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Puppets and Experiments as a Conservation Tool for First Grade Students

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ABSTRACT

This paper discusses the experience of promoting environmental conservation using both puppets and simple hands-on experiments for first-grade students in rural Southwestern Costa Rica. Twenty eight college students wrote puppet plays, designed and built the puppets and performed the plays as well as monitored the science experiments. The experiments attempted to illustrate certain natural phenomena related to the issues performed in the plays. A total of 334 seven-year-old students from 19 elementary schools participated in 2016 and 2017. College students recorded in a log their observations and responses from direct questions to children, based on a questionnaire. A linear regression analysis was used to establish correlations. The analysed data showed that children had a much better understanding about nature and the importance of protecting it after both the plays and the experiments were conducted in sequence.

Keywords: environmental education, conservation, puppetry, first grade, science, Costa Rica

INTRODUCTION

Teaching people the details and intricacies of how nature works is perhaps the best way to promote its conservation. Most people, however, are not interested in science thus it becomes a challenge when you do not have the attentive ear of the general public. Starting educating kids about science at early age might prompt an interest that would last for a lifetime (Corbett, 2006; Ernst, 2014; Robertson, 1978). Because of age-related cognitive conditions, preschool environmental education has to be done using experiential techniques (Borg, Winberg, & Vinterek, 2017; Ernst, 2014; Kos, Jerman, Anžlovar, & Torkar, 2016). Many schools in rural Latin America, however, do not have the resources to have high quality contextualized local environmental information materials nor do they have the appropriate curriculum (González-Gaudiano, 2007; Haines & Kilpatrick, 2007; Viteri, Clarebout, & Crauwels, 2014). In some cases, taking children out of the school for an educational walk in a nearby forest is almost impossible because of school regulations, or resistance to different educational approaches (González-Gaudiano, 2007). Seven year old children, however, are at an age of cognitive development that can properly use inductive reasoning and rules of conservation (Brinums, Imuta, & Suddendorf, 2017; Piaget, 1968); thus, they are able to understand more complex cause-and-effect explanations. First-graders are also young enough to be entertained and impressed by puppets (Ahlcrona, 2012). Puppets, therefore, can be a useful tool to engage first grade children in environmental conservation issues. It might become a more powerful tool when used in combination with the benefits of active learning such as hands-on experiments (Freeman et al., 2014). This paper discusses the experience of promoting environmental conservation using both puppets and simple hands-on experiments to first-grade students in rural Southwestern Costa Rica. It is, therefore, an experimental design that emerges from a compulsory community work that all University of Costa Rica students are required to complete.

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BACKGROUND

The conventional style of teaching science is often the presentation of facts and data to be memorized (Merlos, 2015; Scott & Fisher, 1999; Shulman & Tamir, 1973). Similarly, the teaching of environmental conservation is done in a traditional way of reciting facts to students. However, it is argued that using stories as a teaching method can increase the effectiveness of what is taught because children generally like to listen, see or read them (Morrow, 1985; Phillips, 2013). Lemke's experiments demonstrated that students interacted more when teachers present the information in a narrative and contextualized form; that is, learning improved when narrative and practice were used (Lemke, 1990). More recent research on the positive results from intentionally controlled television narratives in different parts of the world support the argument that storytelling can influence interests and behaviour at the individual and societal level (Bandura, 2012). Narrative or storytelling therefore could be a very effective tool for teaching. Storytelling about science may help achieve higher levels of interest and understanding on the part of students (Gold et al., 2015; Sutton, 1992). The story or narrative serves two very clear purposes in education. The first goal is to illustrate a concept, and the second serves to explain it (Dunne, 2006). Storytelling is in fact a powerful educational technique more appreciated recently, especially in the last decade (Egan, 1993; Gallagher, 2011; Gold et al., 2015; Phillips, 2013).

Storytelling also serves to stimulate the learners' imagination and creativity. Similarly, it can be argued that narrative by visual means such as acting or puppets can be an equally, if not a more, effective educational tool (Bakhit, Clem, & Garcia-webb, 2011; Brinums et al., 2017; Kruger, 2007; Precious & McGregor, 2014). Puppets have been used in many roles in television shows like "Sesame Street" where they served as a hook to teach different things, including words in foreign languages (Ball & Bogatz, 1970; Oades-Sese, Cohen, Allen, & Lewis, 2014). Although there is a continuous debate about the best theoretical and practical approach towards environmental education (Blum, 2009), only a handful of studies have discussed the use of puppets as narrative tool for environmental education (Dantas, Santana, & Nakayama, 2012; Peleg & Baram-Tsabari, 2011).

