The Journal of Environmental Education, 1999, Vol. 31, No. 2, 5–8

The Effect of Environmental Education on Schoolchildren, Their Parents, and Community Members: A Study of Intergenerational and Intercommunity Learning

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ABSTRACT: The authors examined the hypothesis that children learn and retain conservation principles in school environments and transfer them to their parents. After completion of a 1-month environmental education course on Scarlet Macaw conservation and natural history in Costa Rica, students given a pretest and posttest demonstrated learning on 71% of the questions (15 of 21), parents on 38% (8 of 21), and a control group of adults without children who took the course on none (0 of 21) ($p < .05$). Comparing pre- and posttest scores, students demonstrated retention on 67% (14 of 21), parents on 52% (11 of 21), and the control group on 29% of the questions (6 of 21). The authors theorize that children and adults communicate outside the classroom in this village, which may explain the increases in learning rates.

Key words: community-based education, Costa Rica, intergenerational, learning, retention

Environmental education (EE) should be a continuous learning process where individuals become aware of their environment and acquire knowledge, values, skills, and experiences to solve environmental problems for present and future generations. The World Conservation Strategy was the first international document advocating EE to promote sustainable living and emphasize wildlife and wildlands preservation (International Union for Conservation of Nature and Natural Resources, 1980). Jacobson (1995) stated that EE programs for wildlife should increase public knowledge and stimulate action for natural resource management.

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Costa Rica, Wildlife, Biodiversity Preservation, and EE

Costa Rica is considered a global leader in biodiversity conservation and education (Gamez, 1991). For its size, Costa Rica may be one of the world's most biodiverse countries with an estimated 500,000 biotic species (Vaughan, 1989). Between 1971 and 1985, Costa Rica consolidated 27% of its national territory into protected national parks

and equivalent reserves, forest reserves, and indigenous reserves (Vaughan & Rodriguez, 1997).

However, EE evolved more slowly than wildland preservation (Chaverri, 1977) and was officially adopted as government policy only in the late 1980s with completion of the National Conservation Strategy for Sustainable Development (Quesada, 1993). Costa Rican EE programs stress Costa Rica's rich legacy of biodiversity and endangered species and are presented in both urban and rural environments (Carrillo & Vaughan, 1994 ; Milan, 1998; Vaughan & Solís, 1989). Ramirez and Villegas (1996) indicate that EE programs in rural areas should benefit the rural population and prepare people to promote community participation and achievement of a better lifestyle.

Endangered Parrots and EE

The Western Hemisphere harbors 140 parrot species; at least 42 species are endangered, and most of the remaining species are declining because of habitat destruction and exploitation for the pet trade (Collar & Juniper, 1992). EE and other outreach programs are emphasized as priorities for parrot conservation (Beissinger & Snyder, 1992). In the 1970s, only 4 of 14 parrot species remained in the Lesser Antilles, and all were endangered. Through song, dance, theater, and mass media, the forestry departments of Grenadines, Saint Lucia, Saint Vincent, and Dominica used community pride to promote native species preservation. Local attitudes changed, and by the early 1980s, all 4 parrot species populations were increasing (Butler, 1992). This program showed significant learning changes for over 700 interviewed residents.

The Central Pacific Scarlet Macaw Population

The endangered Great Green Macaw (*Ara ambigua*) and Scarlet Macaw (*A. macao*) are the most studied of Costa Rica's 15 species of parakeets, parrots, and macaws (Bjork & Powell, 1995; Marineros & Vaughan, 1995; Solís, Madrigal, Ayales, & Calvo, 1996). The two major Scarlet Macaw populations in Costa Rica are found on the Osa Peninsula (700 macaws) and in the Central Pacific (330 macaws); with the latter as the most studied macaw population in Mesoamerica (Marineros, 1993; Marineros & Vaughan, 1995.

In October 1994, a Central Pacific Scarlet Macaw conservation strategy was developed during a regional interdisciplinary workshop sponsored by the Universidad Nacional and Club Punta Leona. Local EE programs were considered essential for macaw conservation. Since 1996, a Scarlet Macaw conservation program has been held yearly in elementary schools in the area; Milan (1998) developed a Scarlet Macaw EE plan for the region.

The Audience for EE

Environmental educators and donor agencies in Costa Rica typically view children, not adults, as their main target audience (Sutherland & Ham, 1992). In one study in Costa Rica, 55% of environmental educators identified K–16 students as the key audience, compared with 29% of politicians and 11% of parents (Fundación Neotrópica, 1988). Ham, Sutherland, and Barbarok (1990) speculated that many teachers recognize the importance of investing their time and energy in students, because children constitute a captive audience, represent future environmental stewards, and are more easily taught and influenced than adults.

However, decades must pass before children become environmental policymakers. Costa Rica and many developing countries have expanding populations that depend on their remaining rich, renewable natural resource base. This resource base is rapidly deteriorating, as evidenced by deforestation, erosion, and extinction of wildlife species (Leonard, 1987; Vaughan, 1990). These environmental dilemmas mandate immediate solutions. As Medina (1989) noted, "Latin America and the Caribbean do not have the luxury of waiting for today's children to grow up. Unless [adult] behaviors change now, there will be little tropical forest left to save" (p. 3).

