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Relationship between Ecology Fieldwork and Student Attitudes toward Environmental Protection

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Abstract: This article is a summary of research carried out on Spanish secondary school students 14–16 years of age, with the intention of finding out what contributions fieldwork makes toward the understanding of concepts and principles of ecology, and also to ascertain the effects of fieldwork on the defense of the studied ecosystem. Before further research was conducted, an exploratory study was carried out consisting of an initial diagnosis of the pupils' ideas; fieldwork materials were prepared and an ecology unit for the study of a freshwater ecosystem was designed, along with evaluation instruments. The experimental design was given shape thanks to work done with two groups of students on whom a more exhaustive study was performed. The independent variable consisted of a field trip; the dependent variable was the learning of ecological concepts and their application to the assessment of an environmental problem. The study combined qualitative and quantitative research methods. A result of the research work was the conclusion that fieldwork helps clarify ecological concepts and intervenes directly in the development of more favorable attitudes toward the defense of the ecosystem. Both components are seen when making valid judgments for the resolution of problems which negatively affect the ecosystem and for showing the way toward the type of actions and solutions which should be adopted. © 1999 John Wiley & Sons, Inc. J Res Sci Teach 36: 431–453, 1999.

In the last few years, an increasing interest in environmental education has run parallel to the growing degradation of ecosystems and a growth of information about environmental affairs. Environmental problems are no longer unique to one zone of the planet or, for that matter, one particular nation. Thus, environmental education is becoming an integral part of the education of any country's youth. In Agenda 21 (United Nations, 1992), an agreement was made between nations regarding the contribution of environmental education in defense of the environment. It also reaffirmed that an understanding of the environment has never been more important. The response to the need for environmental education (EE) can be seen in the curricular design for education in Spain, as well as in other countries.

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The historical beginnings of the involvement of EE educators include nature studies and rural studies, both popular in the United Kingdom in the first years of this century, along with the development of "open air education" (Oswald, 1971). Several authors (Lucas, 1980; Gayford, 1994) have identified three perspectives in EE: education *about* the environment, in which students acquire a basic knowledge of and understanding about the environment; education *in* or *through* the environment, in which the environment is used as a vehicle for the development of knowledge in many subject areas; and education *for* the environment, in which pupils explore and develop their own attitudes toward the environment.

The global nature of environmental interaction and its complexities led to the study of those environmental questions which would help create a change in the behavior and attitude toward the environment—that is to say, to train people to contribute *for* the care of the environment. These three elements (about, through, and for), however, can be seen as interrelated, although their identification has paralleled the meaning of EE.

This article is situated in the area of education through the study of the environment, the objective of which is to give pupils a series of valid principles to use when they come to make decisions for the defense of the environment.

Some research work which has served as a most immediate reference is related to the influence of environmental studies on attitudes toward the environment. Others make reference to the importance of field trips for learning. The studies by Amstrong and Impara (1991), Hart (1978), Kinsey and Wheatley (1984), Lisowski and Disinger (1991), Orion and Hofstein (1991, 1994), and Yount and Horton (1992) concentrate on analyses which are to a certain extent similar to this one, although the experimental designs are diverse. Therefore, it is not possible to draw strict parallels between the conclusions drawn. The ages of the students involved, the developed curriculum, and the time spent on research are also different. Thus, Hart (1978) demonstrated that "ecology comprehension, not environmental information level, was the best predictor, among variables considered, of environmental attitude" (p. 76). Lisowski and Disinger (1991) showed which concepts of ecology were effectively learned with a designed field trip. On the other hand, Armstrong and Impara (1991) pointed out that "tremendous differences in knowledge and attitudes under these naturalistic settings were not expected" (p. 39). These authors also indicated that "some topics are value sensitive and can be expected to affect attitudes more than topics that are less value sensitive" (p. 40). For their part, Kinsey and Whitley (1984) concluded that "courses in environmental studies do not affect one's attitude toward environmental issues" (p. 682). However, they demonstrated that the students did show significant increases in defensibility (the amount of supporting evidence used in an attitude decision). Yount and Horton (1992) indicated "that students with higher levels of cognitive reasoning were more likely to use knowledge from an environmental studies course in a subsequent attitude decision" (p. 1075).

