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1 **Environmental education in the classroom: pilot study in Cabo Verde suggests differing**  
2 **impacts on students' local knowledge and environmental attitudes.**

3  
4 Romy Rice<sup>a</sup>, Momna Hejmadi<sup>a</sup>, Herval Silva<sup>b</sup>, Robert Kelsh<sup>c</sup>, Janete Agues<sup>b</sup>, Noémie Engel<sup>a</sup>,  
5 Tamás Székely<sup>a, b, d</sup>

6  
7 <sup>a</sup> Milner Centre for Evolution, University of Bath, Claverton Down, Bath BA2 7AZ, United Kingdom

8 <sup>b</sup> Maio Biodiversity Foundation, Maio Island, Republic of Cabo Verde

9 <sup>c</sup> Department of Life Sciences, University of Bath, Claverton Down, Bath BA2 7AZ, United Kingdom

10 <sup>d</sup> Department of Evolutionary Zoology and Human Biology, University of Debrecen, H-4010,  
11 Debrecen Egyetem tér 1, Hungary

12  
13 **Contact details:**

14 **Corresponding author:** Romy Rice, [rr433@bath.ac.uk](mailto:rr433@bath.ac.uk) ORCID ID 0000-0003-3974-7382

15 Momna Hejmadi: [bssmvh@bath.ac.uk](mailto:bssmvh@bath.ac.uk) ORCID ID 0000-0003-2451-2695

16 Herval Silva: [herval.silva@fmb-maio.org](mailto:herval.silva@fmb-maio.org)

17 Robert Kelsh: [bssrnk@bath.ac.uk](mailto:bssrnk@bath.ac.uk) ORCID ID 0000-0002-9381-0066

18 Janete Agues: [janete.agues@fmb-maio.org](mailto:janete.agues@fmb-maio.org)

19 Noémie Engel: [nce25@bath.ac.uk](mailto:nce25@bath.ac.uk)

20 Tamás Székely: [bssts@bath.ac.uk](mailto:bssts@bath.ac.uk) ORCID ID 0000-0003-2093-0056

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25

26 Abstract

27 To execute environmental education effectively, the success and impact of educational activities  
28 must be assessed. In areas of high biodiversity, there is a lack of impact evaluation of  
29 environmental education. This study investigates the effect of a one-time classroom activity on  
30 students' knowledge of local environmental issues, environmental attitudes, and future  
31 aspirations. The project was conducted on the island of Maio, Cabo Verde, a small, highly  
32 biodiverse island, as part of a classroom visit program with the local environmental organization,  
33 Maio Biodiversity Foundation. We visited every 4<sup>th</sup> grade class on the island (n = 142 students)  
34 and delivered a half-day classroom activity. The results showed that this classroom activity did  
35 not influence environmental attitudes, however it did significantly improve students' knowledge  
36 and awareness of local environmental issues. This study shows that environmental education  
37 should not be assumed to automatically improve attitudes and knowledge, but requires individual  
38 evaluation for each type of activity. For environmental education to reach its full potential,  
39 activities should be carefully planned in response to evaluation results to achieve the desired  
40 objectives.

41

42 Keywords: Environmental education, Attitudes, Knowledge, West Africa, Evaluation,  
43 Conservation.

44

45 Introduction

46 Earth's biodiversity is diminishing at an alarming rate. Over the past decade the IUCN has  
47 declared that over 160 species have become extinct, and over 38,500 species are threatened with  
48 global extinction, according to the Red List (IUCN. 2021). Anthropogenic activities such as  
49 pollution, over-exploitation of natural resources and habitat destruction are threatening the future  
50 of plant and animal species, including our own (Ramírez and Santana. 2019). The destructive

51 practices that lead to environmental problems are often authorized and encouraged by a lack of  
52 knowledge and respect for the environment, ultimately caused by inadequate environmental  
53 education (Valderrama-Hernandez et al. 2017).