Some environmental educators advocate targeting adult audiences**,** but this is unlikely to occur in the near future (Vivienne Solís, personal communication, January 17, 2001), However, if children influence their parents' environmental knowledge and attitudes, EE could continue to focus on children. Can children "teach" parents about environmental issues? Unfortunately, published data on intergenerational influences in EE programs are scarce (Ballantyne, Connell, & Fien 1998a, 1998b; Ballantyne, Fien, & Packer, 2001; Holl, Daily, & Ehrlich, 1995;). Thus, few quantitative data exist on measuring the relative success of environmental programs or the transfer of information from children to adults or vice versa (Sutherland & Ham, 1992).

The Scarlet Macaw conservation education program provided an excellent case study to test this hypothesis. In this study we examined the hypothesis that children learn and retain Scarlet Macaw conservation principles in school environments, and parents, in turn, learn and retain this information from their children.

Method

Study Site, Human, and Scarlet Macaw Populations

The study site was the town of Quebrada Ganado (QG) in the Pacific Central region of Costa Rica. QG is a village of about 1,000 inhabitants, 35% of whom are under 21 years of age. It has several churches, a health clinic, four general stores, a community center, a soccer field, two restaurants, and an elementary school. For a rural community, QG has progressive health, education, and development programs. Eighty percent of the working population is involved in tourism at local resorts, hotels, and restaurants. About 50% work in the Club Punta Leona complex, located about 1 km from QG. About 20% of the adult population holds a secondary school degree, and only 3% has a university degree (G. Hernandez, personal communication, August, 2001).

QG is found within the home range of the second largest population of Scarlet Macaws (approximately 330) in Costa Rica (Marineros & Vaughan, 1995). The town's inhabitants see Scarlet Macaws daily as the macaws fly over the town, feed in trees close to homes, and nest nearby.

Established in 1996, a local Scarlet Macaw conservation organization called LAPPA (Pro-psiticine Association) coordinates Scarlet Macaw conservation activities, including the EE programs in elementary schools. Since 1996, the QG elementary school has taught a average of one course per year. QG has a progressive rural school where Humberto Solorzano is a science teacher. He incorporates issues of conservation and biodiversity in the classroom and helps the children apply these principles toward maintaining the school garden and tree nursery.

However, poaching has occurred in the recent past. In QG, 3 residents poached Scarlet Macaw chicks for profit (Marineros & Vaughan, 1995). The local community development organization reported the poachers to the authorities (*La Nacion*, 1995)

Study Methodology

This study was conducted during a 4-week period from July 1 to August 5, 2001. The same teacher was present throughout the course. Approximately 60 third and fourth graders at the QG Elementary School received the 2-hour-per-week course on Scarlet Macaw natural history and conservation based on coloring books (Nemeth, 1995). These coloring books consist of 80 pages divided into 8 booklets that taught the students about the natural history and conservation of the Scarlet Macaw. Games served to review material in the coloring books, and an examination was administered. Students synthesized and discussed their opinions and ideas about the future of the Scarlet Macaw population.

The students' homework consisted of two forms. Each week the students read 2 to 3 coloring books with their parents, coloring them in along the way. In addition, they were given a worksheet with questions whose answers could be found in the book. Both the student and the parent had to sign the homework, attesting that they had completed it together. Based on the course material, a 21-question, multiple-choice test was administered before and after the course to three groups (Appendix 1). The groups included (a) 60 third- and fourth-grade schoolchildren (in 2 groups) in the QG school, (b) 50 parents of these children, and (c) a control group of 50 adults living in QG whose children (if they had any) had never received the course and were not presently enrolled.

Before the course began, the adults and the children took the pretest. The same test was given on the last day of class to the children and within a week after the course finished to both groups of adults. In addition, the same examination was administered 8 months later (on March 18–21, 2002) to test for retention of concepts taught in the course. Approximately 200 hours were devoted to administering the pretest and posttests to the 2 groups of adults, including traveling to each house and explaining the study objectives to each participant. None of the adults who took the pretest were aware that two posttests would also be administered. Questions were analyzed with a chi-squared test with one degree of freedom to measure independence between pretests and posttests given to the 3 groups.