Hands-on activities, or active learning, also serve to enhance the learning process (Bransford, Brown, & Cocking, 2004). Several studies concluded that active learning has a greater positive cognitive outcome for students (Cui, Lockee, & Meng, 2013; Freeman et al., 2014; Prince, 2004). For environmental education with children, simple science experiments can greatly improve the experience overall, and provide them with a better understanding of some concepts about nature. In addition, collaborative work while doing the experiments further enhances the learning of cognitive skills (Prince, 2004). This means that allowing children to cooperate in groups while performing the experiment would serve both to simplify the learning experience as well as to develop social skills (Daniel & Tivener, 2016). By performing simple experiments in a collaborative way among first-graders, therefore, we expect to enhance their understanding of how nature works (Hacieminoglu, 2016; Legare, Opfer, Busch, & Shtulman, 2018).

Our project was performed in 19 different rural elementary schools in the canton of Golfito in Southwestern Costa Rica. The area has large expanses of primary forests, some under conservation regimes such as the Corcovado National Park, the Piedras Blancas National Park, and the Golfito Wildlife Refuge. The large majority of the inhabitants of the canton live less than 3 kilometres from a primary forest. In general, local inhabitants understand the importance of these forests and support their protection in principle, but unfortunately there are many people who act otherwise. The official discourse of the country is about protecting the environment yet the reality on the ground is different, especially at the municipal/canton level (Merino & Chacón, 2017). Some people illegally hunt and even take valuable timber from these primary forests, mainly in areas without protection (Campos Arce, et al., 2007). In addition, there are people in poorer communities that discard their solid waste and greywaters onto creeks (Calvo Brenes & Mora Molina, 2012; Merino & Chacón, 2017). It is also common for people to burn the yard waste, including plastic material (personal observation). On the other hand, both central and local governments do not allocate the necessary resources to adequately protect these forests (Canet-Desanti, Herrera, & Finegan, 2012; Sáenz, Le Coq, Villalobos, & Cathelin, 2011). However, the most efficient way to care for these public resources is to educate people about the importance for their community and for themselves to maintain these healthy primary forests (Balmford, 2002). And perhaps one of the most efficient ways to educate people is by starting when they are still children and it is feasible to stimulate a positive attitude towards the environment (Robertson, 1978). Educating children in marginal, poorer communities, about protecting the environment can be done with a small investment, as in the case of this project, but perhaps with long-term effects (Barnett, 1998).