Although it is difficult to define the meaning of attitude, Shrigley and Koballa (1992) considered research on attitude in learning sciences to have reached an impasse. We feel that three components form what could be defined as attitude: a cognitive component, an affective component and what gives the attitude a directive or dynamic influence over behavior. In short, the third attitude component would be that of action, a direct consequence of the cognitive and affective components. In this respect, environmental attitudes would imply the pairing of conducts of defense and protection of the environment in the short and long term. However, environmental attitudes consist of a wide variety of interests and objects. Possibly, one of the reasons why there is no consensus among programs developed to improve attitudes toward the environment and the evaluation of them (Leeming et al., 1993) is that exactly which attitude should be emphasized has not been clearly defined. Certainly then, it is our task to specify which attitude we are referring to, because it is necessary to clearly recognize the object of the attitude to determine in which context it is possible to predict the conduct.

Crawley and Koballa (1994) pointed out that “the theory of reasoned action presents a conceptual framework for linking behavior to specific antecedent variables—personal beliefs—attitudes, social support, and intentions” (p. 37). Fisbein y Ajzen (1975) proposed the theory of reasoned action that rests in the assumptions that humans are rational, have control over their behavior, and seek out, use, and process all available information about pending decisions before taking action. The environmental attitude that we proposed to develop was that of defense and protection of the ecosystem; thus, it was necessary to mark the limits of the materials that would go furthest in favoring the development of this attitude.

One of the components of attitude is that of the beliefs or knowledge about the object. For this reason, we tried to present a coherent package of resources about the components of the ecosystem and its interactions, to more clearly define the factors of disturbance and the need for protection. However, attitude is also determined by affective components, and some authors consider the emotional factor to be the element that plays the strongest part where attitude is concerned, to the point where they identify it as the attitude itself. Yount and Horton (1992) pointed out that “perhaps emotion tied to an object influences the knowledge assimilation as well as the behavior” (p. 1076). It is possible that knowledge of a determined object is associated with sentiments of affection or dislike, especially if the object is of interest to the individual. In this study, we proposed emphasizing the affective component by means of field trips to an ecosystem to observe the components *in situ,* take samples, and so forth. Our intention was to enable the learners to assimilate the ecological content with the support of information obtained on the field trip, and also to let experiences in the habitat act as a springboard in ensuring an affective component. Regarding the advantages of field trips, Orion and Hofstein (1991) conducted a study to identify factors that influence the learning ability of students during a geological field trip in a natural environment. They concluded that for the older students of the sample—for the 11th grade group, compared with their younger population counterparts—the field trip was a learning event. Afterward in a scientific field trip with geography majors, the same authors (Orion y Hofstein, 1994) concluded that “the novelty space notion might have an important implication for the planning and conducting field trips” (p. 1116). They consequently pointed out that factors (cognitive, geographic, and psychological novelty) can maximize familiarity and thus facilitate meaningful learning during the field trip. The authors suggested placing the field trip “in earlier stages of the curriculum as a means for concretization” (Orion & Hofstein, 1994, p. 1116).

In this study, we sought a set of data that would enable us to determine whether a deeper learning of ecological concepts was acquired by means of field trips to an ecosystem, and whether this learning contributes to students’ environmental education. We considered one of the objectives of EE to be the acquisition of awareness of the relationships between living beings and the environment, and the means to make, at the necessary moment, ecologically rational decisions (commitment) when faced with an environmental problem which implies the destruction of several ecosystems.

To bring this study to fruition (Fernández Manzanal, 1993), we bore two principal elements in mind: the importance of ecology in environmental education and the relationship between cognitive and affective aspects of the learning process—that is to say, what feelings of interest and value occurred when getting to know an ecosystem and how these feelings influenced the attitude toward defense and protection of the ecosystem. Regarding the first of these elements, we believe, as Gray (1982) pointed out, that “it is vital for any ecology course to include sufficient fieldwork for the student to have first-hand experience of the habitat being studied, and at the same time learn important skills involved with sampling and data collection” (p. 183). With regard to the affective component, we agree with Yount and Horton (1992), who stated that “emotional involvement played a much keener role in influencing attitude levels. It may be that, under certain circumstances, people tend to base decisions on emotional (affective) factors rather than on informational ones" (p. 1060).

