# Assessing long-term efficacy of environmental education lessons given to teachers in South-Eastern Madagascar

Michela Balestri[1], Marco Campera[1], K. Anne-Isola Nekaris[1], Giuseppe Donati[1]

[1] Oxford Brookes University, Department of Social Sciences, Oxford, UK.

## Abstract

Increase in knowledge is the very first step in environmental education programs. In particular, a long-term retention of knowledge could bring changes in attitudes and behaviours. Education level in Madagascar is low, especially in rural villages, and most of children do not continue after primary school. The lack of education is one of the main causes of the dramatic habitat loss of this biodiversity hotspot since locals use traditional cultivation ways that have high impact on the forest and give very low profits. In this study we aimed at testing whether four days of training to teachers from Iaboakoho provided an increase in knowledge about environmental issues, with particular focus on lemurs. Iaboakoho is one of the four municipalities facing the South part of the Tsitongambarika protected area, together with Mahatalaky, Mandromodromotra, and Ampasy-Nahampoana. To test whether knowledge was retained, we gave structured questionnaires to 10 teachers from Iaboakoho after one year from the training. We also tested the knowledge of 33 teachers from the other three municipalities as control groups. Each questionnaire encompassed 19 questions and was divided in four sections: General Knowledge, Conservation, Ecology and Behaviour, and Identification. We used Generalised Linear Models with total scores and scores for each section as dependent variables using the log-linear Poisson distribution as link function. Municipalities were the fixed factor, and a post-hoc test was performed to investigate pairwise comparisons. The teachers from Iaboakoho resulted to have higher total scores when compared to the teachers from the other three municipalities. In particular, the teachers from Iaboakoho had better scores for General Knowledge and Identification. Knowledge gained from the environmental education training was not transient, thus teachers can transfer information on environmental subjects to children in the area. This study is the very first step to increase environmental knowledge in the area, and further conservation education programs focused on increasing pro-environmental attitudes and behaviours are required in order to have effective impacts to lower down environmental exploitation.

## Introduction

Environmental education programs aim at increasing knowledge, attitude, and behavior of participants (Kuhar et al. 2010; Ploeg et al. 2011). The Bloom's taxonomy of educational objectives (Bloom 1956) is a well-accepted categorisation of learning and is commonly applied in

environmental education assessment (Bissels and Lemons 2006, Jacobson et al., 2006, Ploeg et al. 2011). Basic knowledge is the first category of the Bloom's taxonomy and includes memorizing facts, figures, and basic processes (Bissels and Lemons 2006). Assessment of basic knowledge and its increase in the short term and in the long term is the first step in environmental education programs (Kuhar et al. 2010). However, only a few studies investigated the long-term efficiency of environmental education programs in a conservation context (e.g. Kuhar 2010; Rakotomamonjy et al., 2015; Richter et al. 2015), whilst more studies only evaluated immediate knowledge and attitudes towards these programs (e.g. Dolins et al., 2010; Damerell et al., 2013). Furthermore, information coming from local educators are likely to be more effective than if delivered by foreigners, thus teacher training is pivotal to facilitate having a long-term retention of environmental knowledge (Wallis et al. 2010).