54

55 As advancements in technology continue, and urbanization of the world is rapidly increasing,  
56 children's exposure to the natural world has decreased, referred to as the extinction of experience  
57 (Pyle. 1978). In 2016, a study concluded that 12% of children participating in a UK survey spent  
58 12 months without visiting a natural area (Hunt et al. 2016), and a study by Ballouard et al.  
59 (2011) showed that while school children could only identify 39.9% of local species presented,  
60 they could identify 46.6% of exotic species, implying a disconnect from local biodiversity. The  
61 need to reconnect society back to nature is apparent, and it is particularly important for the  
62 younger generation. Childhood is the optimal stage to undertake environmental education, with  
63 younger children being more receptive to environmental attitude changes than adults and even  
64 teenagers, as once formed, environmental opinions become increasingly more difficult to sway  
65 (Kellert. 1985, Caro et al. 1994, Damerell et al. 2013, Liefländer and Bogner. 2014).

66

67 Therefore, implementing environmental education in schools is an ideal system to increase pro-  
68 environmental behavior amongst society. It is often assumed that parent-child teaching is  
69 unidirectional, with the parents teaching their children the attitudes and knowledge that they  
70 possess, however studies have shown that children can impact the values and knowledge of their  
71 parents too (Vaughan et al. 2003, Damerell et al. 2013). This bidirectional influence between  
72 adults and children at home gives environmental education the potential to be a very powerful  
73 tool to increase knowledge and positive attitudes towards the environment across younger and  
74 older generations.

75

76 Environmental education does not have one simple definition. Environmental education consists of  
77 a plethora of activities to raise awareness of environmental issues, encourage positive attitudes  
78 towards nature, increase knowledge both of and about the environment, and highlight key problem-  
79 solving skills to allow identification of solutions to environmental problems (Lucas, 1979, Edsand  
80 and Broich, 2020). This type of education is essential to slow the inflated loss of global biodiversity  
81 that we are presently experiencing (Ruiz-Mallen et al. 2009). Biodiversity conservation is  
82 dependent on the understanding of threats to ecosystems, and the workings of ecosystems  
83 themselves (Kassas, 2002, Lanjouw, 2021). It is crucial that local communities become part of  
84 conservation efforts, and this all starts with environmental and conservation education (Ardoin et al.  
85 2020).

86

87 Environmental education is a wonderful tool, with many effective projects being undertaken across  
88 the globe (Ruiz-Mallen et al. 2009, Ortiz et al. 2018, White et al. 2018, Spooner et al. 2019, Karris  
89 et al. 2020). However, due to its many favorable benefits, environmental education can often be  
90 thought of as an all-round general solution to many different environmental problems, without  
91 clearly defining goals or critically assessing the activities undertaken (Edsand and Broich, 2020).  
92 For environmental education to reach its full potential, its impact must be evaluated. An increased  
93 understanding of the impact of environmental education can improve the efficacy of the education  
94 itself and can also help to further improve policies and programs involving the environment,  
95 practices for sustainable development, and environmental career prospects of participants (Kassas,  
96 2002). The change in environmental attitudes, knowledge acquisition and even career trajectories  
97 should be monitored and assessed, often done by case studies focusing on a particular  
98 environmental education (Borchers et al. 2014). However, these evaluations are predominantly  
99 occurring in the USA and Europe (Stern et al. 2008, Kossack and Bogner. 2012, Koutromanos et  
100 al. 2018, Spooner et al. 2019).

101

102 However, in areas of the world that often contain higher levels of biodiversity, such as West Africa,  
103 there appears to be a lack of environmental education evaluation (Kuhar et al. 2010, Borchers et  
104 al. 2014). Due to the increasing appearance of conservation foundations, predominantly non-  
105 governmental organizations (NGOs), environmental education is increasing in Africa, however  
106 there is scarce literature showing any evaluation of these projects (McDuff. 2000, Carelton-Hug,  
107 2010, Borchers et al. 2014, Leeds et al. 2017, Velemplini. 2018). Additionally, it is not known if  
108 the differing cultures, social and educational systems, and environmental circumstances are taken  
109 into account whilst implementing these educational activities, as the differences between Africa  
110 and Europe/North America question the assumption that the same environmental education  
111 strategies will have the same effect, so that the results of any environmental education evaluation  
112 undertaken in Europe/North America may not be applicable in Africa (Bettinger, 2010, Borchers  
113 et al. 2014, Lanjouw, 2021).