Using these suppositions as a basis, the following questions arise:

- What are the differences in learning between the initial stages, before tackling ecology studies, and the final stages?
- How does fieldwork contribute to the learning of ecological concepts, and what part does this knowledge have to play in an attitude of defense toward ecosystems?

Background

To formulate these questions and establish a research design that would enable us to answer them, it was necessary to complete an initial inquiry of an exploratory nature which lasted for two academic terms. Perhaps at this stage a brief explanation of the process would help to give a clearer insight into the nucleus of the article. The participants were six class groups taken from the first year of the Bachillerato Unificado Polivalente (secondary phase of education) (BUP). The students' ages ranged from 14 to 16 years and they enrolled in subjects that in 3 years' time would generally lead to access to courses in further and education in university.

Four class groups (136 students) were involved in the first year. A pretest was prepared (the questions can be seen in the Instruments section) as well as an initial exploration of students' conceptions of the subject matter of ecology. The fieldwork was also prepared, which consisted of a field trip to a freshwater ecosystem. Along with the fieldwork, the ecology unit was set in motion so that the components and relationships studied could be related to elements brought from the field trip. Before starting on the field trip, one class session was given to explaining the characteristics of the work students were about to embark on. As Falk (1983) pointed out, the ability of students to conduct cognitive tasks during a field trip depends on the familiarity of the field trip setting. Orion and Hofstein (1991) stated that there is "the need for preparing the students, before taking a learning field trip, in order to reduce the gap between their expectations and the reality they will meet" (p. 518). Two of the groups involved in the experiment participated in the trip. The other two groups, for their part, started to study the subject by means of a class session using slides about the characteristics and components of a freshwater ecosystem. An initial version of the ecology unit was also prepared in this course. The results our exploration of students' initial conceptions presented us with the need to deal with some preliminary concepts necessary for tackling other concepts in ecology. These concepts referred to the meanings of "animal," "plant," and "nutrition plant." As other authors (Bell and Barker, 1982) stated, "the difficulties students experience with abstract ecological concepts (such as consumer) may be in part due to students not having scientifically acceptable concepts of basic ideas such as 'animal'" (p. 200). It also became necessary to define the most interesting subject matter within ecology for EE. Notable ecologists concur that the study of ecology leads to knowledge about the beauty of the planet and the variety of life forms on it (Odum, 1992), and that problems of nature conservation are basically ecological, which means that they should be approached from an educational point of view (Margalef, 1974). However, establishing this content is not an easy task. In the exploratory study by Cherret (1989) along with other ecologists to determine fundamental concepts for the teaching of ecology, a long list was encountered. Given the educational level of this work (students 14–16 years of age), the concepts and principles chosen for this study focused on the following meanings: preliminary concepts and ecological concepts (the meaning of the ecosystem, the study of abiotic factors, biotic components, transfer of energy and material, alimentary relationships, trophic levels, species diversity, and the role of decomposers and nutrient cycles). These were chosen because we felt that they were the most adequate for giving an overall vision of the environment.

Finally, the posttest was prepared and administrated to all pupils of the sample. A description can be seen in the Instruments section. The results of the posttest were contrasted with the two groups of learners who had been in the same course in the classroom and lab, but who had not participated in the fieldwork. Differences were found in comprehension of concepts and principles of ecology, the higher scorers being those who had taken data and samples from the ecosystem. The fact that the groups had worked with different teachers led us to think that the results had only given us an initial insight into what direction further research should take.