APPENDIX A. Test on Scarlet Macaw Knowledge

1. Approximately how many Scarlet Macaws live in Costa Rica? (a) 50, (b) 200, **(c) 1,000**, (d) 5,000.
2. How many Scarlet Macaws live in the Central Pacific? (a) 50, (b) 100, **(c) 300**, (d) 1,000.
3. When do Scarlet Macaws reproduce in the Central Pacific? (a) all year, **(b) summer**, (c) winter, (d) never.
4. How many species of macaws are there in the world? (a) 1, (b) 5, **(c) 16**, (d) 50.
5. Where are there more macaws? (a) Asia, **(b) Latin America**, (c) United States, (d) Africa.
6. What other species of macaws are there in Costa Rica? (a) Hyacinth Macaws, **(b) Green Macaws**, (c) Yellow Macaws, (d) no others.
7. What time do macaws get up and fly from the Guacalillo Mangrove to Carara National Park? (a) 12 noon, **(b) 5 a.m.**, (c) 9 a.m., (d) 1 p.m.
8. What do Scarlet Macaws eat? (a) fruit, (b) leaves, (c) meat, **(d) a & b**.
9. Where do most Central Pacific Scarlet Macaws sleep? (a) Carara, (b) Jaco, (c) Orotina, **(d) Guacalillo**.
10. What other animals compete for nest sites with the Scarlet Macaw? (a) other macaws, (b) iguanas, (c) wasps, **(d) a, b, & c**.
11. Where do Scarlet Macaws make their nests? (a) in soil, **(b) in tree cavities**, (c) in bushes, (d) in caves.
12. How many eggs does a Scarlet Macaw lay in its nest? (a) 1, (b) 2, **(c) 4**, (d) 7.
13. How many chicks become adults? **(a) 1**, (b) 2, (c) 4, (d) 7.
14. What activities endanger the Scarlet Macaws? (a) hunting chicks, (b) deforestation, (c) hunting adults, **(d) a, b & c**.
15. What tree species do Scarlet Macaws prefer for feeding and nesting? (a) roble, **(b) gallinazo**, (c) cedro, (d) pochote.
16. Why do Scarlet Macaws travel together? (a) protection, (b) look for food, (c) to teach their young, **(d) a, b, & c**.
17. LAPPA is: (a) a rock band, (b) a fishing boat, **(c) a local group interested in conserving scarlet macaws**, (d) none of the answers.
18. What is ACOPAC? (a) a fishing boat, **(b) a government agency working with natural resources**, (c) a rock group, (d) I don't know.
19. What benefit do Scarlet Macaws bring to the Central Pacific? (a) beautify the site, (b) bring tourism, (c) nothing, **(d) a & b**.
20. Who is responsible for Scarlet Macaw protection in the Central Pacific? (a) government, (b) local communities, (c) tourist developments, **(d) a, b, & c**.
21. What would you do to protect the Central Pacific Scarlet Macaw population? (a) protect macaw nests, (b) turn poachers into officials, (c) plant trees that macaws feed on, **(d) a, b, & c**.

Note. Boldface indicates correct answers.

Results

A comparision of the results from the pretest and posttest given immediately after the course revealed that students demonstrated learning by their correct answers on 71% of the questions (15 of 21), parents on about 38% (8 of 21), and the control group on only 1 ($p < .05$). To assess retention of course material, the same test was given 8 months later to the same 3 groups. A comparison of the pretest and the March 2002 test scores revealed that students demonstrated retention on 67% of the questions (14 of 21), parents on 52% of the questions (11 of 21), and the control group on 29% of the questions (6 of 21). Results are presented in Table 1 and Appendices 2, 3, and 4, and are summarized by student group, parent group, and control group.

Student Group

Between 56 and 62 students from the third and fourth grades answered questions in pretests and posttests. The number of correct answers varied from 16% to 87% in the pretest and between 36 and 94% in the posttest. Fifteen of 21 (71%) posttest questions had a significantly higher percentage of correct answers, including 11 of 18, which had strong ($p < .01$) or very strong ($p < .001$) statistical significance (Appendix 2). This was the highest level of significance among the three groups examined. With regard to the comparison of pretest and the posttest scores 8 months later, 14 of 21 questions had a significantly higher percentage of correct answers ($p < .05$) with 11 (of 14) very significantly different ($p < .001$) (Table 1 and Appendix 2). Finally, in comparing first posttest and the posttest given 8 months later, we found that correct answers to 6 of 21 questions (30%) were significantly improved ($p < .05$) from the first to the second posttest. However, this included four questions with significantly fewer correct answers.

Parent Group

Thirty-seven to 49 parents of third- and fourth-grade children participated in the pre- and posttests. Their answers varied between: (a) 18% and 92% correct answers in the pretest, (b) 57% and 88% correct answers in the first posttest, and (c) 55% and100% correct answers in the posttest given 8 months later (Table 1 and Appendix 3). Chi-squared values varied from (a) 0 to 18.48 ($p = .00–.99$) between the pretest and first posttest, (b) .58 to 16.93 ($p = .00–0.88$) between the pretest and second posttest, and (c) .02 to 5.14 ($p = .02–.88$) comparing the first and second posttests. Correct answers to 8 of 21 questions significantly improved comparing the prettest with the first posttest given immediately after the course. However, correct answers to 11 of 21 (52%) questions significantly improved comparing the pretest to the second posttest. Of these 11, two questions had strongly significant differences ($p < .01$), and five had very strongly significant differences ($p < .001$). Only 2 of 21 questions had a significantly higher percentage of correct answers when we compared the first posttest and the 8-month posttest, meaning that most learning occurred during the 1-month course (Table 1 and Appendix 3).

TABLE 1. Improvement (%) in Correct Responses to Questionnaire Pre- and Post-Conservation Course (July 2001, March 2002)[a]

Group taught	Immediate (1 vs. 2)	Retained (1 vs. 3)	Retained (2. vs. 3)
Students	71	67	5[b]
Parents of students	38	52	10
Control adults	0	29	33

[a]$n = 21$.
[b]Four questions had correct answers that significantly decreased.
Note. 1 = Test 1, which was given before the course began (July 1–4, 2001). 2 = Test 2, which was given immediately after the course ended (July 31–August 3, 2001). 3 = Test 3, which was given 8 months after the course ended (March 15–17, 2002).