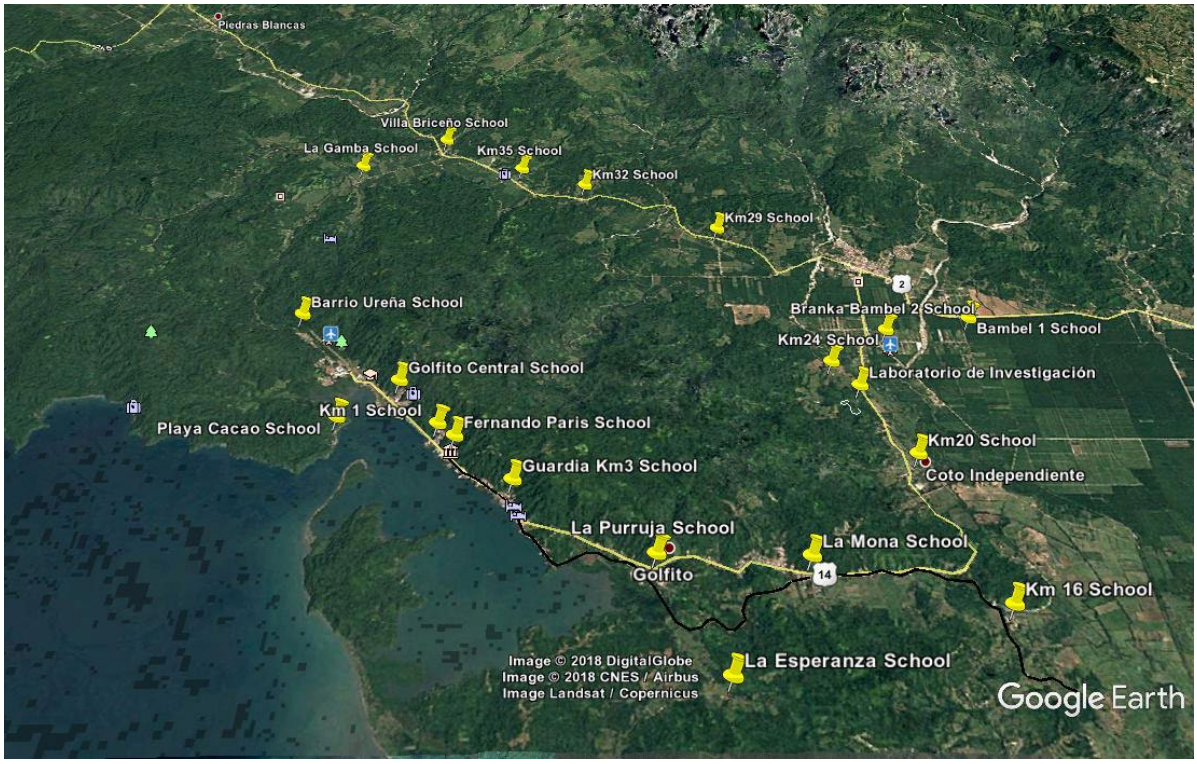

Figure 1. The canton of Golfito, Costa Rica. 19 schools visited
Source: Google Earth

METHODOLOGY

The project was organized into three parts. The first was to write plays, design and build puppets and portable puppet stages, and to select and adapt science experiments. The second part was dedicated to rehearsing and make adjustments to the plays, practicing the science experiments, and designing the research instrument. The third segment was the actual performance in the selected schools and data collection. With the cooperation of 28 University of Costa Rica at Golfito (UCR-Golfito) students participating in their compulsory "community work," the project started on January 8, 2016. Most of them are third-year and some are fourth-year (20 and 21 years of age respectively) students and participated for 12 months, 6 of them for 15 months. They included biology, electrical engineering, computer science, English, and ecological tourism majors. The gender distribution was 13 females and 15 males. Some of the students designed and wrote 9 puppet plays. The prevalent theme of the plays was about the environment, more specifically on how humans are interfering with the natural balance. Then the student designed and built 17 puppets (up to 10 copies of each character). Other students designed and built small puppet stages to bring to each school and later donate together with some puppets after each performance.

The puppet plays were written following the conventional 5-act structure because it is the easiest for younger kids to follow (Morrow, 1985). The plays covered topics such as the loss of homes due to the "advance of progress", the secondary effects of forest loss, domestic cat predation, air pollution, water contamination and its effects on wildlife and humans, illegal poaching and contamination by plastics. Each play had between 4 and 7 characters including humans, plants, animals as well as "inanimate" objects such as a trees, smoke and the sun. All characters were anthropomorphized following the tradition of the ancient fables, as they are very much liked and understood by children and adults (Zafiropoulos, 2001). Yet, most of the time some of the characters suffer or die because of the loss of a natural balance. In that tradition, our plays serve to persuade kids to develop a positive ethical approach towards nature. On the same note, the issue of pets was also included in one of the plays as means to introduce the discussion of wildlife and the ethics of pet ownership (Franquesa-Soler & Serio-Silva, 2017; Ross, Vreeman, & Lonsdorf, 2011).

A second group of students designed several experiments, some of them based on well-known experiments for late primary school, or secondary school children. The experiments were designed to be performed using

common materials and supplies easily found in rural Golfito. They served to provide a connection between the puppet story and the science of nature in an entertaining way for first-graders. The experiments covered topics such as photosynthesis, the food chain, etc., but adapted to this age group (Kneidel, 1993). One such experiment is about loosely explaining the production of oxygen and the capture of CO_2. In this case, after the first-graders have seen a puppet play where a "good-old tree" ends up toppled, we explain to them that more or less what they are about to experiment only exemplifies how one chemical process can generate oxygen, or any other gas. We give each group of 3 or 4 kids an empty plastic bottle, a rubber balloon, 100 millilitres of vinegar, and 40 grams of sodium bicarbonate. Once they pour the bicarbonate from the balloon into the bottle, they are marvelled about the reaction and how the balloon inflates. Experiments like this one have a twofold purpose; the first is for first-graders to have a grasp of natural phenomena, and the second one is to instil a curiosity for science, and knowledge in general (Pluck, Graham & Johnson, 2011). In addition, it has the benefits of developing social skills through the collaborative work necessary to perform the experiments (Daniel & Tivener, 2016; Prince, 2004).