114

115 This study aims to add to the limited publications evaluating the impact of environmental education  
116 in West Africa. The island of Maio, Cabo Verde, was used as a case study, and the impact of a one-  
117 time classroom intervention undertaken by the local conservation NGO Maio Biodiversity  
118 Foundation was evaluated across all 4<sup>th</sup> Grade classes (n = 10 classes) on the island. The objectives  
119 of this evaluation were to investigate if and how a single exposure to environmental education in the  
120 classroom could influence 1) attitudes towards the environment, 2) knowledge acquisition of local  
121 environmental problems, and c) future aspirations regarding career and studies.

122

### 123 Study Area

124 Cabo Verde is an archipelago consisting of ten islands, approximately 600 km west of the coast of  
125 Senegal, West Africa. The island of Maio (15°13' N, 23°10' W) is one of the smallest of the nine  
126 inhabited islands of Cabo Verde, with an area of 269 km<sup>2</sup> and a population of approximately 6980  
127 inhabitants (Instituto Nacional de Estatística de Cabo Verde 2015). Cabo Verde is home to a vast

128 array of marine fauna, flora, and endemism. The island of Maio is home to a wide range of this  
129 biodiversity, including some of the endemic bird taxa of Cabo Verde: Iago sparrow (*Passer*  
130 *iagoensis*), Bourne’s heron, (*Ardea purpurea bournei*), Alexander’s swift (*Apus alexandri*) and  
131 Cream-coloured courser (*Cursorius cursor exsul*) (Rice et al. 2020). Maio is also home to the  
132 largest, resident breeding population of Kentish plover *Charadrius alexandrinus* in the  
133 Macaronesian archipelagos (Engel et al. 2020, McDonald et al.2021). Maio hosts a range of sea  
134 turtle species during the reproductive months of June – October, including Olive Ridley  
135 (*Lepidochelys olivacea*), Green (*Chelonia mydas*), and is one of the three Cabo Verde islands with  
136 the largest nesting colonies of Loggerhead (*Caretta caretta*) (Lopes et al. 2016, Patino-Martinez et  
137 al. 2022). Maio consists of thirteen distinct communities, split into four zones, containing eleven  
138 primary schools. This study focused on 4th grade students, with the age range of 9-10 years old (n =  
139 142 students). Due to the small population size of some rural communities in Maio, 4th grade  
140 students were condensed into 10 classes distributed across 8 schools. The content taught was  
141 relevant to the island’s largest wetland, the “Salinas do Porto Inglês”. This is a RAMSAR site of  
142 approximately 535 ha (Oliveira, 2013, Pereira, 2016), containing saltmarsh, grassland and semi-  
143 desert habitats and home to a variety of biodiversity, including the aforementioned bird and turtle  
144 species.

145

## 146 Methods

### 147 Environmental Education Intervention.

148 From the 18th-25th May 2021 we collaborated with Maio Biodiversity Foundation and visited  
149 every 4th grade class on the island of Maio (n = 10). At each school, we (Romy Rice and Herval  
150 Silva) delivered a two hour long environmental education intervention. The researchers took  
151 control of the session, however the teacher stayed present in the classroom to assist with any  
152 issues, such as discipline. The topic of the intervention was “Ecosystems in Maio”, and we used  
153 local examples to show the impact of human activity on ecosystems, both detrimental (threats

154 such as litter and vehicles) and beneficial (conservation work such as turtle patrols and beach  
155 cleans).

156

157 First, we introduced the topic of ecosystems in a 10-minute presentation about the different types  
158 of habitats found in Maio, and the species in each ecosystem. The focus was on the protected  
159 area “Salinas do Porto Inglês”, the island’s largest wetland and terrestrial biodiversity hotspot.  
160 For this chosen ecosystem, the class discussed what kind of species were present, and what the  
161 ecosystem consisted of, including both biotic and abiotic components. For every organism  
162 suggested, the class discussed what that organism depended on, therefore starting to make links  
163 between ecosystem components. We then helped the students create an ecosystem network,  
164 containing all organisms that were suggested, and all the connections discussed. We identified  
165 threats to the ecosystem, and we used 5 key examples for the activity: 1) quad bikes, 2) illegal  
166 sand extraction, 3) too many people, 4) litter, and 5) hotel construction. We then recreated this  
167 ecosystem with the children. Every child represented part of the ecosystem e.g., species of birds,  
168 turtles, plants, water, and sand, by using cartoons on paper. The connections between ecosystem  
169 components were represented by holding a rope. Depending on the classroom size, some  
170 children represented the suggested threats, also with cartoons. The five threats were presented,  
171 and for each threat we discussed what kind of problem this threat generated for an organism or a  
172 connection. If a connection (rope) between the organisms (children) was broken by the threat, the  
173 rope was placed on the floor. All threats were presented until all the ropes were on the floor,  
174 therefore the ecosystem was ruined. After the activity, we held a group discussion to talk about  
175 the work of Maio Biodiversity Foundation and discuss what we can all do to prevent threats from  
176 destroying local ecosystems.