All the prepared materials were again put to the test in the second year with a group of 1st-year BUP students (34 pupils). Consequently, all field and classroom activities were exhaustively followed through with the intention of defining any difficulties, coherence, and so forth. One particular tool used was that of guidelines prepared to follow each activity in the class diary. During this period, assistance was provided by a teacher who attended classes as an observer and took notes on the comments made about each activity by different groups. Also, some questions for an interview were prepared to clarify the process of knowledge transference about ecology for the defense of the environment (see Instruments section). Along with the materials for the school group, interviews were conducted with this group and another of the same level (34 learners) that was studying an ecology course with similar subject matter but had not carried out fieldwork. The second group belonged to another school and had studied the subject with a different teacher. The interview set the same environmental problem for each student with the objective of clarifying the use of knowledge of ecology for problem resolution and to ascertain how attitudes related to care of the ecosystem. The problem analysis showed great differences in the use of ecological concepts between the two groups, again with higher marks coming from the group that had participated in fieldwork. After promising results were produced by the exploratory study, the decision was made to embark on a research project in accordance with the experimental design described below.

As a result of what we said before, this initial work enabled us to establish the system of categories of questions in the tests, how to quantitatively qualify the conceptual maps, organize the typology for following up the classwork, and evaluate the interviews. It also enabled us to recognize the conceptions of the students about preliminary concepts and concepts of ecology. This aspect has been discussed in another article (Fernández- Manzanal and Casal-Jiménez, 1995). Similar concepts appeared in work of Munson (1994).

Description of Fieldwork under Investigation

The ecology fieldwork under investigation can be defined as structured fieldwork in a natural environment with a trip to a freshwater system 5 km outside the city. The ecology fieldwork would be a component of the development of the curriculum. As Orion and Hofstein (1994) pointed out, “the outdoor environment is the one most neglected by teachers, curriculum developers, and researchers” (p. 1097). The trip to the ecosystem, which took 6 h, was preceded by a classroom activity explaining the route, types of activities to be carried out, materials necessary for fieldwork, etc. The students then formed small groups of three to four individuals. Each team received a guide with a description of the activities it had to carry out at the lagoon. All students participating already had some experience of field trips; that year, they had been on a geology field trip which formed another part of the school curriculum. Once at the lagoon, the students were taken on a circuit of its banks. They then carried out the following activities: (a) location of the lagoon on the map; (b) preparation of a diagram, with particular attention being paid to the accurate marking of the water inlets and outlets; (c) recognition of plant species using the corresponding key and the location of the most important groups on the diagram; (d) recognition of waterfowl using the corresponding key; (e) recognition of the habitat of different animals; (f) the taking of water temperature in different areas; and (g) the taking of water samples in different areas. We spent 6 h on these activities.

The Ecology Unit

The ecology unit consisted of 30 varied activities, the most notable of which were: (a) identification of the location as an ecosystem, and description of the biotic and abiotic components; (b) identification of planktonic organisms, paying special attention to their trophic level; (c) establishment of the meanings of *autotrophic, producer, heterotrophic, consumer,* and *decomposer;* (d) study of relationships between biotic components; (e) identification of trophic levels in aquatic and terrestrial ecosystems; (f) preparation of trophic chains and food webs using examples of organisms from aquatic and terrestrial ecosystems; (g) relationships between abiotic and biotic components; (h) preparation of cycles of elements; and (i) comments on new areas that would be interesting to follow up or fieldwork that might be worth developing further.

The strategies used in the activities were also very varied. Some were designed with the intention of changing students' understanding of certain concepts, such as the meaning of "animal," "plant," or "nutrition plant." Others were designed to amplify their understanding of initial concepts such as the extension of meaning from a food chain to a food web. With the aim of amplifying this meaning, we set problems of increasing complexity about individual variation in a population and how these variations can affect other populations within a certain range. As Alexander (1982) stated, "food web analysis is an excellent way to broaden student awareness of the natural environment, i.e., students perceive not only individual parts (organisms), but also how these parts fit together to form the whole (ecosystem)" (p. 186). Food webs are often introduced as a more realistic model for the representation of feeding relationships than the simple food chain model. However, misconceptions many occur if students consider a food web to be functionally like a network of individual food chains (Griffiths & Grant, 1985). Experimental designs were also prepared for the comprehension of the influence the modification of a given factor would have on the life of organisms. These activities were achieved in about 20 h.

