Evaluating the impact of an environmental education programme: an empirical study in Mexico

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This study draws on information from 11 in-depth interviews, two focus groups and 72 written questionnaires to evaluate an extra-curricular environmental education programme on forestry designed for preparatory school students from a small rural community in Mexico. Specifically, the study assessed the impact of the programme on the ecological knowledge of 72 students. Qualitative feedback suggests that students learnt about forestry, acquired greater awareness of the importance of conservation for the local environment and enjoyed the participatory teaching methods used in the programme. Quantitative results show a positive and significant association between the number of times a student participated in the programme and the student’s ecological knowledge. Students who participated in the programme once had a 16.3\% higher knowledge on ecological concepts and knew, on average, 1.5 more local forest plants than students who never attended it (p<.001). Findings suggest that the inclusion of participatory environmental education programmes in preparatory schools would improve the acquisition of ecological knowledge. Further research could consider the consistency of the findings by replicating participatory methods presented here and by using an experimental research design.

Keywords: environmental education; impact assessment; Mexican indigenous adolescents; knowledge acquisition; evaluation

Introduction

Environmental education research emerged during the 1970s. Since then, formal as well as non-formal education programmes addressing child and adult environmental education have been designed and implemented from regional to international levels (see UNESCO 2007).

Today the marked growth of studies about environmental education is producing significant data concerning both learners and learning in this area (Rickinson 2001). However, the effectiveness of environmental education programmes has not routinely been empirically evaluated (Walsh-Daneshmandi and MacLachlan 2006). For instance, Rickinson (2001) notes that there is considerably less research about the ways in which learners gain knowledge from environmental education programmes than there is concerning the characteristics of learners in isolation.

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The scarcity in research on environmental education programmes is usually noted to be concentrated geographically in North America, the UK and Europe, South Asia and Australia. However, it applies to Latin America, where a great variety of international organisations and foundations (e.g., UNESCO and WWF) are supporting a considerable amount of environmental education programmes, but few studies have assessed their impacts. Gonzalez-Gaudiano (2007) explains the scarcity of studies evaluating programmes by arguing that environmental education research is a field still under construction in the region. The development of the field began later in Latin America than it did in more developed countries as a result of unfavourable economic and political conditions. By the late 1980s, shifts in Latin American economic relations, as well as the globalisation of information technologies, made it possible for environmental education researchers to establish communication networks for exchanging information about their studies and findings.

It was not until the 1992 United Nations Conference in Rio de Janeiro and the Ibero American Environmental Education Congress in Mexico, however, that Latin American experts truly became engaged in environmental education research at the international level. Despite their efforts to build up the field, the fact that environmental education has largely been relegated to the periphery of the formal educational system has not favoured its institutionalisation. Consequently, questions such as the evaluation of programmes are still underdeveloped subjects in the field (Gonzalez-Gaudiano 2007).

This article offers a formal evaluation of an extra-curricular environmental education programme at Ixtlan de Juarez, a largely indigenous community in Oaxaca, Mexico. An extra-curricular programme is understood here as a non-classroom-based educational programme which includes, but is not restricted to, concepts that are taught in school. The programme was designed for adolescents (aged 14- to 20-years-old) attending the Ixtlan preparatory school and was planned collaboratively among students, teachers and community members. It consisted of theoretical and practical sessions about local environmental and ecological issues. The evaluation focused on assessing students’ ecological knowledge, but it was also concerned with environmental awareness and learning experiences. In this sense, the main argument of this article is that students’ active participation in the environmental education programme increases their ecological knowledge and raises their environmental awareness.

Previous research on the evaluation of environmental education programmes

According to Scott and Gough (2003), evaluation of educational programmes is concerned with the measurement of effectiveness or quality of a programme. One indicator of the quality of any intervention is what participants have learnt, and learning can be measured by assessing participants’ knowledge after attending the programme. The authors, following Biggs (1996), take the position that the most effective methodological approaches to knowledge assessment encompass both quantitative and qualitative elements. Because this is a common position for many social researchers, it is worth exploring some of the concrete ways in which the separate approaches each provide insights for environmental education research.