177

178 Questionnaires



179 We designed a questionnaire to evaluate the environmental attitudes, future aspirations, and  
180 knowledge of local environmental issues of 4th grade students before and after the  
181 environmental education intervention (Supplementary material 1 & 2). The questionnaire  
182 consisted of fourteen statements with a 1-5 Likert scale (1= strongly disagree, 5=strongly agree),  
183 and three open ended questions, categorized into 5 groups (1. Science, 2. Animals, 3. Litter, 4.  
184 Future aspirations and 5. Knowledge of local environmental issues). We developed the  
185 questionnaire in English, then translated it into Portuguese, and the final edit was undertaken by  
186 a Cape Verdean with experience in schools, to ensure that the questions and language were  
187 appropriate and understandable. In the results section for questions regarding future aspirations  
188 the acronym “FMB” refers to Maio Biodiversity Foundation. We applied the questionnaires  
189 immediately before the intervention, and one week after. In total, 131 students filled out at least  
190 one questionnaire, however nine students were absent for one of the two applications, therefore  
191 122 students filled out both pre- and post-activity questionnaires. We excluded the nine students  
192 that only filled out one questionnaire from the analysis. Students’ identities were kept  
193 anonymous, using a numbered system rather than full names.

194

### 195 Analysis

196 The first fourteen quantitative statements were scored 1-5 and the last three questions were open  
197 ended. These open questions were interpreted by one independent researcher and converted into  
198 a score between 1-5. The highest score of five represented a complete answer showing full  
199 comprehension of the question. The lowest score of 1 represented no useful answer, an incorrect  
200 answer, or no understanding of the question. Two of the statements implied a negative opinion,  
201 1) “I find science boring” and 2) “I leave my litter on the floor”, therefore the scores for these  
202 were reversed for analysis. For each group of statements (1. Science, 2. Animals, 3. Litter, 4.  
203 Future aspirations and 5. Knowledge of local environmental issues), we applied a Multivariate  
204 Mixed Model analysis to assess the effect of the intervention. The relationships between the

205 dependent variables (Scores of questions) and 3 fixed independent variables (School, Gender,  
206 Intervention) were investigated, with the Student ID as a random effect. To determine the effect  
207 of gender and school on students' learning, the difference in scores were calculated before and  
208 after the intervention, and a two-way multivariate analysis of variance (MANOVA) was  
209 conducted on these differences. Gender and school type were the independent variables,  
210 difference in score per question were the dependent variables.

211

212 All statistical analyses were performed using R studio version 4.1.3 (RStudio Team. 2021). Data  
213 were visualized with package ggplot2 (Wickham 2016) and models used the package lme4  
214 (Bates et al. 2015).

215

## 216 **Results**

217 Exposure to the environmental education intervention (variable "Intervention") was the most  
218 influential variable on the questionnaire outputs (Tables 1). The scores of eleven out of  
219 seventeen statements and questions significantly differed before and after the intervention, and  
220 nine varied between schools. Responses did not vary between the genders.

221

## 222 **Opinions regarding science**

223 The statement "I like science lessons" was significantly affected by both "Intervention" and  
224 "School". The students stated they liked science lessons less after the intervention, however  
225 students from the school of Morro scored this statement significantly higher compared to other  
226 schools. Interestingly, students scored higher for the statement "I want more science lessons at  
227 school" after the intervention. The intervention did not affect students' scores for "I find science  
228 boring", although students from the school Figueira and Calheta scored this statement  
229 significantly higher in comparison to the other schools (Table 1).

230

231 **Opinions about animals**

232 Of the five statements regarding opinions towards animals, only one, “Animals are important.”  
233 was positively affected by “Intervention” or school. The statement “I want to learn more about  
234 animals” scored higher in the school of Morro, and the statement “I like seeing different animals  
235 on T.V and in books” scored higher in two schools (Pilão Cão and Morrinho) (Table 1).