Methods

Subjects

The research project was carried out in the academic year 1990–1991 with 67 students belonging to the first year of the BUP (14–16 years of age). Their general characteristics were similar to those we had worked with in previous courses in the exploratory phase. Thirty-six students were female and 31 were male. Their families' economic status was middle class and their academic expectations were similar to the those previously mentioned for BUP students—that is to say, they would lead to access to higher education in 3 years' time. The school was located in the center of a medium-sized city (175,000 inhabitants) in the northern half of the country.

Procedure

Two groups, one experimental and one control, were used for the study (Figure 1). The subjects for the experimental and control groups were selected randomly. The first group consisted

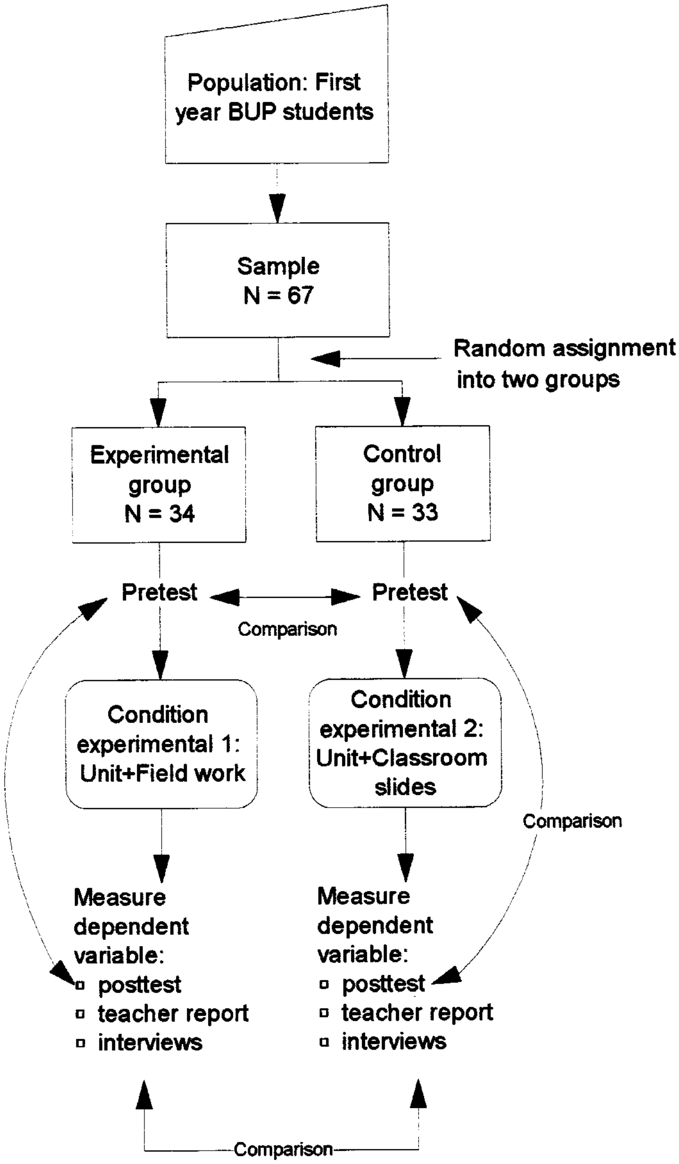

Figure 1. Research design.

of 34 students (18 female, 16 male), while the second consisted of 33 (18 female, 15 male). A pretest was used to establish the initial equivalence of both groups. Campbell and Stanley (1966) stated that the more similar the experimental and control groups are in the initial recruitment, and the more this similarity is borne out by the results of the pretest, the more effective the control is. The independent variable was the performance of fieldwork with the previously mentioned selection of activities. The dependent variable consisted of two components: learning the concepts of ecology and the attitude toward the defense of an ecosystem. Regarding the first, preliminary concepts were included (animal, plant, and plant nutrition) along with others ecological concepts (producer, consumer, decomposer, trophic levels, components relationships, etc.). As for the latter, the involvement of students in the defense of the ecosystem studied was considered; this was evaluated by applying their knowledge of ecology and their willingness to preserve an ecosystem.