Control Group

Between 30 and 50 adults answered questions in pre- and posttests. Their answers varied between a) 21% and 91% correct answers in the pretest, b) 29% and 89% correct answers in the first posttest, and c) 37% and 93% correct answers in the second posttest (Table 1 and Appendix 4). Chi-squared values varied from (a) .02 to 3.02 ($p = .08–.96$) between the pretest and first posttest, (b) .00 to 16.18 ($p = .00–.85$) between the pretest and second posttest, and (c) .05 to 11.05 ($p = .00–.82$). Initially comparisons between answers given for pretest and the first posttest showed no significant difference in learning (Table 1). The percentage of correct answers (6 of 21, or 29%) to questions was significantly higher after the 8-month period compared with the pretest. Correct answers for 7 of 21 (33%) of questions were significantly higher in the second posttest as compared with the first posttest (Table 1). In addition, 2 of the 7 significantly different responses comparing both posttests were strongly ($p < .01$), and 2 were very strongly ($p < .001$) significant. This result indicates that members of the control group used their knowledge base to continue learning after the course and initial posttest.

Discussion

The results indicate that both children and their parents learned a significant amount about macaw conservation during the 1-month EE course. The control group did not show improvement initially, but there was a significant improvement in learning 8 months (Table 1 and Appendix 4). This discussion will focus on the following points: (a) children's performance, (b) intergenerational transfer, (c) intercommunity transfer, (d) natural history information learned, (e) significance of interpretation and commitment questions, (f) EE targeting children versus adults, (g) importance of careful evaluation to gauge EE's usefulness, and (h) requisites for successful EE programs.

APPENDIX B. Students' Group Questionnaire Results, Quebrada Ganado, Costa Rica (July 2001, March 2002)

	Questionnaire	Test 1[a] % correct	*n*	Test 2[b] % correct	*n*	Test 3[c] % correct	*n*	Test 1 vs. 2[d] χ^2	*p*	Test 1 vs. 3[e] χ^2	*p*	Test 2 vs. 3[f] χ^2	*p*
1	Number of Scarlet Macaws in Costa Rica?	38	62	82	62	62	48	24.598	.00	6.127	.01	5.440	.02
2	Number of Scarlet Macaws in Central Pacific?	36	61	72	62	63	49	16.531	.00	8.052	.00	1.100	.29
3	When do macaws reproduce?	67	58	80	61	79	48	2.643	.10	1.879	.17	0.022	.88
4	Number of macaw species in Latin America?	25	62	93	62	79	48	59.118	.00	3.823	.00	5.038	.02
5	Where are macaws found worldwide?	57	61	75	62	68	48	4.699	.03	1.481	.22	0.679	.41
6	Other macaw species in Costa Rica?	64	59	59	59	83	48	0.323	.57	4.799	.03	7.279	.01
7	When do Scarlet Macaws wake up?	62	61	90	61	93	48	13.073	.00	14.633	.00	0.456	.50
8	What do Scarlet Macaws eat?	21	60	70	60	72	48	28.229	.00	28.367	.00	0.111	.74
9	Where do Scarlet Macaws sleep?	42	61	80	62	72	48	18.827	.00	1.003	.00	0.920	.34
10	What animals compete for nest sites?	24	61	63	61	62	48	19.137	.00	15.926	.00	0.024	.88
11	Where do Scarlet Macaws nest?	86	61	96	59	95	48	3.713	.05	2.581	.11	0.044	.83
12	How many eggs are laid?	52	57	71	59	53	47	4.240	.04	0.003	.95	3.643	.06
13	Number of chicks becoming adults?	16	61	67	61	41	48	32.378	.00	8.601	.00	7.114	.01
14	Why are Scarlet Macaws endangered?	40	61	59	61	66	48	3.967	.05	7.103	.01	0.670	.41
15	What tree species are preferred for nesting/feeding?	25	60	68	60	70	48	22.634	.00	22.601	.00	0.079	.78
16	Why do macaws live in family group?s	45	61	50	61	60	48	0.295	.59	2.269	.13	1.000	.32
17	What is LAPPA?	55	56	60	60	72	48	0.256	.61	3.437	.06	1.975	.16
18	Benefits of Scarlet Macaws to Central Pacific?	26	60	50	58	66	48	6.806	.01	17.280	.00	0.369	.54
19	What is ACOPAC?	68	58	83	60	78	47	3.364	.07	1.264	.26	2.986	.08
20	What would you do to protect macaws?	35	59	50	59	74	47	2.797	.09	15.865	.00	6.154	.01
21	Who is responsible for Scarlet Macaw protection?	26	61	50	61	62	48	7.787	.01	14.488	.00	1.487	.22

[a]Test 1 was given before the course began (July 1–4, 2001). [b]Test 2 was given immediately after the course ended (July 31–August 3, 2001). [c]Test 3 was given 8 months after the course ended (March 15–17, 2002). [d]Test 1 vs. 2 measures immediate improvement in learning. [e]Test 1 vs. 3 measures retained (8-month) improvement in learning. [f]Test 2 vs. 3 measures retained (8-month) improvement in learning from two posttests.