Anthropogenic pressure such as habitat degradation, overexploitation, and the degree of exposure to them are the main factors that lead to species extinction risk (Lootvoet et al., 2015). Madagascar is a biodiversity hotspot and widely recognized as conservation priority (Brooks et al. 2006). Also, it is one of the poorest countries in the world, since more than 92% of Malagasy people live with less than $2/day (World Bank 2007). Habitat exploitation, such as forest fragmentation, logging, and hunting are threatening many species (Schwitzer et al. 2014). For instance, 94% of lemur species are threatened with extinction (Schwitzer et al. 2013). Education level is low in Madagascar, especially in rural villages, and most of the locals do not have the means (e.g. money and books) to receive proper education (Ratsimbazafy, 2003; Dolins et al., 2010). Only 38% of children start at least the first class of schools (UNDP Human Development Report 2014), hence targeting primary schools for environmental education allows reaching out the largest portion of Malagasy children (Richter et al. 2015). This lack of education is one of the reasons for the dramatic habitat loss over the last 60 years in Madagascar (Green and Sussman, 1990; Dolins et al., 2010). In fact, many locals use traditional cultivation methods (e.g. slash-and-burn agriculture), which have a high impact on the forest and give very low profits (Styger et al. 2007). Also, little is taught about endemic lemurs, their ecology and their protected status, especially in rural areas, despite their use as flagships in many development programs (Ratsimbazafy, 2003; Keane et al., 2011). Moreover, despite the integration of environmental education in teaching programs at all levels by the Malagasy government, many teachers have a limited knowledge on this subject and do not receive appropriate training (Dolins et al., 2010). Environmental education is thus crucial in Madagascar to encourage long-term protection of the habitats.

The Protected Area of Tsitongambarika is one of the last remnant lowland rainforests of Madagascar and it is one of the 30 priority areas for conservation on the island in the most recent Lemur Conservation Action Plan (Schwitzer et al., 2013). Unfortunately the Anosy region, which hosts this forest, is also one of the regions with a lower education level in Madagascar (BirdLife International, 2011), and locals have a high impact on the forest (Campera et al. in prep). In fact, human exploitation such as hunting, slash-and-burn agriculture, logging, and timber harvesting are common in the area (Campera et al. in prep). A program of environmental education in the area is still lacking, and launching one has been hindered by high illiteracy in the area (BirdLife International, 2011). In the year 2015, the local NGO Asity linked to Birdlife International, in collaboration with Qit Madagascar Minerals, started a project on environmental education following international programs for primary schools (UNESCO 1983). .

During the environmental education program promoted by Asity Madagascar, we provided four days of training to teachers of Iaboakoho between July and September 2015. The aim of this study was to test whether the lectures given to the teachers from primary schools of the municipality of Iaboakoho had been retained and the teachers were thus able to provide information on lemurs and their biology to the students. To test this, after one year from the training we gave structured questionnaires to 43 teachers from the primary schools in the municipalities of Iaboakoho, Mahatalaky, Mandromondromontra, and Ampasy-Nahampoana. These four municipalities have been selected since they are in the same region (Anosy), along the national road 12A, and all about the same distance from the Tsitongambarika Protected Area. The hypothesis to be tested is that the teachers from Iaboakoho retained the information given and have a higher knowledge on lemurs and their biology than the teachers from the other municipalities. A North-South trend is expected since schools that are more distant from the main town, Fort Dauphin, are expected to have teachers with lower education levels (Faniry Rakotoarimanana, head of the offset-site project of Asity Madagascar, pers. comm.).

## Methods

### Case study

The Tsitongambarika Protected Area was established in 2008 by the Ministry of the Environment and Forests and is managed by Asity Madagascar with the financial aid of Qit Madagascar Minerals (BirdLife International, 2011). Tsitongambarika has also been included in the 30 priority areas for lemur conservation in the Lemur Action Plan (Schwitzer et al. 2013). At the end of April 2015, a