236

237 **Opinions about Litter**

238 All three statements regarding litter were affected by “Intervention” and two statements were  
239 affected by “School”. The statements concerning litter dropping “I always put my litter in the  
240 bin” and “I leave my litter on the floor” were both negatively affected by the intervention, with  
241 students admitting to dropping litter more after the intervention. These two statements were also  
242 affected by school, with “I always put my litter in the bin” scoring higher in two schools, and “I  
243 leave my litter on the floor” scoring higher in five schools. However, students also admitted to  
244 more feelings of sadness when they see litter in the street or the beach after the intervention.  
245 (Table 1).

246

247 **Opinions about future aspirations**

248 The two statements related to becoming involved with conservation activities “I want to work  
249 with the environment” and “I would like to volunteer with FMB one day” were both positively  
250 affected by the intervention. The statement “I would like to volunteer with FMB one day” was  
251 affected by “School”, with one school (Morro) showing overall higher scores compared to the  
252 others (Table 1).

253

254 **Knowledge of local environmental issues**

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

258

### 259 **School**

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

265 The two-way MANOVA results indicated a statistically significant difference in students’ learning  
266 between schools; Wilks’ Lambda = 0.0496,  $F = 1.33$ ,  $p = 0.02949$ , however no difference between  
267 genders. Specifically, three of the seventeen questions showed a significant difference in learning  
268 between schools; “I always put my litter in the bin”;  $F = 2.989$ ,  $p = 0.00975$ , “I like animals”;  $F =$   
269  $2.395$ ,  $p = 0.0324$ , and “What are the environmental problems in Maio?”;  $F = 2.805$ ,  $p = 0.0142$ .

270

271

### 272 **Discussion**

273 This study provides four main results. First, the scores of most statements regarding  
274 environmental attitudes and actions were not immediately improved by the one-time exposure to  
275 the environmental classroom activity that this study presented. Second, questionnaire responses  
276 suggested that students seemed more willing to get involved with environmental activities in the  
277 future soon after the intervention. Third, the intervention significantly increased students’  
278 knowledge of local environmental issues. Fourth, students’ attitudes and learning are dependent  
279 on the type of school they attend. Overall, we can conclude that this study highlights the  
280 necessity of evaluations of environmental education and suggests that environmental education

281 cannot be assumed as a general solution, but rather as a tool that requires careful planning much  
282 like any other conservation action.

283

284 The majority of statements regarding attitudes towards science lessons, litter and animals did not  
285 show a significant change in score after the environmental education intervention. Although the  
286 scores suggested that students would like more science lessons, they did not suggest that students  
287 liked science lessons more after the intervention. This mixed response also applied to the  
288 statements regarding litter. Scores revealed that after the intervention students felt more aversion  
289 towards seeing litter in the streets and at the beach, however showed higher levels of litter  
290 dropping. Finally, of the five statements regarding attitudes towards animals, just one increased  
291 in score after the intervention, with the rest not affected. Therefore, of the eleven statements  
292 regarding environmental attitudes and actions, only three positively increased in score after the  
293 intervention. It is often assumed that environmental education encourages more positive  
294 environmental attitudes, due to the encouraging responses of some programs (Armstrong &  
295 Impara. 1991, Farmer et al. 2007, Ruiz-Mallen et al. 2009). However, this study suggests that  
296 this is not always the case. This could be due to the fact that this was a one-time exposure  
297 activity. Several studies that have shown to improve environmental education attitudes were long  
298 term programs, or at least had a higher exposure rate than just one occasion (Volk & Cheak.  
299 2003, Hsu. 2004, Ruiz-Mallen et al. 2009). Although there have been instances of one-time  
300 exposures to environmental educational activities making a difference (Farmer et al. 2007,  
301 Spooner et al. 2019), a one-time classroom educational intervention or activity such as this study  
302 may not be sufficient to change the students' opinions about science lessons in general, or their  
303 overall attitude towards littering and animals. Perhaps the intervention design itself was not  
304 optimal, or simply more exposures are necessary to generate attitudinal changes. This result  
305 highlights the importance of evaluating all types of educational activities, as the outcome may  
306 not be the positive influence that is commonly expected.