Performance of Children

A number of factors affected student performance. Because some children had siblings who had previously taken the EE course, they looked forward to taking the course themselves.The course was given during school hours, with no grades. Lack of pressure from grades combined with appealing activities kept children interested in the material. Significant time was spent reviewing test questions and answers. The first posttest was on the last day of class, while the information was fresh in the children's minds, and they were not informed of their test scores.

The children significantly improved their correct answers on 18 of 21 questions between the pretest and first posttest and retained this knowledge (15 of 21) 8 months later (Table 1 and Appendix 2). These children, as a group, were highly motivated throughout the course and spent a considerable amount of time asking and answering questions, coloring in their books, and talking about macaws.

Also, Children actually significantly decreased the number of correct responses on 4 questions (Questions 1, 4, 12, and 13) between the first and second posttests (Table 2). These questions were specific natural history questions and required feedback based on memory.

Intergenerational Transfer

We detected a high level of information transfer from children to their parents concerning Scarlet Macaw conservation material. Parents improved on 8 of 21 questions (38%) from pretest to the first posttest. However, they retained this learning by significantly improving on 11 of 21 questions (52%) from the pretest to the second posttest (Table 1). Thus, they learned after the course was finished.

Ballantyne, Fien, and Packer (2001) found that Australian students shared environmental learning and attitudes with parents, and this brought about positive change in households. However, Sutherland and Ham (1992) found Costa Rican child-to-parent information transfer neither consistent nor reliable. They believed that adult EE was important, given Costa Rica's many environmental challenges, but found that the child-to-parent transfer vehicle was unsatisfactory in "deliberate transfer," in which the child consciously volunteers his or her knowledge to change the adult. Similarly, "parent-initiated transfer," in which parents solicit information from children, was inadequate. They felt that these situations forced parents and students into an uncomfortable classroom situation.

This study indicates that the use of coloring books and homework probably was important to effectively transfer informal knowledge from teachers to students to parents. Important concepts in this study included collaborative learning principles by parents and students that stimulated interactions, interest, and knowledge transfer. In this study, the visible presence and charisma of Scarlet Macaws pro-

APPENDIX C. Parents' Group Questionnaire Results, Quebrada Ganado, Costa Rica (July 2001, March 2002)

	Questionnaire	Test 1[a] % correct	*n*	Test 2[b] % correct	*n*	Test 3[c] % correct	*n*	Test 1 vs. 2[d] χ^2	*p*	Test 1 vs. 3[e] χ^2	*p*	Test 2 vs. 3[f] χ^2	*p*
1	Number of Scarlet Macaws in Costa Rica?	32	46	61	49	55	38	7.793	.01	4.361	.04	0.314	.58
2	Number of Scarlet Macaws in Central Pacific?	30	43	59	49	56	39	7.737	.01	5.729	.02	0.069	.79
3	When do macaws reproduce?	65	40	65	49	73	38	0.001	.98	0.690	.41	0.702	.40
4	Number of macaw species in Latin America?	16	43	60	48	60	40	18.480	.00	16.929	.00	0.002	.97
5	Where are macaws found worldwide?	83	37	75	48	86	37	0.966	.33	0.107	.74	1.723	.19
6	Other macaw species in Costa Rica?	75	40	72	47	82	39	0.079	.78	0.581	.45	1.126	.29
7	When do Scarlet Macaws wake up?	92	42	88	50	100	40	0.610	.43	2.966	.09	5.143	.02
8	What do Scarlet Macaws eat?	27	47	62	50	62	40	11.527	.00	1.663	.00	0.002	.96
9	Where do Scarlet Macaws sleep?	37	48	61	49	71	39	5.460	.02	1.156	.00	1.080	.30
10	What animals compete for nest sites?	17	40	59	49	52	40	15.885	.00	1.769	.00	0.400	.53
11	Where do Scarlet Macaws nest?	97	49	97	48	87	40	0.000	.99	3.832	.05	3.726	.05
12	How many eggs are laid?	45	42	60	46	74	39	2.156	.14	7.103	.01	1.739	.19
13	Number of chicks becoming adults?	18	43	43	48	55	40	6.605	.01	11.893	.00	1.105	.29
14	Why are Scarlet Macaws endangered?	67	46	77	48	75	40	1.103	.29	0.601	.44	0.052	.82
15	What tree species are preferred for nesting/feeding?	65	41	57	47	67	40	0.653	.42	0.025	.88	0.928	.34
16	Why do macaws live in family groups?	55	43	71	49	70	40	2.427	.12	1.782	.18	0.022	.88
17	What is LAPPA?	69	43	65	46	78	38	0.209	.65	0.885	.35	1.922	.17
18	Benefits of Scarlet Macaws to Central Pacific?	59	47	69	49	76	38	1.010	.31	2.666	.10	0.242	.62
19	What is ACOPAC?	68	44	82	47	86	38	2.714	.10	3.988	.05	0.514	.47
20	What would you do to protect macaws?	57	45	80	47	82	40	5.781	.02	6.096	.01	0.039	.84
21	Who is responsible for Scarlet Macaw protection?	53	45	68	48	67	40	2.327	.13	1.771	.18	0.016	.90