research station has been set in the northernmost portion of Tsitongambarika with the collaboration of Asity Madagascar, Qit Madagascar Minerals, and Oxford Brookes University. The research station was established in a portion of Tsitongambarika included in the municipality of Iaboakoho. Training lessons were given to teachers from the primary school in Iaboakoho and the other primary schools included in the municipality. Not all the teachers attended all the lessons; for this reason we asked only the teachers who attended all of them to do the test. These trainings were organized with the aid of Asity Madagascar that programmed training for teachers including environmental education from July to September 2015. Each lesson lasted for about two hours in which we discussed the following subjects: "Generalities on the Tsitongambarika forest and the new research station", "The lemur species present in Tsitongambarika and their ecology", "The importance of plant biodiversity for humans and lemurs", and "Ecosystems equilibrium". The first lesson was meant to provide information about the research station and the research on lemurs that we are conducting in the area. Also, we emphasised the importance of the Tsitongambarika forest and the reasons why we chose this site for the installation of a new research station. In the second lesson we discussed more in depth about the lemur species that are present in Tsitongambarika with information about their scientific names, activity, and diet. The third lesson involved the discussion of the concept of "Biodiversity", as well as the discussion of possible threats and possible ways to preserve biodiversity. Furthermore, in this lesson we provided information about the importance of plant biodiversity for humans and lemurs, with particular focus on the priority species for *Eulemur collaris* that is the biggest frugivore in the South-East Madagascar, and thus the main seed disperser in the area (Bollen et al. 2004). In the last lesson we introduced the concept of ecosystems and provided some examples to make it easier to understand this concept. Also, we explained the trophic chain providing some examples with local species and explaining the concepts of primary producers, consumers, and decomposers. During the trainings, a member of Asity Madagascar translated in Malagasy the information given. Before starting a new lesson, we asked teachers to participate actively by answering to oral questions concerning the previous subjects treated. After one year from the first lesson, we organized a test to evaluate the efficacy of these trainings. As control groups, we asked teachers from other 3 Municipalities (Ampasy-Nahampoana, Mandromodromotra, Mahatalaky) to do the same test. These municipalities are all close to the Tsitongambarika forest and are the only four municipalities (including Iaboakoho), which are located on the South side of this forest. At the end of the test we provided summarized information to the teachers from the municipalities who did not receive environmental training.

**Permission and research ethics**

The research was approved by the Oxford Brookes University ethics committee. We obtained permission from the Ministry of Environment and Forest (53/16/MEEMF/SG/DGF/DAPT/SCBT.Re) and from each school director of the schools in the four municipalities. Before the test, we met the school directors to explain them our project and to agree a day for tests. We explained all the details of the research and that participation was voluntary and that participants had the chance to withdraw at any time during tests.

**Questionnaire design**

Each questionnaire consisted of nineteen multiple-choice questions (Table 1). Questions were grouped in General knowledge (G), Conservation knowledge (C), Ecology and behavior (E), and Identification (I) (modified from Grossberg et al. 2003). Questionnaires were originally in English and translated in Malagasy (with terms from the Anosy dialect) by a University student from Fort Dauphin (main city of the Anosy region). The questions were related to topics we previously included during trainings. We asked the participants to write their sex and municipality at the beginning of the test. A total of 43 teachers from the four municipalities participated to the test (Table 2).

| | Iaboakoho | Mahatalaky | Mandromodromotra | Ampasy-Nahampoana |
|---|---|---|---|---|
| Females | 3 | 5 | 4 | 9 |
| Males | 7 | 6 | 6 | 3 |
| Total | 10 | 11 | 10 | 12 |

**Table 2.** Composition of teachers participating to the test. Remember that this needs to stand alone – what is the test for for example

The test encompassed questions about general knowledge on lemurs and questions on activity, ecology, and biology of the lemur species inhabiting the Tsitongambarika forest. Furthermore, we assessed teachers' ability to associate the vernacular name of lemurs to photographs.
The lemur species (common and vernacular names in brackets) present in Tsitongambarika are: *Hapalemur meridionalis* (southern lesser bamboo lemur; halo), *Eulemur collaris* (collared brown lemur; varika), *Daubentonia madagascariensis* (aye-aye; aye-aye), *Avahi meridionalis* (southern woolly lemur; fotsy-fe), *Lepilemur* sp. (sportive lemur; pondiky), *Microcebus tanosi* (Anosy mouse

lemur; tsitsidy); *Cheirogaleus major* (greater dwarf lemur; matavyrambo). Part of the test included general questions about the Tsitongambarika forest, conservation, biodiversity, and ecosystems.

