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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
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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 4th 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, Velepini. 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 4th 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 km² 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 4th 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.

430

431

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433

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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.

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Statement/Question	Variable	Estimate	t-value	p-value
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 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			
Litter				

Statement/Question	Variable	Estimate	t-value	p-value
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
Future 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 FMB one day	“Intervention” (After)	4.674	4.674	0.00
	“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

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

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