards science lessons, litter and animals did not show significant changes in scores after the environmental education intervention. Although the scores suggested that students would like more science lessons, they did not suggest that students liked science lessons more after the intervention. This mixed response also occurred in the statements regarding litter. The scores revealed that after the intervention students felt more aversion towards seeing litter in the streets and on the beach, but these students also showed higher levels of litter dropping. Finally, of the five statements regarding attitudes towards animals, just one increased in score after the intervention, with the rest not being affected. Therefore, of the 11 statements regarding environmental attitudes and actions, only three increased in score after the intervention.

Because of the encouraging findings of some programmes, it is often assumed that environmental education encourages more positive environmental attitudes (Armstrong & Impara, 1991; Farmer et al., 2007; Ruiz-Mallen et al., 2009). However, our study suggests this is not always the case. This could be because the intervention was a one-time activity. Several studies that have shown improved environmental education attitudes were long-term programmes or at least had a higher exposure rate than just one occasion (Volk & Cheak, 2003; Hsu, 2004; Ruiz-Mallen et al., 2009). Although there have been instances of one-time exposures to environmental educational activities having a positive effect (Farmer et al., 2007; Spooner et al., 2019), a one-time classroom educational intervention or activity such as that employed in our study may not be sufficient to change student opinions about science lessons in general or their overall attitudes towards littering and animals. Perhaps the design of the intervention was not optimal, or it could be that more exposure is necessary to generate attitudinal changes. This result highlights the importance of evaluating all types of educational activities. Without evaluation it cannot be assumed that attitudes have improved.

These mixed responses to statements regarding environmental attitudes could indicate a fault in the study design. Although self-completion questionnaires are often used as an effective method of data collection for large studies as the anonymity of this format encourages honest responses (Strange et al., 2003), in our study the use of questionnaires could have been a limitation. The young students may have struggled to understand the questionnaire (although a simpler questionnaire might have reduced the power of this data collection method). Students could have felt pressurized to answer in a certain way if they felt the questionnaire was in the format of an exam. Although we explained this was not the case, the first statement was 'I like science lessons' and the students may have felt pressure within the classroom situation to give a high score to this question. The same concern could apply to the statements that required honest responses, such as those regarding litter dropping. During the first round of questionnaires, students may have felt compelled to give more socially desirable answers (Milfont, 2009) because of the presence of representatives of the local conservation NGO in the classroom. Once they had completed the activity and realized it was not an exam, they may have felt more relaxed and so more able to answer honestly. Statements requiring honest responses might not be the optimal way of assessing the students' views, and a more subjective method may be preferable, such as interviews or personal observations (Jahedi & Méndez, 2014; McIntyre & Milfont, 2016).

Our second finding was that after the intervention student aspirations about becoming involved with environmental issues seemed to have increased, but the children did not appear more inclined to continue to study science. This finding reinforces the link between effective environmental education and interest in conservation. Although the questionnaire included only two statements regarding future environmental activities, the responses to both statements significantly increased after the intervention: children were more inclined to want to volunteer with Maio Biodiversity Foundation and to consider working with the environment. This could be because outside organizations entering schools may present new ideas and provide a change to the usual curriculum, enabling them to motivate children to a greater extent than routine classroom activities (Fitzakerley et al., 2013). However, a more detailed questionnaire would be required to investigate this. Future studies could potentially include the use of a control group not exposed to the external intervention,.

Our third finding was that student knowledge regarding local environmental issues increased after the intervention. All three questions regarding local environmental issues significantly increased in score, and to a greater degree than the other attitude-based statements. Many student responses also included extra details, showing not just memorization of information but also understanding. For the question 'What are the environmental problems in Maio?', after the intervention many students listed the five threats mentioned in the activity: quad bikes, illegal sand extraction, too many people, litter and hotel construction; however, some students reinforced their answers with additional details, such as 'quad bikes making water and sand dirty' and 'quad bikes destroying bird nests'. Some students included threats that were not mentioned in the activity, such as 'people killing animals', 'driving cars through protected areas' and 'turtle poaching'. These extra details suggest that students were able not only to learn the information that was being taught but also to apply their knowledge to the question after the activity.

These results suggest this type of classroom environmental education is most powerful when targeted towards teaching information and knowledge retention, even if this may not necessarily spark interest or change opinions. These evaluation results can then be used to plan environmental education that specifically aims to improve learning. However, as we conducted the follow-up questionnaires only 1 week after the intervention, we do not know for how long thereafter the students retained the learning. Future studies could potentially include follow-up over a longer time period.

Our fourth finding was that although Intervention was the most influential variable overall, the school that a student attended also affected the responses to some statements. There did not seem to be a trend to this, and these School effects were particular to the question. Overall, students from the school Morro gave higher scores for five of the nine questions affected by School, but these were spread over the topics of all five groups of questions, making it difficult to draw any conclusions regarding the effect of School. Morro had a class size of only seven students, and some studies suggest that smaller class sizes facilitate improved learning (Altinok & Kingdon, 2012; Fogarty, 2012). However, other research suggests that class size alone is not sufficient to affect learning outcomes but that a mixture of socio-economic factors is important (Hattie, 2005; Köhler, 2022). Additionally, the effect of School could relate to the location of a school rather than the school itself. Morro, for example, is a small rural village, and the culture of the village, teacher or home life could have been influential factors. More research is required to determine the specific effect of the individual school on environmental attitudes and knowledge.

In summary, this study has shown that evaluation is crucial to understanding the impacts that educational activities have on student knowledge, environmental attitudes and aspirations. This one-time classroom activity successfully increased student knowledge of local environmental issues and raised awareness of solutions to these problems. However, the activity was not effective in improving environmental attitudes. Although this study was small and simple, the results suggest that environmental education is

not a general solution to environmental issues, but rather a technique that needs careful planning and design. Environmental education has the potential to be a powerful tool in conservation but it should be assessed and organized like any other environmental action. To expand and consolidate the conclusions drawn from this study, we suggest using subjective observations in addition to questionnaires, or using a different data collection method such as interviews. Additionally, adding another follow-up stage to the study design, such as after 1 month or 1 year, would help clarify the effects of any environmental education intervention. To achieve the full potential of environmental education, future work is necessary to evaluate further the effects of other types of activities, such as those that take place outside the classroom.

Author contributions Conceptualization: RR, TS; development and participation in the educational intervention: RR, HS, JA, NE; statistical analysis: RR; writing: RR; advising on concepts, analyses and supplementary figures: MH, RK; revision: all authors.

Conflicts of interest None.

Ethical standards Maio Biodiversity Foundation was granted full clearance to undertake this study in the fourth-grade classes across schools in Maio by Maria Ribeiro, the education delegate of Maio. This research abided by the *Oryx* guidelines on ethical standards. Student identities are kept anonymous in the dataset. We explained the objectives and implications of the research to the students and staff members, who freely provided consent for their participation.

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