| | **Question** | **Answers (correct one underlined)** |
|---|---|---|
| 1 | How many species of lemurs are present in Madagascar? (G) | A) Less than 10, B) Around 50, C) More than 100 |
| 2 | Are wild lemurs only present in Madagascar? (G) | A) Yes, B) No |
| 3 | Why the Tsitongambarika forest is a priority area for conservation? (C) | A) Because it is important to have trees to build pirogues and houses, B) Because of the high number of endangered species that are present in the area, C) Because it provides bushmeat |
| 4 | Why is the "Varika" important for conservation? (C) | A) Because it is good to eat, B) Because it is the biggest frugivorous of the area, C) Because it is gorgeous and attire tourists |
| 5 | Are leaves the main food item for the "Varika"? (E) | A) Yes, B) No |
| 6 | Which is the scientific name of "Pondiky"? (G) | A) *Avahi* sp., B) *Eulemur* sp., C) *Lepilemur* sp. |
| 7 | Is the "Pondiky" active both by day and by night? (E) | A) Yes, B) No |
| 8 | Is the "biodiversity" the number of animals present in an area? (G) | A) Yes, B) No |
| 9 | Is the "Tsitsidy" the smallest lemur? (G) | A) Yes, B) No |
| 10 | Is it necessary to hunt lemurs to preserve the plant biodiversity? (C) | A) Yes, B) No |
| 11 | The "tavy" (slash-and-burn agriculture) is not a threat for biodiversity. (C) | A) True, B) False |
| 12 | The division of the forest in "conservation zone" and "exploitation zone" is a good way to preserve biodiversity. (C) | A) True, B) False |
| 13 | The "Voapaky" (*Uapaca* sp.) is very important for the "Varika" especially during the lean season (E) | A) True, B) False |

| | | |
|---|---|---|
| 14 | Which one of those lemurs is not present in the Tsitongambarika forest? (G) | A) Halo, B) Matavirambo, C) Sifaka, D) Fotsy Fe |
| 15 | Which one of the following species is a primary producer? (G) | A) Halo, B) Fossa, C) Voapaky, D) Varika |
| 16 | Associate the correct vernacular name to the following picture (I) | A) Tsitsidy, B) Varika, C) Pondiky, D) Fotsy fe |
| 17 | Associate the correct vernacular name to the following picture (I) | A) Tsitsidy, B) Varika, C) Pondiky, D) Fotsy fe |
| 18 | Associate the correct vernacular name to the following picture (I) | A) Tsitsidy, B) Varika, C) Pondiky, D) Fotsy fe |
| 19 | Associate the correct vernacular name to the following picture (I) | A) Tsitsidy, B) Varika, C) Pondiky, D) Fotsy fe |

**Table 1.** List of questions and answers included in the questionnaires given to teachers. Again this needs to stand alone – describe what the categories are here

**Data analysis**

Questions were marked with a "0" for wrong/not given answers and "1" for correct answers, with a maximum score of 19. The single test has been used as statistical unit. To test differences between sex and municipalities we used Generalised Linear Model with the score as dependent variable (fitted with a log-linear Poisson distribution for counts) and municipality as fixed factors. We tested whether total score and scores for single categories (G, C, E , I) changed between municipalities. Fisher's least significant difference (LSD) has been used as post hoc test for pairwise differences between municipalities. Statistical tests have been performed via IBM SPSS 22 using $p<0.05$ as level of significance.

**Results**

The total score was significantly different between municipalities (Figure 1; Wald $\chi^2 = 13.185$, $p=0.002$) with Iaboakoho having a significant effect ($B=0.363$, $p=0.004$) but not the other municipalities (Mahatalaky: $B=-0.022$, $p=0.869$; Mandromodromotra: $B=-0.060$, $p=0.666$; Ampasy-Nahampoana set as 0). Post hoc test revealed a significant difference between scores of teachers from the municipality of Iaboakoho (Score: 13.900±SE 1.179) and teachers from, Mahatalaky (Score: 9.455±SE 0.927) ($p=0.003$), Mandromodromotra (Score: 9.100±SE 0.927) ($p=0.002$), and Ampasy-Nahampoana (Score: 9.667±SE 0.898) ($p=0.004$) while no other differences have been found between the other municipalities.