The quantitative tradition in this field typically implies measuring the amount of knowledge that an individual has acquired and is particularly associated with fixed-response questionnaires. For example, Barraza and Cuaron (2004) measured the extent to which 10 environmental concepts were known to 102 English and 144 Mexican school children (aged seven- to nine-years-old) by using a multiple-choice test. Results
showed that, on average, these children knew the meaning of 5.8 environmental concepts out of the 10 concepts under consideration. The authors concluded that students had a low to moderate level of environmental knowledge judged against the expectations of the national curriculum in both countries.

Quantitative studies also assess students’ ecological knowledge acquisition after attending an environmental education experience by using quantitative methods such as questionnaires consisting of science questions (Bradley, Waliczek, and Zajicek 1999), pre- and post-test questions regarding ecological concepts (Fernandez-Manzanal, Rodriguez-Barreiro, and Casal-Jimenez 1999), or knowledge scales (Walsh-Daneshmandi and MacLachlan 2006). Overall these studies found that students’ environmental knowledge increases after students have completed the educational experience.

In contrast, the qualitative tradition recognises the reflexive aspect of learning, defining it as a process through which the learner progressively constructs meanings out of past and present experiences. Thus a more qualitative approach to knowledge assessment in this field might include the interpretation of learners’ reports (Farmer, Knapp, and Benton 2007; Schneller 2008). Schneller (2008), for instance, interviewed Mexican secondary students, as well as their teachers and parents, to explore students’ learning after attending an experiential course on environmental studies. His findings revealed that the course positively contributed towards students’ knowledge of environmental issues and pro-environmental behaviours and attitudes.

The quantitative and the qualitative methodological traditions are compatible when evaluating environmental education programmes (Morgan 1997). According to Bericat (1997), such methodological integration increases results validity versus using a single method. For instance, Engels and Jacobson (2007) used mixed methods (i.e., surveys and focus groups) to assess the impact of the Golden Lion Tamarin Association programme in Brazil. Their analysis of survey data indicated that the programme increased local knowledge of the Tamarin but not the specific biological knowledge. Focus group discussions gave researchers a better understanding of the strengths and weaknesses of the programme, such as the moderate success of the programme in increasing citizen awareness and public support of the Tamarin.

In another study, Hart, Taylor, and Robottom (1994) introduced participatory enquiry as an alternative educational evaluation methodology within a traditional context. This form of evaluation process is conducted by the participants themselves and is based on self-reflection and self-evaluation of their own environmental education programme. The authors evaluated the Canadian Yukon Native Teacher Education Program by using informal interviews, forums, participant observations and written comments from programme participants. They concluded that the iterative processes of reporting accompanied by negotiation were essential to engaging the key issues in decision-making that improved the quality and effectiveness of the programme.

In sum, previous research suggests that ecological knowledge might be enhanced by participating in environmental education programmes, and mixed-methods and participatory approaches provide valuable information for improving programmes.

In Mexico, most environmental education programmes have not been externally evaluated (Murueta 2004), signalled by the lack of articles published in peer reviewed journals dealing with such programmes to any significant degree. For example, using ‘evaluation AND Mexico’ as search terms in the EBSCOhost Research Database for two of the most internationally recognised journals on environmental education research, The Journal of Environmental Education and Environmental Education Research.
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Research, the results showed a total of 26 studies, three of which were conducted in Mexico, but none of which was the evaluation of an environmental education programme (EBSCOhost). The present article draws on in-depth information gathered over an extended period of time from a single Mexican community for evaluating an extra-curricular environmental education programme.

The Ixtlan’s environmental education programme

Ixtlan de Juarez, Oaxaca, is an indigenous community of about 5000 people, which has been internationally recognised since the 1990s for the sustainable management of its communal forest. The community carries the double responsibility of ensuring the continuing well-being of the forest, including the maintenance of its biodiversity, whilst developing its natural resources in a way that benefits community members. This has meant the development of a commercial enterprise that manages forest resources. The ongoing success of this communal project thus requires extensive knowledge of environmental as well as economic processes.