307

308 However, these mixed responses to statements regarding environmental attitudes could reflect a  
309 fault in the study design. Self-completion questionnaires are often used as an effective method of  
310 data collection for large study samples, as this format allows for honest responses due to the  
311 anonymity of the set-up (Strange et al. 2003). However, for this particular study, the use of  
312 questionnaires could have been a limitation of data collection. Young students may struggle to  
313 understand complicated questionnaires and therefore shorter, simpler questionnaires are  
314 recommended for younger age groups. However, by creating a toned-down questionnaire for  
315 ease of use of younger students, we may reduce the power of this data collection method. The  
316 use of questionnaires with children might also have produced issues with honesty whilst  
317 answering certain questions. For example, students may have felt pressure to answer in a certain  
318 way if they felt that the questionnaire was in the format of an exam. Although researchers  
319 explained that this was not an exam, the first statement was “I like science lessons”, therefore  
320 young students may have felt pressure to give a higher score than what they may honestly be  
321 feeling. The same theory could apply towards the statement that require a certain level of  
322 honesty, such as the statements regarding litter dropping. During the first round of  
323 questionnaires, students may have felt compelled to put more socially desirable answers  
324 (Milfont. 2009), due to the presence of the local conservation NGO in their lesson. Once they  
325 had done the activity and realized that this was in fact not an exam, they may have felt more  
326 relaxed to answer sincerely. In future studies, perhaps these “honesty” type statements are not the  
327 optimal way of assessing views, and it may be better to use a more subjective method, such as  
328 interviews or even personal observations (Jahedi & Méndez. 2014, McIntyre & Milfont, 2016).

329

330 The second finding of this study was that after the intervention, students’ aspirations about  
331 getting involved with the environment seemed to positively increase, however children did not  
332 feel more inclined to continue to study science. This result reinforces the link between effectual

333 environmental education and interest in conservation. A limitation of this study is the small  
334 simple questionnaire used to collect data, therefore there were only two statements regarding  
335 future environmental activities. Nonetheless, the response to both statements significantly  
336 increased after the intervention; children were more inclined to want to volunteer with Maio  
337 Biodiversity Foundation and think about working with the environment. This may be since  
338 outside organizations entering schools often present new ideas and a change to the usual  
339 curriculum, and therefore can motivate children to get involved more than usual classroom  
340 activities (Fitzakerley et al. 2013), however, to fully support this conclusion a larger number of  
341 questions would be necessary. Future studies could also include the use of a control group that is  
342 not exposed to an external intervention, therefore assessing the effect of the presence of an  
343 organization within a school.

344

345 The third major finding of this study was that students' knowledge regarding local environmental  
346 issues significantly increased after the intervention. All three questions regarding local  
347 environmental issues significantly increased in score after the intervention, and considerably  
348 more than the other attitude-based statements. Many students' responses also included extra  
349 details, showing not just memorization of the information taught, but understanding too. For the  
350 question "What are the environmental problems in Maio?" after the activity, many students  
351 listed the five threats mentioned in the activity: 1) quad bikes, 2) illegal sand extraction, 3) too  
352 many people, 4) litter, 5) hotel construction, however there were numerous instances of students  
353 reinforcing their answers with extra details, such as "quad bikes making water and sand dirty",  
354 and "quad bikes destroying bird nests". Additionally, some students included the five mentioned  
355 threats, and extra threats that were not mentioned in the activity, such as "people killing  
356 animals", "driving cars through protected areas" and "turtle poaching". These extra details  
357 suggest that students were able to learn information taught but also apply their knowledge to the  
358 question after the activity.

359 These results suggest that this type of classroom environmental education is most powerful when  
360 targeted towards teaching information, and knowledge retention, even if it may not necessarily  
361 spark interest or change opinions. This information can then be used to plan out environmental  
362 education specifically aiming to improve learning. However, a limitation of this result is that it is  
363 not known how long the information was retained for. The follow-up questionnaires were  
364 undertaken 1 week after the intervention; however, we do not know how long students preserved  
365 the information they learnt for long term. Future studies could perhaps include not just a 1-week  
366 follow-up, but also a 1-month or even a 1-year follow-up.