The score of General Knowledge was significantly different between municipalities (Figure 1; Wald $\chi^2 = 8.263$, p=0.041) with Iaboakoho having a significant effect (B=0.588, p=0.020) but not the other municipalities (Mahatalaky: B=-0.230, p=0.390; Mandromodromotra: B=-0.080, p=0.788; Ampasy-Nahampoana set as 0). Post hoc test revealed a significant difference between scores of teachers from the municipality of Iaboakoho (Score: 3.900±SE 0.625) and teachers from Mandromodromotra (Score: 2.000±SE 0.447) (p=0.013) and Ampasy-Nahampoana (Score: 2.167±SE 0.425) (p=0.022), but not Mahatalaky (Score: 2.723±SE 0.498) (p=0.142).

The score of Conservation did not differ between municipalities (Figure 1; Wald $\chi^2 = 0.676$, p=0.879). Also, no significant differences were found between scores of Ecology and Behaviour between municipalities (Figure 1; Wald $\chi^2 = 1.386$, p=0.709).

The score of Identification was significantly different between municipalities (Figure 1; Wald $\chi^2 = 20.678$, p<0.001) with with Iaboakoho having a significant effect (B=0.824, p=0.003) but not the other municipalities (Mahatalaky: B=-0.270, p=0.439; Mandromodromotra: B=-0.248, p=0.486; Ampasy-Nahampoana set as 0). Post hoc test revealed a significant difference between scores of teachers from the municipality of Iaboakoho (Score: 3.800±SE 0.616) and teachers from Mahatalaky (Score: 1.273±SE 0.340) (p<0.001), Mandromodromotra (Score: 1.300±SE 0.361) (p<0.001), and Ampasy-Nahampoana (Score: 1.667±SE 0.373) (p=0.003), while no other differences have been found between the other municipalities.