The preparatory school, Science and Technology Studies Centre of the State of Oaxaca (CECyTE)-Plantel 3, offers a Spanish three-year curriculum with concentrated vocational training in information technologies and nursing. Over 300 students between 14- and 20-years-old attend Ixtlan preparatory school each year. Biology and ecology are taught as core school subjects in the first and second years respectively. The school also has an ethnobotanical garden, an extra-curricular initiative of school teachers.

Ixtlan’s community-based environmental education programme (hereafter EEP) was the outcome of joint planning. In a previous research conducted in the same community (Ruiz-Mallen, forthcoming, 119), preparatory school students and teachers, experienced forest workers and community authorities were invited to participate in a focus group and encouraged to exchange opinions on environmental learning at school. During the focus group, adolescents expressed their interest in learning about relevant socio-environmental issues to their community and adults identified the need to transmit local ecological knowledge and environmental values to them. Under the suggestion of researchers, participants decided to construct, collectively, an EEP focused on forest management. Because of the rigidity of the Mexican formal educational system it was impossible to include the EEP into the school curriculum, so it was planned as an extra-curricular programme and sessions took place during the afternoons or weekends.

Thirty-three students participated in the entire EEP in the academic year 2004–2005 (May–June 2005) and 31 students participated in the subsequent EEP later in the year (September–November 2005), 25 of whom were students who had already participated in the academic year 2004–05. All students voluntarily attended the totality of the programme sessions.

EEP planning included both the definition of the course content, which was to be introduced over eight sessions to be taught over a two-month period, and the organisation of the pedagogic activities themselves. Teaching methods were consciously varied and encompassed fieldtrips, practical field-based exercises, lectures and group workshops (Table 1).

The specific aims for the EEP, which emerged out of a series of discussions with teachers and community authorities, were to foster students’ ecological knowledge and commitment to the future of the community itself. Thus, the ecology teachers
collaborated in planning the programme content so that it reinforced the ecological concepts included in the preparatory school curriculum. Several concepts, such as ecosystem, biological conservation and resource management, were taught both in the classroom and in the EEP. In addition, representatives of the forest collective therefore provided fieldtrip instruction which gave students the opportunity to see how different areas of the communal forest were being regenerated. Furthermore, in an attempt to enrich students’ appreciation of their own community, a greater recognition of the knowledge held by local experts was promoted. All teaching was conducted by representatives of the communal bodies.

**Methods**

To evaluate the EEP, qualitative and quantitative research methods were used in the interests of methodological completeness (Bericat 1997; Morgan 1997). Qualitative methods included 11 in-depth interviews which assessed ecological knowledge and two focus groups which provided a descriptive context for the study results. Quantitative methods included a post-test written questionnaire to assess students’ ecological knowledge. All the evaluation was conducted in Spanish, which is the first language of the participants as well as of most of the researchers. Figure 1 shows the timeline of evaluation methodology.
Qualitative procedure

After finishing the second EEP, student participants were asked for permission to be interviewed on a one-to-one basis. The following question was used by researchers to initiate conversation: ‘What do you think about the environmental education experience conducted in your community?’ Other questions asked related to interviewees’ perceptions about ecological knowledge acquisition through participation in the EEP. In the first 10 interviews, the majority of students answered using monosyllabic responses, thus appearing as if they were afraid to give a ‘wrong’ answer; only two of the young men looked comfortable. Since the validity of the information obtained in this way could be compromised by the tendency to give socially acceptable responses (Stokking et al. 1999), we decided to interview adult participants previously identified as key informants rather than students. Nine adults were interviewed: five preparatory school teachers, three forest workers who taught during the EEP, and the Mayor of the Municipality who is the highest authority in the community with educational oversight, a teacher himself, and someone who helped in coordinating the programme activities.

As a result of interviewing two students and nine adults, a total of 11 interviews were transcribed and analysed, supported by Atlas.ti 4.2 software (SSD 2005). The software helps the researcher analyse qualitative data by supporting the construction and interpretation of thematic categories based on interviewees’ representations of reality. The information was coded into two thematic dimensions: (1) ‘ecological knowledge’; and (2) ‘environmental awareness’.