367

368 The fourth result of this study was that although intervention was the most influential variable  
369 overall, the school that a student attended also affected the responses to some statements. There  
370 did not seem to be a directional trend, and the schools that affected scores depended on the topic  
371 of the question. Overall, the school of Morro provided higher scores for five of the nine  
372 questions affected by school, however these are spread over the topics of all five groups of  
373 questions, making it difficult to draw any conclusions regarding the effect of school. However,  
374 Morro had a class size of just seven students and some studies suggest that smaller class sizes  
375 improve learning (Fogarty. 2012, Altinok & Kingdon. 2012.). However other literature suggests  
376 that class size alone is not enough to affect learning outcomes, but rather a mixture of  
377 socioeconomic factors (Hattie. 2005, Köhler. 2022.) Additionally, the effect of “School” could  
378 relate to the particular location of that school, rather than the school itself. Morro for example is  
379 a small village, and more rural than some other communities in Maio. This may be a limitation  
380 of the study design, as some sample sizes of individual schools are very small, therefore  
381 confounding factors may affect the outcome, such as the culture of the village, teacher, or home  
382 life. More research is required to investigate the specific effect of school on environmental  
383 attitudes and knowledge.

384



385 To conclude, this study has shown that evaluation is crucial in understanding the impact that  
386 educational activities have on student knowledge, environmental attitudes, and future aspirations.  
387 This one-time classroom activity was successful at increasing students' knowledge of local  
388 environmental issues, as well as raising their awareness of solutions to the problems, however it  
389 was not effective at improving environmental attitudes. Although this study was small and  
390 simple, the results do suggest that environmental education is not a general solution to the array  
391 of environmental issues that the world is facing, but in fact a technique that needs careful  
392 planning and judgement. Environmental education has the potential to be a powerful tool in  
393 conservation, however it should be assessed and organized like any other environmental action.  
394 To expand and solidify the conclusions drawn from this study, we suggest developing a more  
395 complex questionnaire in combination with subjective observations, or using a different data  
396 collection method, such as interviews. Additionally, adding another follow-up to the study  
397 design, such as after one month or one year, would help clarify the effects of environmental  
398 education. To access the full potential of environmental education, future work is necessary to  
399 further evaluate the effect of other types of activities, such as those that take place outside of the  
400 classroom.

401

#### 402 Author contributions

403 RR and TS developed the concept of the paper. RR, HS, JA and NE developed and participated in  
404 the educational intervention. RR conducted the statistical analyses and wrote the first draft of the  
405 manuscript. RK and MH provided advice on concepts, analyses and supplementary figures. All  
406 authors contributed to edits and preparation of the final manuscript.

407

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413

#### 414 Conflicts of interest

415 None

416

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423

#### 424 Ethical Standards

425 Maio Biodiversity Foundation was granted full clearance to undertake this study in the 4<sup>th</sup> grade  
426 classes across schools in Maio by Maria Ribeiro, the education delegate of Maio. This research  
427 abided by the Oryx guidelines on ethical standards. Students' identities are kept anonymous in the  
428 dataset. The objectives and implications of the research were explained to the students and staff  
429 members, who provided freely consent for their participation.

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642 **Tables**

643

644 **Table 1.** Multivariate mixed model output testing the effect of “Intervention” and “School” on  
 645 scores of statements regarding “Science”, “Animals”, “Litter”, “Future aspirations” and “Local  
 646 environmental issues”. Table 1 shows the corresponding significant variables, estimates, t-values  
 647 and p-values. The non-significant variable “Gender” was removed from the models.  
 648 Corresponding degrees of freedom: 548, 995, 542, 514, and 548.

649

Statement/Question	Variable	Estimate	t-value	p-value
<b>Science</b>				
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
<b>Animals</b>				
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 T.V and 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 Cape Verde	No significant variables			
<b>Litter</b>				

<b>Statement/Question</b>	<b>Variable</b>	<b>Estimate</b>	<b>t-value</b>	<b>p-value</b>
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 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
<b>Future aspirations</b>				
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 FMB one day	“Intervention” (After)	4.674	4.674	0.00
	“School” (Morro)	0.805	2.054	0.040
<b>Local environmental issues</b>				
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

<b>Statement/Question</b>	<b>Variable</b>	<b>Estimate</b>	<b>t-value</b>	<b>p-value</b>
Who is responsible for taking care of the environment?	“Intervention” (After)	1.356	8.699	<0.001

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