The research instrument was elaborated with the cooperation of the college students. As per the ongoing discussions of the entire experience, questions were arising about the designs and constructions of plays, puppets, experiments, and rehearsals. Seventeen questions/issues were selected as pertinent to these three main areas of the project. All responses were scaled on 7 options Likert-type format, to be in agreement or disagreement with the statement. Eleven of the issues were not directly related to the primary school experience, so they are not part of the analysis and discussion of this paper. Six of the questions were related to measure the relevance of using puppets and experiments as a conservation teaching tool: (1) The kids that watched the puppet plays showed that they understood the underlying message; (2) The puppet theatre is an effective didactic tool for 7 year-old kids; (3) Participating kids showed that they understood the idea of the experiments; (4) The experiments were appropriately designed for kids to learn about basics of nature; (5) The didactic tool of puppet theatre in combination with experiments opens up the opportunity for kids to gain an interest in environmental conservation; and (6) Kids that participated in school events increased their interest to protect the environment.

Each of these six questions was worded differently so that we could ask the first-graders directly: (1) Why did the protagonist (corresponding name) suffered such calamity/issue or problem?, (2) Do you like to learn about the environment using puppets?, (3) Can you explain what happens in this experiment?, (4) How many of you understood the experiment?, (5) How do you think this experiment relates/explains what happened to the protagonist (name) or the victim (name)?, (6) What things can you do to protect the environment? In the original Spanish wording of the questionnaire items we used the "@" to replace "a" and "e" because in certain words it creates a gender differentiation. We did this in order to establish a gender neutral language environment for the college students as means for them to convey similar attitude towards the school children when asking the questions.

It needs to be clarified that we were not able to apply the evaluating instrument directly to children because Ministry of Education (MEP) regulations do not allow it. The request for an exception is a lengthy process and in the end it would have required the presence of parents at the moment of the activities. Considering that most parents work during weekdays, it was decided not to follow this path. Instead we opted to a simple legally-accepted solution to verbally ask questions, from the questionnaire, to all kids as a group. The college students logged the responses as accurate as possible about the numbers of kids raising their hands to respond for each questions and a scale valuation about those responses, as previously indicated.

THE FIELD WORK

From May through November 2016 we visited 8 different schools. And from March through November 2017 we visited an additional 11. All schools use the same curricula and methodological approach prescribed by MEP, and are located not more than a 30-minute drive from the UCR-Golfito campus. One of the schools had as many as 45 first-grade students, while others had as little as 1 first-grader, and 6 students for the entire school. In those small schools the presentation was done with the participation of all students. Gender distribution was very similar in all schools with about a 50/50 ratio. A total of 147, mostly first-graders, participated in 2016, and 186 in 2017. The plays, experiments and treatment was the same for both year groups.

In each visit, our college students performed four different plays with four different experiments after each play. Each play performance was about 10 minutes long. The experiments lasted from from 15 to 20 minutes

each. After every play one of our students asked questions, from the questionnaire, about the topic presented in the play. All of our students noted in a log the kid's responses and the number of kids that responded. All college students used identical logs to mark and write comments. It included the 6 questions in a Likert-type scale format to mark the first-graders responses, and to note the number of kids responding for each question. And the same process was repeated after the corresponding experiment was administered, so onwards for each play/experiment. After the programme was over, we shared a healthy snack of juices and homemade low-sugar biscuits with the kids. We used this opportunity to obtain some additional feedback from them. The entire activity usually lasted between two and three hours, not including travelling time.

The first play is about an owl that looses his home as it was chopped due to the "advance of progress."The kids response was always sympathetic towards the protagonist, as children tend to project their feelings onto this character (Oades-Sese et al., 2014). The play is followed by an experiment that demonstrates the effects of deforestation. Two scale-models of the same hill, one with trees and the other one without, are built on two separate small tubs. Water is poured on both using a hand garden sprinkler. One of the models ends up with mud at the bottom "lake" and the other one with fairly clean water. We then asked the first-graders for their explanations on what happened; and based on their answers, we followed up asking them to relate the loss of the owl home. The students then take note on the number of kids that raised their hands and the answers.

We followed the same pattern for the remaining three plays and experiments. After each play was performed, we allowed the first-graders to carry out the experiments. One of the plays was about the local custom of burning natural waste from home yards, including many times plastics. In this play, several lady characters are trying to convince a neighbour to stop burning yard waste because it is provoking serious respiratory problems to many of them, including the culprit herself. In addition, the play presents the idea that natural waste should be used as a natural fertilizer for the tree orchard the same character owns. This play was followed with the vinegar-bicarbonate "gas production" experiment. This experiment was used to demonstrate the generation of gases, whether toxic or not. The first-graders were highly surprised and enthusiastic about the results. The follow up questions and discussions indicated that they understood that some gases are dangerous for people and nature in general, and the difference between burning and using the matter for composting.