In addition, joint evaluations were conducted using two focus groups after concluding the first and the second programmes respectively. Most of the students,
teachers and forest workers who voluntarily attended both focus groups. Researchers guided the discussion of programme-related issues, recorded participants’ comments and proposals, and promoted the development of plans for improving the EEP.

**Quantitative procedure**

After the second EEP was concluded, data were collected from 72 students between 14 and 20 years of age who were randomly selected among all the students in the three academic years taught in the school (N = 286). A 100% response rate from the random sample was obtained. In the sample, 49 students had never participated in EEP whereas 17 of them were involved once and six had participated twice. All 23 students who had participated at least once in the programme were in the second and third year of school. All students in the second and third year (N = 55, 23 participating in the programme and 32 non-participating) had also attended the compulsory preparatory school ecology course.

The following model was used to test the hypothesis that participation in Ixtlan’s EEP improves students’ ecological knowledge:

\[
E_{Ki} = \alpha + \beta P_{iy} + \varepsilon_{iy}
\]

The outcome variable, ecological knowledge (EK), relates to the ecological knowledge of the preparatory school student \(i\) in the school year \(y\). Then, the ecological knowledge was divided into two categories for evaluation: ‘school ecological knowledge’ (SEK) – generated through school-based activities – and ‘local plant knowledge’ (LPK) acquired through other household or community-based avenues. Both kinds of knowledge were assessed independently as outcome variables in two separate equations, because they may describe distinct domains of ecological knowledge. For instance, some adolescents might have acquired knowledge of local medicinal plants because of their parents, but might not have the academic interest to learn the ecological concepts taught in ecology school subject. \(P_{iy}\) is a variable that captures the number of times the student participated in the EEP (0, 1 or 2 times). \(\alpha\) indicates the SEK’s or LEK’s value when \(P\) is zero. \(\varepsilon_{iy}\) is a random error term. If our hypothesis is true, then, the coefficient for \(\beta\) should be positive and statistically significant.

A written questionnaire was used to assess student’s ecological knowledge. It was organised in three parts:

1. Multiple-choice questions related to seven concepts randomly chosen from a list of environmental and ecological concepts obtained by reviewing 19 textbooks used in the Ixtlan preparatory school. Four concepts related to ecology (i.e., ecosystem, food chain, sustainability and renewable resource) and three related to forest management (i.e., silviculture, ecological function of forests and forest degradation consequences). The four concepts related to ecology had been taught in the ecology course and the seven concepts had been introduced in the EEP. Students were asked to choose the right definition or example from four possible answers for each concept given. The same questions were previously used with preparatory school students from other Mexican
indigenous community involved in forestry, San Juan Nuevo Parangaricutiro in Michoacan, and worked well (Ruiz-Mallén and Barraza 2008).

(2) A free-listing exercise (Bernard 1995) in which the students were asked to write the local name of all the plants they knew in the communal forest. The exercise was used to capture knowledge that was environmentally related – but not necessarily forestry related – because of the pre-existing strong agricultural tradition that historically has included attention to medicinal plants in Ixtlan. In several EEP lectures, forest technicians told students about the most important forest plants in Ixtlan and they also showed them to them while visiting forests.

(3) Questions on students’ demographic characteristics (sex, age and year of schooling) and participation in the EEP.

Outcome variables

School ecological knowledge (SEK). A score of SEK was created with students’ answers to the multiple-choice questionnaire. To create the score, one point was assigned to each correct answer – where we equated right with the answer found in the textbook – and zero to each incorrect answer, so the score ranges between zero and seven. For the regression analysis, the score was normalised by transforming it via logarithms.

Local plant knowledge (LPK). Free-listings of Ixtlan local plants were analysed using ANTHROPAC (Borgatti 1996). A list was generated that included all the plants mentioned by students in the free-listing exercise. With the help of a local forest technician and botanical information on the area (Linares 2005), plants that are not actually present in the communal forest were excluded from that list. To calculate the individual scores of LPK, one point was given for each named plant which was found in Ixtlan forest and all the points were added to generate the final LPK score. The score was not transformed to logarithms for the regression analysis because 15 students (20.8%) had a score of zero. Eleven of the students who could not mention any local plant had never participated in the EEP, three had participated once, and one had participated twice.