Both groups worked with the ecology program for 4 weeks (about 20 h) with the same teacher. The control group students completed the same classroom and laboratory activities as the experimental group, at the same time and with the same materials. However, they did not obtain samples, nor did they participate in fieldwork. All initial information about the study site was imparted by means of slides or information given by the teacher.

As the research developed, all precautionary measures were taken concerning the intrasessional progress by following in detail all activities and their notation in the class diary (teacher report). Possible dangers to the internal validity of the design regarding development, etc., were controlled. In the case of a unpredicted variation occurring in one of the groups at the students' suggestion, the variation was passed over to the other group so that both groups received the same input.

Instruments

The two dependent variable components were measured by means of qualitative and quantitative instruments. A pretest and posttest with five and six questions, respectively, were used to assess the questions research. Both were pencil and paper tests and included multiple choice questions with or without answer justification, open answer questions, etc. The sixth question involved the preparation of a conceptual map. The pretest consisted of the following questions.

Pretest Questions.

a. Animal or plant? A multiple choice question which showed different figures on eight pages (a flowering plant, human being, frog, plant without flowers, bird, tree, starfish, and earthworm). The pupils were asked to select 3 reasons from a list of 28 provided. The list included scientific characteristics and a characteristics of living things, rather than of just animals or plants. This was a question similar to that used by Bell (1981) and slightly modified given that the examples were of two types: animals and plants.

b. Grow tree: plant nutrition. The question was designed to be open-ended to asses whether pupils spontaneously used the idea that plants make their own tissue from elements taken in from the environment. The question was modified from Driver (1982).

c. Autotrophic/heterotrophic. The student was asked to place six organisms in one or another of the two columns.

d. Trophic level: identification of other ecological concepts. Different elements and texts of a comic strip were used in which pine trees, birds, caterpillars, human beings, etc., had to be related to concepts such as producer, consumer, decomposer, herbivore, and carnivore.

e. Trophic chains. This was an open answer type question in which a sequence of four figures (A–D) linked by arrows could be seen. The purpose of the question was to establish what would happen to Element D if Element B decreased to the point of disappearance. The figures shown were: (A) herbaceous plant, (B) snail, (C) bird, and (D) bird of prey.

The pretest was conducted a week before the teacher started to prepare the students for the fieldwork.

Posttest Questions. The questions formulated in the posttest were the following.

a. Animal or plant? The question was similar to that formulated in the pretest. However, in the posttest the examples given were organisms observed in the field or in sample identification.
b. Grow tree: nutrition plant.
c. Trophic levels. This question consisted of a three-level diagram; students were asked to recognize the level corresponding to producers (autotrophic) and the two levels corresponding to consumers (herbivores and carnivores). This was equivalent to Question c of the pretest. Students were also asked to complete the levels with examples of organisms from two ecosystems: aquatic and terrestrial. This was equivalent to Question d of the pretest.
d. Food web. Students were given a food web diagram [similar to the model by Griffiths and Grant (1985) and Webb and Bolt (1990)] and two sections to answer. In one, pupils were asked to determine the effect of a sudden change in one population on another, which is not adjacent and is higher up in the same food chain, when the effect is transmitted along more than one route. In the other section, students were asked to determine what the effects on a given population would be if there were marked growth of another population located in another chain. The difference of this question in comparison to the trophic chains question in the pretest hinged on the introduction of innovations such as the complexity of the diagram and the use of symbols in the food web nodes instead of names of organisms. The complexity of the questions is situated at Skill Level 6, as defined by Griffiths and Grant (1985), in the first section, and Skill Level 9 in the second.
e. Decomposers. This was an open answer question to establish the comprehension of the role of decomposers and the cycle of elements.
f. Preparation of a conceptual map with nine defined terms that could be used to include others as yet undefined. The terms used were: *ecosystem, light, bacteria, biotic, heterotrophic, decomposer, abiotic, producer,* and *annelid*.