RESULTS

The results of the student questionnaire served to generate an understanding of the entire puppet-plays-and-experiments educational experience. The data were first measured for internal consistence using SPSS (v.20) Cronbach's Alpha test. **Table 1** shows a Cronbach's Alpha of .743, which indicates a good level of internal consistency, especially considering that it only includes 6 items.

Table 1. Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha based on standardized items	N of items
0.743	0.802	6

Note: Cronbach's Alpha analysis of 6 items and 28 cases

All answers were averaged and the standard deviation for each items was computed to generate the results shown in **Table 2**.

Table 2. Descriptive Statistics

	Item	Mean	Std. Dev	N
1	Understood play	6.39	0.57	28
2	Puppets Teaching Tool	6.25	0.75	28
3	Understood experiments	6.21	0.79	28
4	Appropriate experiments	5.39	1.37	28
5	Puppets & Experiment	6.71	0.53	28
6	Increased Interest Conservation	6.11	0.99	28

Note: Students' evaluations based on field log questionnaire

The lowest score was for question 4 with a 5.39 with a standard deviation of 1.37. Students thought that maybe some of the experiments were not the best to illustrate a particular natural phenomenon.

The highest score was question 5 (6.71), about combining puppet theatre with experiments as a means for kids to gain an interest in environmental conservation. It was also one of the lowest standard deviation with a 0.53. This question addressed the core issue of this dual-approach programme. The fact that it was the highest score it appears to accentuate our original proposition that this combination is an effective approach for this educational purpose. This was a fundamental cornerstone in the design of the programme so the student observations on the field also validated what the revised literature indicated.

We performed series of linear regression analyses using SPSS (v.20) to better understand if there was an "Increased Interest in Conservation" based on three scenarios: 1. The kids understood the plays, 2. Understood the experiments, and 3. All 5 predictors (independent variables). The first analysis using "Understood the Plays" indicates a high degree of correlation of .777 with an R^2 variation of .604, as in **Table 3**.

Table 3. Model Summary

Model	R	R^2	Adj R^2	Std. Error of the Estimate
1	.777[a]	.604	.588	.638

a. Predictor: (Constant), Understood play
Note: Linear regression "Increased Interest for Conservation"

The prediction for the dependable variable is also highly significant with a p value < 0.0005 as seen below in the ANOVA **Table 4** below.

Table 4. ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	16.102	1.000	16.102	39.586	.000[b]
	Residual	10.576	26.000	.407		
	Total	26.679	27.000			

a. Dependent Variable: Increased Interest Conservation
b. Predictors: (Constant), Understood play

The second analysis tests the predictor "Understood the Experiments." The result indicates a high level of correlation of .964. This is even higher than the previous analysis. In this case a very large 92.9% (R^2) of the variation can be explained with this predictor in **Table 5**.

Table 5. Model Summary

Model	R	R^2	Adj R^2	Std. Error of the Estimate
1	.964[a]	.929	.927	.269

a. Predictors: (Constant), Understood experiments

The ANOVA test (**Table 6**) of this analysis also indicates a highly significant correlation with a p value < 0.0005. An "Increased Interest for Conservation" can be explained because the first graders "Understood the Experiments."

Table 6. ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	24.794	1	24.794	342.055	.000[b]
	Residual	1.885	26	.072		
	Total	26.679	27			

a. Dependent Variable: Increased Interest Conservation
b. Predictors: (Constant), Understood experiments

The third linear analysis included all 5 independent variables. In **Table 7** the output R display a very high degree of correlation with a .983 result. At the same time the R^2 suggests that a 96.7% of the total variation can be explained by these 5 independent variables.

Table 7. Model Summary

Model	R	R^2	Adj R^2	Std. Error of the Estimate
1	.983[a]	.967	.959	.201

a. Predictors: (Constant), Puppets & Experiments, Understood experiments, Appropriate experiments, Puppets Teaching Tool, Understood play

This is a very large and significant result that can be corroborated with the ANOVA result in **Table 8**. In this third analysis the *p* value is also of < 0.0005. This and the other two analysis indicate that the regression models predict the dependant variables (Increased Interest for Conservation) very well.