Explanatory variable

Students were asked the number of times they had participated in the EEP. The information was used to generate the variable Participation, coded as zero if the student had never participated in the programme, one if the student had participated once, and two if the student had participated twice.

Quantitative analysis

Analysis of variance (ANOVA) and ordinary least square (OLS) multivariate regressions were used to test the hypothesis that participation in the EEP increases student’s ecological knowledge. Regressions included the outcome against the explanatory and control variables with robust standard errors (heteroskedasticity was tested and rejected) and clustering by SchoolYear variable. Clustering allowed us to control for fixed-effects related with standard errors for intragroup correlation.
Limitations of methods

As mentioned before, there is a limitation in the qualitative method related to the invalid data obtained from students’ interviews. Limitations or weaknesses in one method could be avoided by using a second method in the sense of triangulation (Bericat 1997). Therefore, data from the students’ focus groups, as well as data from students’ questionnaires and adult EEP participants’ interviews, were employed instead of data from students’ interviews.

The quantitative design has an intrinsic limitation that could affect the validity of the results. The limitation relates to the voluntary nature of students’ participation in the EEP. Given that attendance was voluntary, it is possible that students who decided to participate in the programme were the most motivated students about learning environmental issues or were the students who already possessed a relatively high ecological knowledge. Since the study design does not include a pre-test, we have no data to compare students’ knowledge before and after the EEP and it is not possible to judge objectively whether or not students who participated in the EEP had more ecological knowledge than those who did not attend it even before they participated in the programme. It is also possible that students who both did well in school and liked nature were the ones who voluntarily participated in the EEP. Unfortunately, and because grades are confidential, we do not have the information to test this hypothesis.

Two additional potential biases in our estimations relate to small sample size and random measurement error. First, our sample size is small (N = 72), although it represents 25% of the students registered in the Ixtlan preparatory school at the time of the research. Second, dependent variables might have random measurement error (i.e., students might have given random answers when answering the knowledge test). Random measurement error in outcome variables would inflate standard errors.

Qualitative results

Interviewees’ answers

The two students interviewed asserted that they had acquired ‘ecological knowledge’ as a result of their participation in the EEP:

The course motivated me to learn about my environment. (Student 1)

I learnt a variety of things. For example, I learnt the value of our natural resources because we have a lot of things and we did not know about them. I learnt that we can do something to preserve what we have. (Student 2)

The adult interviewees supported students’ opinions:

When we talk with students who attended the programme they mention that they have a better knowledge of forest management than they had before attending the programme. (Forest worker 1)

Three teachers also pointed out the importance of fieldtrips for promoting students’ ecological knowledge on forest issues.

The category of ‘environmental awareness’ was cited by seven interviewees. Students told that, in their opinion, the majority of their peers who participated in the EEP also acquired an awareness of the value of conservation. Accordingly, five adults mentioned that the programme changed students’ cultural values: ‘Students now are
more conscious on environmental conservation in their community than they were before the programme’ (Teacher 2).

Focus group
In both focus groups, participants agreed that the EEP should continue. Students and teachers mentioned they enjoyed programme activities and learnt how the communal forestry enterprise manages their forest. Communal authorities expressed their satisfaction with adolescents’ environmental learning.

Participants also made proposals to improve the EEP from the first to the second year. In the first focus group, students and teachers reported the need of including elements concerning water conservation and garbage disposal as key ecological challenges facing the community: ‘We would like to learn about other environmental topics in the course. For example, we would like to learn about water because water is very important for life in our community’ (Student 3). As a result, four sessions on those topics were added to the second EEP.

During the second focus group, participants discussed the importance of formally inserting the EEP into the preparatory school curriculum system. The researchers informed the Oaxaca State Department of Education about the success of the Ixtlan EEP. Subsequently, in the academic year 2006–2007 the programme was officially included as a part of the second year ecology subject at the preparatory school in Ixtlan.