[a]Test 1 was given before the course began (July 1–4, 2001). [b]Test 2 was given immediately after the course ended (July 31–August 3, 2001). [c]Test 3 was given 8 months after the course ended (March 15–17, 2002). [d]Test 1 vs. 2 measures immediate improvement in learning. [e]Test 1 vs. 3 measures retained (8-month) improvement in learning. [f]Test 2 vs. 3 measures retained (8-month) improvement in learning from two posttests.

vided a readily shared theme, and the town's inhabitants indirectly understood that the presence of the macaws provides jobs in tourism for many members of the community. During the course, the children's excitement about the coloring books helped increase the opportunities for information transfer to parents (and others such as the control group). Children commented that they read their books numerous times with their parents. Parent interest was also apparent during administration of both posttests. Adults shared personal stories about the Scarlet Macaws and were eager to learn more about the macaws' natural history. It is significant that the control group demonstrated only a 5% change in learning from one posttest to the next, underscoring the importance of the course in making a difference for parents and children. Kaplan (1994) developed a functional community participation program model, Neighborhoods 2000, based on promoting intergenerational cooperation as a means of addressing community planning issues.

Intercommunity Transfer

The results indicate that no change in learning occurrend initially within the control group; and a 5% significant difference between pretest and first posttest scores may have been random. However, when we compared pretest and posttest results 8 months later, the control adult group improved (a) from 0% to 29% (6 of 21 questions), and (b) on 33% of (7 of 21) questions comparing first and second posttest results (Table 1). We feel that informal learning must occur in this village outside the classroom. Quebrada Ganado is a progressive community where people live in proximity and converse frequently. It is possible that the combination of daily observation of macaws, coloring books, and the conservation work of LAPPA (the local conservation group) has culminated in discussions and learning among members of the community.

Niesenbaum and Gorka (2001) mention a community-based ecoeducation in Las Abangares (Costa Rica), but do not quantify its benefits to local community members except as economic benefits resulting from the United States students they bring. Korsching and Borich (1996) state that continuing education helps rural communities by promoting multicommunity collaborations and providing new models for local development.

Natural History Information Learned

The first 17 questions of the pre- and posttest measured knowledge of Scarlet Macaw natural history, such as the species' population in Costa Rica, number of species of macaws in the world, number of eggs laid, and so forth. (Appendix 1). Students and their parents significantly improved their correct answers on Questions 14 and 9, respectively, of these 17 questions comparing pre- and

APPENDIX D. Adult Control Group Questionnaire Results, Quebrada Ganado, Costa Rica (July 2001, March 2002)

Questionnaire	Test 1[a] % correct	*n*	Test 2[b] % correct	*n*	Test 3[c] % correct	*n*	Test 1 vs. 2[d] χ^2	*p*	Test 1 vs. 3[e] χ^2	*p*	Test 2 vs. 3[f] χ^2	*p*
1 Number of Scarlet Macaws in Costa Rica?	51	45	43	48	38	44	0.505	.48	1.399	.24	0.248	.62
2 Number of Scarlet Macaws in Central Pacific?	50	46	39	48	44	43	1.031	.31	.301	.58	0.198	.66
3 When do macaws reproduce?	67	46	55	47	78	42	1.428	.23	1.384	.24	5.367	.02
4 Number of macaw species in Latin America?	27	43	31	47	33	42	0.172	.68	0.295	.59	0.020	.89
5 Where are macaws found worldwide?	88	43	82	45	93	44	0.661	.42	0.603	.44	2.467	.12
6 Other macaw species in Costa Rica?	80	45	78	46	86	44	0.042	.84	0.643	.42	1.010	.31
7 When do Scarlet Macaws wake up?	76	39	81	44	90	43	0.304	.58	2.909	.09	1.442	.23
8 What do Scarlet Macaws eat?	21	46	33	48	63	44	1.578	.21	16.182	.00	8.448	.00
9 Where do Scarlet Macaws sleep?	44	45	31	48	65	44	1.723	.19	4.142	.041	1.052	.00
10 What animals compete for nest sites?	30	43	43	48	30	43	1.771	.18	0.000	1.00	1.771	.18
11 Where do Scarlet Macaws nest?	91	45	89	48	95	43	0.062	.80	0.622	.43	1.062	.30
12 How many eggs are laid?	34	47	29	48	57	40	0.261	.61	4.808	.03	7.188	.01
13 Number of chicks becoming adults?	40	47	31	47	37	43	0.737	.39	0.098	.75	0.279	.60
14 Why are Scarlet Macaws endangered?	65	46	66	48	77	44	0.022	.88	1.591	.21	1.274	.26
15 What tree species are preferred for nesting/feeding?	60	43	60	45	79	43	0.002	.96	3.528	.06	3.760	.05
16 Why do macaws live in family groups?	55	45	64	48	72	44	0.790	.37	2.849	.09	0.705	.40
17 What is LAPPA?	76	42	67	46	79	43	0.836	.36	0.101	.75	1.539	.21
18 Benefits of Scarlet Macaws to Central Pacific?	51	45	68	48	72	44	3.016	.08	4.403	.04	4.652	.03
19 What is ACOPAC?	63	47	65	47	85	42	0.047	.83	5.543	.02	0.175	.68
20 What would you do to protect macaws?	73	46	77	48	79	43	0.128	.72	0.328	.57	0.052	.82
21 Who is responsible for Scarlet Macaw protection?	63	46	60	48	83	43	0.069	.79	4.825	.03	6.036	.01