Table 8. ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	25.786	5	5.157	127.142	.000[b]
	Residual	.892	22	.041		
	Total	26.679	27			

a. Dependent Variable: Increased Interest Conservation

b. Predictors: (Constant), Puppets & Experiments, Understood experiments, Appropriate experiments, Puppets Teaching Tool, Understood play

DISCUSSION AND CONCLUSIONS

It has been documented that puppets are a very powerful tool to engage young people (Ahlcrona, 2012; Bakhit et al., 2011; Ball & Bogatz, 1970; Brinums et al., 2017; Oades-Sese et al., 2014). In addition, the narrative of a puppet-show serves to further engage students (Phillips, 2013). And as such, our field work proved correct that all 334 kids that watched the puppet shows were very engaged and attentive. They laughed and responded when a puppet addressed the audience and many times they warned a puppet character of an impending danger. This engagement was used to bring to the attention of the first-graders several issues relevant to the natural environment. With this puppet shows kids realized that humans are unnecessarily provoking more damage to the environment than required to guarantee our survival. However, what made most of the difference for the kids to understand the significance of a healthy environment was when we combined the puppet shows with hands-on experiments. First-graders were very active and responsive to both participate in a collaborative way and to make conclusions about the results of each experiment. The college students attested that the kids' level of comprehension and understanding of the logics of nature was furthered improved after they took part in both watching the puppet show and participating in the experiments, as suggested with the results of the three linear regression analyses. This improved difference from one response to the other are very much attune with the benefits of active learning (Kos et al., 2016). First-graders had a better grasp of the issue in hand when watched the play and did the experiments.

When kids were asked if they liked working together, they responded positively including some of them indicating why they would have not been able to conduct the experiments by themselves. When responded in such a way, we proceeded to give a feedback on the importance of collaborating to achieve a goal. This was done with the intention of reinforcing their motivation and curiosity for learning (Wijnia, Loyens, & Derous, 2011; Van den Bergh, Ros, & Beijaard, 2013).

Our perception about possible differences between genders was not obvious. Both boys and girls participated equally in both classroom activities as well as those done outdoors. We made sure that when setting up the working groups that there was a balanced mixed of girls and boys. However, we noticed that only girls would react more disgusted when viewing ants under the microscope. Yet, we do not believe there was a need to change our approach to consider gender differences for this type of situation, as seen in other studies (Carrier, 2009). Our position was reinforced by a gradual change of attitude all the "disgusted" girls because they returned to watch again and again. Each time their reaction was less "dramatic". In addition, the girls that reacted in disgust were the minority of the girls.

This experience of combining puppet-shows about environmental problems with simple participative experiments proved to be success among first-graders. Scenic arts in this project aligns with the position that arts have the potential to re-direct attention and to educate to care about science and the environment (Gold et al., 2015; Hicks & King, 2007; Precious & McGregor, 2014) It showed that first-graders can be enthusiastically engaged and positively intrigued about issues of environmental nature and science. Our observations indicated that they really liked the activities and had afterwards a better understanding that nature must be protected and certain human activities must be stopped or modified. This improvement in understanding was observed after both the plays and the experiments were conducted in sequence. The linear analyses also suggest that there was an increase of interest for conservation after watching and participating in the experiments from a correlation of .777 to .964. Granted that we were not able to test the reverse order nor just the plays or experiments by themselves.

Watching, enjoying and actively participating was a crucial mixture of activities for the participating kids. First-graders still do not have an advanced knowledge about nature, but the field-work demonstrated that this programme helped them acquire a comprehension of its basic rules and a positive attitude towards protecting the environment. Moreover, the active, collaborative work might have helped them develop not only social abilities but also cognitive skills (Freeman et al., 2014). In conclusion we assessed that this dual-approach environmental education programme provided several benefits for school children but above all it served to cultivate the appropriate pro-environment values. However, we were not able to determine the exact dimensions of this programme outside the classroom or on a temporal basis, since it was not part of the scope of the community work/research. As we interacted with the kids for several hours, new questions emerged. This lead us to ponder about the need for a future research on this dual-approach programme that could study the long-term effect on the lives of participating first-graders. We believe that there is a need to continue exploring this approach on a larger scale so that it could also include a set of schools only performing the plays and others only the experiments. The results of our experience suggests that this format might be an effective way for environmental education and that its worth the effort to further explore its impact and ramifications.

Disclosure statement

No potential conflict of interest was reported by the authors.

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