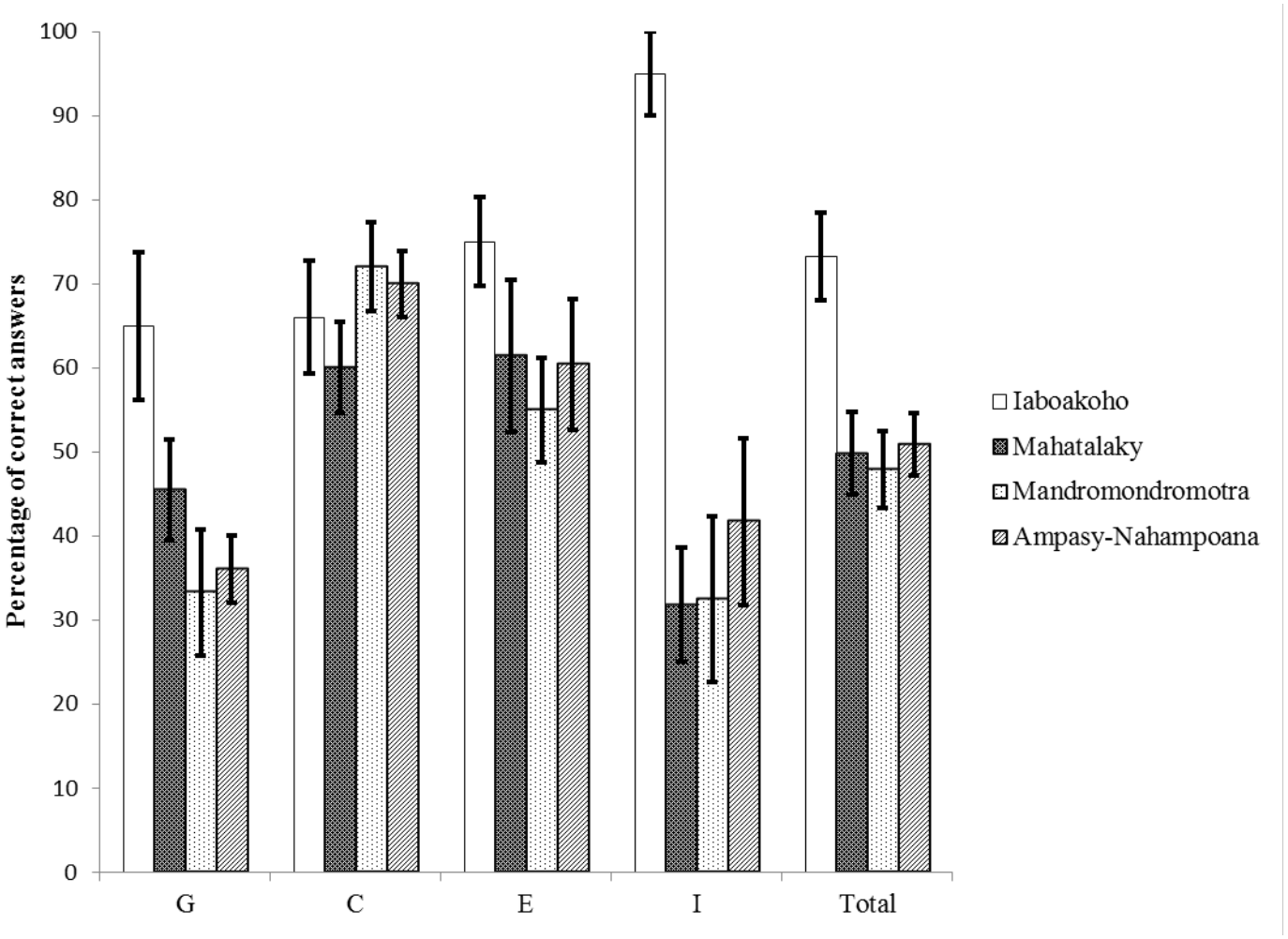


**Figure 1.** Percentages of correct answers by teachers from the four municipalities. Values are means and standard errors. Scores of General Knowledge (G), Conservation (C), Ecology and Behaviour (E), Identification (I), and Total score are shown.

## Discussion

Overall, our results suggested that the teachers retained most of the information provided during the training lessons took one year before the test. In fact, despite the lower level of education and preparation due to the longer distance from Fort Dauphin (Faniry Rakotoarimanana, head of the offset-site project of Asity Madagascar, pers. comm.), the teachers from Iaboahako had significantly higher scores than teachers from the other three municipalities. This supports the finding that people living in rural areas as can retain environmental knowledge tested with children and their parents in Mangabe, eastern Madagascar (Rakotomamonjy et al. 2015). Also, students from primary schools at Lake Alaotra showed higher knowledge one year after the end of the environmental education program (Richter et al. 2015). Further evidences come from a study in the Kalinzu Forest Reserve, Uganda, where students showed long-term knowledge retention about environmental subjects (Kuhar et al. 2010). Furthermore, in this study we showed that teachers, even in rural areas where

they are supposed to have lower preparation as compared to teachers from the main town, can retain information and, thus, can transfer the information on environmental subjects to students in the area (Wallis et al. 2010). Nevertheless, we cannot exclude the fact that some teachers from Iaboakoho received better education than teachers from the other three municipalities, although this is likely not to be the case from what the members of Asity Madagascar declared. Providing teachers the right means to teach their students is fundamental since they can deliver lessons about environmental education over years to many children (Wallis et al. 2010). Moreover, several studies (e.g. Damerell et al. 2013, Rakotomamonjy et al. 2015) showed that parents can benefit from education given to their children who may transfer information to them. Thus giving trainings to teachers is pivotal to favor the long-term environmental education of an area.