Quantitative results
Descriptive statistics
Table 2 shows summary statistics of the variables used in the quantitative analysis.

On average, students in the sample answered correctly 4.37 (SD = 1.21) of the seven questions included into the SEK score, which represents a percentage score of 62.5% (SD = 17.36). The concept most frequently identified correctly was that of the ecological function of forests (91.7%) followed by the consequences of forest degradation (77.8%). In terms of ecological concepts, 70.8% of students gave the right answer to the meaning of ecosystem, 63.9% answered the question about the meaning of a food chain correctly, and 59.7% knew the meaning of sustainability. Less than half of the students (41.7%) could correctly define silviculture. The question on renewable resource was the question with the fewest number of correct answers (31.9%).

On the free-listing exercise, students listed a total of 29 plants found in Ixtlan’s forest. On average, students listed 2.66 (SD = 1.86) forest plants. The mean percentage for the variable LPK score was 38.1% (SD = 26.70). Fifteen students did not mention any plant from the local forest, and only three students were able to cite as many as six forest plants. Trees (pine, oak, orchid, cedar, Ocote or smooth-bark Mexican pine and madrone) were listed more times than other plants.

Analysis of variance
Results from the ANOVA (not shown) suggest no significant difference in SEK scores between students who participated and students who did not participate in the EEP.
Table 2. Definition and summary statistics of variables used in ANOVA and OLS regression for the total sample (N = 72) and for the students groups of participation times.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>N = 72</th>
<th></th>
<th>N = 49</th>
<th></th>
<th>N = 17</th>
<th></th>
<th>N = 6</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>Std. Dev.</td>
<td>Mean</td>
<td>Std. Dev.</td>
<td>Mean</td>
<td>Std. Dev.</td>
<td>Mean</td>
<td>Std. Dev.</td>
</tr>
<tr>
<td>Outcome</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEK</td>
<td>School ecological knowledge score</td>
<td>4.37</td>
<td>1.21</td>
<td>4.28</td>
<td>1.19</td>
<td>4.29</td>
<td>1.26</td>
<td>5.33</td>
<td>1.03</td>
</tr>
<tr>
<td>LPK</td>
<td>Local plant knowledge score</td>
<td>2.66</td>
<td>1.87</td>
<td>2.02</td>
<td>1.62</td>
<td>2.76</td>
<td>1.85</td>
<td>3.00</td>
<td>2.19</td>
</tr>
<tr>
<td>Explanatory</td>
<td>Participation Number of times the student participated in the EEP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Never</td>
<td>.68</td>
<td>.47</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Once</td>
<td>.24</td>
<td>.43</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Twice</td>
<td>.08</td>
<td>.28</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Control</td>
<td>Student’s school year</td>
<td>1st</td>
<td>.38</td>
<td>.49</td>
<td>.55</td>
<td>.50</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2nd</td>
<td>.32</td>
<td>.47</td>
<td>.45</td>
<td>.50</td>
<td>0.06</td>
<td>.24</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3rd</td>
<td>.31</td>
<td>.46</td>
<td>0</td>
<td>0</td>
<td>0.94</td>
<td>1.3</td>
<td>1</td>
</tr>
<tr>
<td>Sex</td>
<td>Student gender: 1= male, 0 = female</td>
<td>.43</td>
<td>.49</td>
<td>.41</td>
<td>.49</td>
<td>.53</td>
<td>.51</td>
<td>.33</td>
<td>.51</td>
</tr>
<tr>
<td>Age</td>
<td>Age of the student (in years)</td>
<td>16.82</td>
<td>1.35</td>
<td>15.77</td>
<td>.89</td>
<td>17.82</td>
<td>1.01</td>
<td>18.00</td>
<td>1.54</td>
</tr>
</tbody>
</table>
Using the same type of analysis, a significant difference was found between the LPK scores of those students who participated in the EEP and those who did not participate (F = 3.45; p = .07).

**Multivariate analysis**

Table 3 contains results of OLS regressions between the two ecological knowledge scores (outcome variables) and explanatory and control variables. The set of dummy variables that captures the number of times a student participated in the EEP was used as an explanatory variable. The excluded category was the dummy variable with a value of ‘one’ assigned to students who never participated in the EEP.