[a]Test 1 was given before the course began (July 1–4, 2001). [b]Test 2 was given immediately after the course ended (July 31–August 3, 2001). [c]Test 3 was given 8 months after the course ended (March 15–17, 2002). [d]Test 1 vs. 2 measures immediate improvement in learning. [e]Test 1 vs. 3 measures retained (8-month) improvement in learning. [f]Test 2 vs. 3 measures retained (8-month) improvement in learning from two posttests.

posttests. The Costa Rican school system promotes memorization with frequent exams. Answers to questions such as Questions 1, 2, 4, 7, and 11 were either numbers or simple facts about the size of the local macaw population—easy items for a child accustomed to memory work. The increase in correct answers between tests (pretest 5–86%, first posttest 59–93%, second posttest 41–95%) was expected. On Question 4, improvement rose from 25% to 94% correct between the first two tests. However, after 8 months, study participants performed significantly worse ($p < .02$), demonstrating a lack of retention about the number of macaw species in Latin America. Four questions (Questions 1, 4, 12, and 19) had significant reduction in overall percentage of correct answers. Perhaps these memory-based questions contribute little to long-term conservation work.

Adults knew more facts about Scarlet Macaw natural history. Between 83% and 97% of the parent group knew answers to Questions 5, 7, and 11 on the first test. Between 80% and 91% of the control group knew the answers to Questions 5, 6, and 11. As expected, no significant changes occurred for either group on either posttest. For both the parent group and the children, significant improvement was observed on Questions 1, 2, 4, 8, 10, and 13, suggesting that they discussed this information together outside of class.

What do Commitment Questions Really Signify?

For all questions except Questions 18, 20, and 21, the examinee repeated from memory information presented in the course coloring books (Appendix 1). Answers to these questions required interpretation of earlier questions, prior knowledge of Scarlet Macaws, or both. For example, Question 21 asked examinees what they would do for macaw conservation. Students showed significant differences in responses from pretest to first posttest, and to the second posttest ($p < .09$, .00, and .01, respectively), and their commitment increased from 35%, 50%, and 74%. Perhaps after reflecting on the Scarlet Macaw's conservation needs, they wanted to commit to protecting the birds. Parental responses were less revealing of learned behavior, although their commitment expressed in Question 21 was significantly higher after the course and remained as such for the second posttest (Appendix 3). This result is an important basis for a stronger conservation program.

Question #18 asked how Scarlet Macaws benefit the region and students had highly significant responses between the pretest and first posttest ($p < .011$), whereas parents showed a progressive change among the three tests in the percentage of correct answers (59%, 69%, and 76%), indicating changes in attitude or commitment. The control group improved during the three examinations with two significant changes (first posttest versus second posttest, and pretest versus second posttest). No significant learning was

noticed in the parental group response, although both the control group and parents shared a similar percentage of correct answers to this question.

Likewise, answers to Question 21 ("Who is responsible for Scarlet Macaw protection in the area?") revealed which stakeholders are needed to make conservation work. The control group significantly increased in correct answers between pretest and second posttest, and between first and second posttests but did not show change from pre- to posttest ($p < .791$) (Appendix 4). Children seemed to understand the question better than their parents. The percentages of correct responses for parents between the pretest and posttest were 53% and 68% ($p < .13$) , whereas student correct responses increased from 26% to 50% ($p <.005$), and to 66% after the 8-month period. Although the parents' answers approached significance, students seemed to understand that stakeholders (government, tourist development, and local communities) needed to work together to protect the Scarlet Macaw population.

Responses to Question 20 reveal increasing community commitment to macaw conservation in their region. Correct responses involved combining activities (protecting nests, reforestation, and reporting poachers to authorities) to protect the species (Table 1). For the control group, the percentage of correct responses increased among the three tests (73%, 77%, and 79%), although the improvements were not significant. Likewise, student responses increased from 36% to 51% of correct answers ($p < .094$), and parental responses from 58% to 81% of correct answers ($p < .005$). These results indicate a collective commitment to Scarlet Macaw conservation, not surprising in a small community that is culturally and socially connected.

Possible answers include "turning a poacher over to the authorities" (Appendix 1), a difficult and likely improbable option for adults and children living in a small town, whose neighbors and relatives may somehow be connected to poachers. However, an increasing percentage of the control group, parent group, and children seem committed to Scarlet Macaw protection, a positive indicator for future conservation programs in this region. In both posttests, children improved significantly on Questions 19 and 21. These questions refer to benefits of Scarlet Macaws to their community and their commitment to protecting them. Responses rose from 50% to 66% to protect local Scarlet Macaws ($p < .08$) through several activities versus only one ($p < .01$). The EE course seems to have stimulated a change in children's attitudes. The control group changed significantly in attitude over time (Question 21), but the parent group increased significantly for Question 20 from pre- to posttests, then remained constant.

Should EE Target Children or Adults?