One of the clearest indications from this study is that there is a very limited knowledge on lemurs and their diversity as suggested in previous studies in Madagascar (Dolins et al. 2010, Keane et al. 2011, Rakotomamonky et al. 2015) and on other primates (Kuhar et al 2010). In fact, scores of general knowledge and lemur identification were lower than the other scores of teachers from the control municipalities, while they were significantly higher in the municipality of Iaboakoho. This confirm previous findings that there is a lack of knowledge that there are many species of lemurs which differ in colours, sizes, activity patterns, geographical distribution, vocalizations, and other characteristics (Dolins et al. 2010). Also, it has been previously shown that it is difficult to realize that wild lemurs occur only in Madagascar (Dolins et al 2010; Richter et al. 2015). Even teachers from Iaboakoho had low scores for this question and this can be explained by the fact that some of them might know that lemurs are present in zoos outside Madagascar. Also, it might have been difficult for them to understand scientific terminologies such as the term “endemic species” that we used during the lessons we took. For this reason, we strongly suggest to stress the concept of endemic species while planning training in environmental education especially in areas with many endemics like Madagascar (Brooks et al. 2006).

The main limitation to this study is the sample size since, although we selected most of the teachers from the four municipalities, we only had 43 teachers of which 10 received the training. This is something difficult to solve since we considered all the municipalities that are faced to the South part of the Tsitongambarika forest and that are at similar conditions. We considered the Municipalities of Mahatalaky, Mandromodromotra, and Ampasy-Nahampoana as control groups since all are rural areas and are at the same distance from the forest as Iaboakoho. This might justify the lack of a pre-training test in Iaboakoho, although we cannot be sure that the level of environmental education in Iaboakoho was the same as in the other three municipalities. Although, we can assume that it was the same since we found no statistical differences among the other three

municipalities. Also, we found a slight trend of higher percentages of correct answers given by the teachers from the municipalities closer to Fort Dauphin with Ampasy-Nahampoana having better performances in three questions when compared to the other two municipalities. Thus, being Iaboakoho the more distant municipality from Fort Dauphin, we can assume that the pre-training knowledge about environmental education was not higher than the knowledge of teachers from the other three municipalities. Another limitation of this research is the lack of a post-training assessment of the effectiveness of the environmental education on the participants, as in other studies (Kuhar et al. 2010, Rakotomamonji et al. 2015). However, we conducted research on hunting pressure in the area after the installation of the research station (Campera et al. unpub data), showing that local people had a lower level of forest exploitation after the installation of the research station, especially in villages closer to it. Also, densities of *Eulemur collaris* and *Hapalemur meridionalis*, the most hunted lemurs, were higher at the end of the study as compared at the density at the beginning of the study (Campera et al. in prep). Thus, we can argue that there was an overall reduction of human impact in the area as a consequence of the conservation effort we made, and the conservation education program was a fundamental part of this project.

From this experience, we can argue that, apart from an efficient conservation education program, it is really important to integrate the program with other activities (e.g. the installation of the research station which provided a significant decrease of human exploitation of the forest, Campera et al. in prep), and the collaboration with local NGOs. This has been suggested from other researchers who shared similar experiences (Padua 2010, Kuhar et al. 2012). The ultimate goal of environmental education programs is behavioral change that results in positive changes towards the environment. This goal cannot be achieved until basic knowledge and even empathy towards an environmental issue is establishes. This study is the very first step to raise awareness on lemurs in the area, and other tests, lessons and follow-up controls on attitudes and behaviours are required in order to have effective impacts to reduce environmental exploitation (Richter et al. 2015). In fact, the sole knowledge increase from an environmental education program does not necessarily result in participants showing positive attitudes and behaviours (Kuhar et al. 2010).

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