In Column A the SEK score is used as the outcome variable. Results show a positive and significant association between students’ SEK score and participation in the EEP. On average, a student who participated in the programme once had a 16.3% higher SEK score than a student who never attended it (p<.001). Since the average SEK is 4.4, a 16.3% increase means to go from 4.4 points to 5.1 over a total of 7 points. A student who participated in the EEP twice showed a 43.2% increase in the SEK score (p = .01). The increase means to go from 4.4 points for students who did not attend the EEP to 6.3 points for students who participated twice.

Column B shows the results of the regression analysis using the LPK score as the outcome variable. Students’ knowledge of local plants was associated with participation in the EEP. The association was positive and important in real terms. On average, students who participated once in the programme listed 1.5 local plants more than those who did not participate (p<.001). Moreover, on average, students who participated twice listed 1.8 local plants more than students who did not participate in the EEP (p<.001).

Table 3. OLS regression of the logarithmic school ecological knowledge score and the local plant knowledge score against explanatory and control variables.

<table>
<thead>
<tr>
<th></th>
<th>School ecological knowledge (logarithmic)</th>
<th>Local plant knowledge (raw)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanatory</td>
<td>[a]</td>
<td>[b]</td>
</tr>
<tr>
<td>Never participated(^a)</td>
<td>^= excluded category, intentionally omitted from the analysis; (^a)= dummy variable.</td>
<td></td>
</tr>
<tr>
<td>Participated once(^a)</td>
<td>.163(.009)**</td>
<td>1.501(.023)**</td>
</tr>
<tr>
<td>Participated twice(^a)</td>
<td>.432(.007)**</td>
<td>1.829(.015)**</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>School year2(^a)</td>
<td>.055(.023)</td>
<td>1.011(.338)*</td>
</tr>
<tr>
<td>School year3(^a)</td>
<td>.037(.064)</td>
<td>.271(1.126)</td>
</tr>
<tr>
<td>Sex(^a)</td>
<td>.044(.027)</td>
<td>−.019(.143)</td>
</tr>
<tr>
<td>Age</td>
<td>−.086(.028)*</td>
<td>−.301(.442)</td>
</tr>
<tr>
<td>Obs</td>
<td>72</td>
<td>72</td>
</tr>
<tr>
<td>R2</td>
<td>.110</td>
<td>.114</td>
</tr>
</tbody>
</table>

Notes: [a] and [b] use the core model clustering by School year. Heteroskedasticity tested. \(^=\) excluded category, intentionally omitted from the analysis; \(^a\)= dummy variable.
Discussion

The discussion is organised around two main findings that emerge from our work. The first finding relates to the positive impact of the EEP on both students’ awareness of local environmental conditions and on ecological concepts more generally. The second finding relates to the reinforcing influence on knowledge acquisition when students participate in the programme more than once, a finding that has implications not only for recognising the importance of repeated interaction, but also for the means by which the concepts are being taught.

Ecological knowledge acquisition

As expected, results suggest that preparatory school students who participated in the EEP had greater school and local ecological knowledge than their peers who did not participate in the programme, including peers who were in schools’ compulsory ecology classes. This is consistent with the results from our in-depth interviews and meshes with findings from previous research (see Bradley, Waliczek, and Zajicek 1999).

There are several potential non-excluding explanations to the finding. First, adolescents who participated in the EEP were more exposed to the selected environmental topics than adolescents who did not attend. The higher number of hours of classes for the group participating in the programme might explain their higher scores. Second, the pedagogic methods used in the EEP sessions might have improved knowledge acquisition. According to Kola-Olusanya (2005), significant environmental learning is more likely to occur when it is based on a person’s constructive engagement with the opportunities presented in non-formal than in formal contexts. In this case, it is relevant that such engagement was not only focused on local environmental conditions, but also was being presented by people who interact in those conditions on a daily basis (in addition to teachers). For example, during the EEP’s classroom based activities, local experts in forestry explained ecological concepts by giving examples of local forest management and bringing specimens from the forest into the classroom. It is possible that local experts were more precise, complete and immediate in their explanations than preparatory school teachers; it is indisputable that their understanding of the issues for the immediate well-being of the forest environment was direct and committed. However, students showed a poor understanding of some ecological concepts, such as renewable resources and sustainability, even when the concepts were taught by forestry experts. We do not have a clear explanation as to why some concepts were better understood than others. It is possible that the aforementioned were too complex or abstract for the students to understand. Future research should address the reasons why some ecological concepts are more elusive than others.