In consideration of limited budgets and human resources to educate people, the question remains of who should received EE programs? Vivienne Solís, a respected Costa Rican environmental educator, advocates adult education because "there isn't enough time to wait for children to grow up, when environmental change is needed immediately" (Vivienne Solís, personal communication, January 17, 2001). The following EE programs focus on children in Costa Rica: (a) cultural biology program in the Guanacaste Conservation Area (Tripoli, 1989); (b) The Sarapiqui Learning Center in North Central Costa Rica (Sarpapiqui Learning Center, 2000), (c) Centro de Educación Creativa, Monteverde (Centro de Educación Creativa Web site, 2000), (d) Earth Education Partnership Program (Environmental Club National Network, 2000), and (e) the World Teach Program (World Teach Web site, 2000). Our study demonstrates that under certain conditions, a joint school-based education program can serve both adults and children.

Importance of Evaluation to Measure EE Progress

Similar to Butler's (1992) work in the Lesser Antilles, the World Society for the Protection of Animals implemented an EE program in the Costa Rican public school system in 1989. The society measured long-term changes in pupils' attitudes about human and environmental issues, conducting three evaluations over a 12-month period (March 1991 to March 1992). Many students had a positive attitude toward animals and the environment, as perceived from examinations administered to them (Zuman, 1993). However, limited testing is carried out in most of the EE programs mentioned in this article concerning learning or retention; thus, we cannot infer whether they have been successful, even in the short term. An exception was the work of Ballantyne et al. (1998b, 2001), which focused on intergenerational learning.

Requisites for Successful EE Programs

Norris and Jacobson (1998) found that less than half of the tropical education programs studied achieved their objectives and that successful programs required a minimum of 3 years with formal evaluations to measure progress. Eagles and Demare (1999) felt that EE programs had to form a holistic part of a school curriculum over many years to make a significant impact. Lindemann-Matthies (2002) found that Swiss schoolchildren's perception of biodiversity improved with an increase in time spent in an education program.

Without evaluations, how can success be measured? Pretests and posttests are a prerequisite to evaluating projects. Long-term projects are preferable to short-term projects, but our results support the concept that children, their parents, and third-party adults learn significantly even with short courses. Although the course has been given for the last five years in this school, this is the first time we have evaluated results.

A second requisite for a successful EE program is that frequent field trips with outdoor activities related to nature are necessary to actually observe what is taught in the classroom. This is practiced widely at nature centers and sum-

mer camps in the United States (Dettmann-Easler & Pease 1999; Moseley, Reinke, & Bookout 2002) and Finland (Palmberg & Kuru, 2000). Costa Rica also is training many biologists and naturalist guides for ecotourism through field experiences.

Conclusions and Recommendations

If EE programs for children are designed and conducted in the appropriate environment, parents and third-party adults can learn and retain information.

Evaluations (pretests and posttests) measure relative success in EE programs. Assessments are necessary before the course begins and immediately on course completion to monitor retention of knowledge offered in the course.

Significant learning transfer by students to parents and later to the control group suggests that information was disseminated from classroom to community.

The EE program on Scarlet Macaw conservation was dynamic and interactive, and included highly illustrated coloring books and other materials. These factors may have had an impact on information dissemination.

The study group in the EE program spent only one morning in the field visiting Carara National Park. If the program is presented between February and April, students would also be able to observe Scarlet Macaw chicks in a protected nest. The amount of field time should be increased to provide the students with more "out-of-doors" experiences.

Community conservation changes will be progressive. Learning techniques involving community members in activities are crucial, especially activities that involve commitment and activism. The present Scarlet Macaw EE program deals mostly with transmitting knowledge. Future research must examine the ways that cognitive growth leads to behavioral change. Questions 20 and 21 test interest and commitment of parents and adults. However, tests must be designed to study these aspects and especially link them to activism.

ACKNOWLEDGMENTS

We wish to thank the Wildlife Trust for funding this project. Their commitment over the last 3 years has allowed the ecological research, monitoring, and community-related activities to progress. We also thank Lizbeth Mora, director of the QG grade school, who facilitated our conservation education course, and all of the students and adults from QG who took part in our EE program.

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Such an environmental education of preschool children helps kids to get a detailed picture of the relationship in nature, acquire initial ecological knowledge. Educators teach their wards to be responsive to health and the environment.Â Ecological education of schoolchildren has becomepopular in many regions of Russia. Thanks to the joint work of environmentalists and teachers, there are techniques that take into account social and natural local conditions that allow preserving national traditions.Â Long-term observations suggest a detailedthe study of the connection between plants and their habitat, as well as the analysis of morphofunctional fitness. Without the constant supervision and assistance of the caregiver, such an option of observing the results will not bring. The effects of environment-based education on students' critical thinking skills and disposition toward critical thinking. Environmental Education Research, 10(4), 507 - 522. presented at the 2004/11/01/. Google Scholar.Â The effect of environmental education on schoolchildren, their parents, and community members: A study of intergenerational and intercommunity learning. Vaughan, C., Gack, J., Solorazano, H. and Ray, R. (2003) The Effect of Environmental Education on Schoolchildren, Their Parents, and Community Members: A Study of Interaenerational and Intercommunity Learning. The Journal of Environmental Education, 34, 12-21. http://dx.doi.org/10.1080/00958960309603489. has been cited by the following articleÂ Indicating spillover effect on families derived from education of children, psychological factors and behavior of parents were improved. Awareness of effectiveness and behavior of children had significant effects to the most psychological factors of parents, leading to intentional and behavioral change. Furthermore, behavior of parents got influenced by expectations from children.