Regarding methods, while the preparatory school curriculum is primarily taught using traditional teaching methods, such as textbooks, the EEP design emphasised participatory methods such as group workshops and fieldtrips, which might have enhanced learning. Workshops frequently included group discussions on environmental topics between students, teachers and local experts. Group discussions provide a valuable means for integrating information by exchanging knowledge among participants (Hansmann et al. 2003). Thus, it is possible that group workshops promoted not only students’ knowledge acquisition, but also ecological knowledge active assimilation and a greater awareness of its importance for the community itself. Informal comments made
to the researchers support this view. Several students, on being asked about their preferred aspect of the experience, said it was ‘the opportunity to discuss, to argue about the issues’.

As several interviewees suggested, fieldtrips might have also improved students’ practical understanding of ecological concepts (i.e., ecosystem and food chain) as well as forestry issues (i.e., plants, diseases and fires). Fieldtrips were designed to give the students concrete data complementing the information imparted in classrooms, thus enabling them to understand ecological concepts and to interpret ecological relationships. In the words of the Mayor of the Municipality: ‘they [students] began to show interest in research on environmental issues because they realised that they are participating in looking for, analysing, acting… and not only receiving and receiving’.

Environmental education programme participation

Results also suggest that students acquired more environmental knowledge when they participated in the EEP twice rather than only once. This may be related to the time that students need to assimilate theoretical ecological knowledge, in the context of reinforcing and extending prior learning. For example, students who participated in the programme twice had more opportunity to revisit and process the information through hands-on-engagement as well as discussion than those students who only participated once; and they had the double opportunity to explore the immediate pertinence of the information for local environmental conditions.

An alternative and non-excluding explanation to the finding relates to students’ active participation in the EEP planning. Participatory approaches to education are important tools for developing and sharing knowledge, skills and experiences among learners and teachers (Hart 2007). We have already discussed the possible influence of participatory techniques on enhanced learning. It is also possible that students’ participation in planning and evaluation activities positively motivated their active learning during the EEP. According to Uzzell and others (1994), students and teachers must engage with community decision-makers to create collaborative projects because these projects can support students in developing knowledge about environmental issues, gaining experience with interaction and action, and perceiving themselves as people who can influence their surroundings. The results of the present project provide further evidence in support of that position.

Conclusions

This study represents one of the first steps in the literature on the formal evaluation and research of environmental education programmes in Mexico.

Results of this study reinforce previous international findings on the efficacy of environmental education programmes for promoting ecological knowledge acquisition. The impact of the EEP increased when students participated in the programme more than once, which suggests that environmental education programmes might be more effective when planned as a long term activity, with repeated exposures through years or academic courses. Thus, it is important to promote the continuity of an EEP for improving students’ knowledge acquisition and reinforcing those concepts that are not only taught at school, such as local environmental issues.

The study also points out the relevance of using participatory teaching methods in EEP to promote students’ ecological knowledge acquisition. Moreover, results
suggest that a participatory approach used to plan and evaluate the EEP promoted students’ ecological knowledge assimilation and awareness of local environmental conditions. However, additional research should address the real effect of involving students in planning educational programmes on their environmental learning. It is also recommended to elaborate an evaluation strategy based on an experimental design with pre- and post-test evaluation of students’ knowledge.

Finally, it should be mentioned that if students’ interest in EEP might influence their environmental learning, it does not determine it. In the case of Ixtlan, active collaboration in designing and implementing the EEP on the part of community, as well as school members, was very important to increasing the programme’s effectiveness. As environmental education researchers, it would be of some importance to find out what is needed for involving local people in voluntarily planning an environmental education programme.

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