The posttest was administrated 15 days after the students had finished the ecology unit.

Construct and content validity were established through the expert opinion of 6 secondary school science teachers and 2 professors of ecology at the University of Santiago de Compostela. Reliability for each question was determined by considering the degree of agreement in answers given by 75 biology students in their final year at the university. A large number of the questions had already been analyzed in previous research work by other authors (Adeniyi, 1985; Barker & Carr, 1989; Bell, 1981, 1985; Bell & Barker, 1982; Griffiths & Grant, 1985; Wandersee, 1983; Webb & Bolt, 1990).

Attitude Measure. Attitude was measured using two tools: the class diary and interviews. Answers to activities done by the two groups were noted down in the diary as teacher report. The type of information noted during class observation had been established as a result of experience acquired in activity programs in previous courses. The established code included the following features: characteristics of examples used in the resolution of activities, references to the ecosystem being studied, and interest in the fieldwork and in the completion of other observations. The interviews, which were semistructured in form, were given 1 month after study. Twenty-four students participating in each group were selected randomly. The data collection procedure used was the same as the class diary inasmuch as the formulation of questions was given shape by an evaluation system of coded answers taken from previous courses. This experience had enabled us to see what new comments should be used by the interviewer in response to students' answers. The interviews were conducted as a friendly conversation and were also audiotaped and later analyzed. The evaluation system for the interviews can be seen in the Data Analysis section. The question formulated to the students was the following.

> Imagine that you are given responsibility for a natural space such as a park or the lagoon we studied. If you had to describe what aspects function well or badly, what features would you bear in mind? What would you pay special attention to? If you suddenly discovered that a large number of individuals of the same species had died, what would you think? What measures would you adopt/take?

Data Analysis

Evaluation of the pretest and posttest questions was made by means of a system of categories in which the measurement applied was the ordinal scale. Nonparametric statistics were used following the recommendations of Siegel and Castellan (1988) for cases such as the ones that concerned us—that is to say, data measurement on an ordinal scale.

> When at least ordinal measurement has been achieved for the variables being studied, the *Wilcoxon–Mann–Whitney test* may be used to test whether two independent groups have been drawn from the same population. This is one of the most powerful of the non parametric tests, and it is a very useful alternative to the parametric *t* test when the researchers wishes to avoid the *t* test's assumptions or when the measurement in the research is weaker than interval scaling. (Siegel & Castellan, 1988, pp. 128–129)

To establish the difference of learning between the experimental and control group, all the questions analyzed were subjected to the Mann–Whitney *U* test, with the level of significance at $p < .05$. The same test with the same level of significance was employed to evaluate the initial situation of the groups and establish their possible equivalence. To establish the contrast between the learning of ecological concepts before and after the course, the Wilcoxon test for matched groups was used. A significance level of $p < .001$ was established a priori as for all Wilcoxon tests. According to Siegel and Castellan (1988), the researcher is able to make the judgment of "greater than" between the score of any pair's two values, as well as between any two difference scores arising from any two pairs. As Lehman (1991) stated, "these two tests are the most frequently used when the measurement level of the variables involved is at least ordinal, . . . for making inferences about differences in center without making normal-distribution assumptions" (p. 315).

All categories of the questions were graded in alphabetic arrangement. Letter grades assigned were A–F. These constitute an ordering of performance: $A > B > C > D > E > F$. Numbers assigned to these letters were a function of the number of categories in each question.

Statistical calculations of each tests were made using the application Nonparametric Tests from the statistical package SPSS (version 6.0.1).

To demonstrate the characteristics of the categories and the ordinal level applied, in the following section the evaluation system of the second part of posttest, Question d, can be seen. This question (Figure 2) was presented in the following way.

Look at the diagram of the food web.

a. Determine the effect of a sudden decrease in Population A on the size of Population J. Give a full explanation of your answer.
b. Determine the effect of a sudden increase in Population I on the size of Population K. Give a full explanation of your answer.

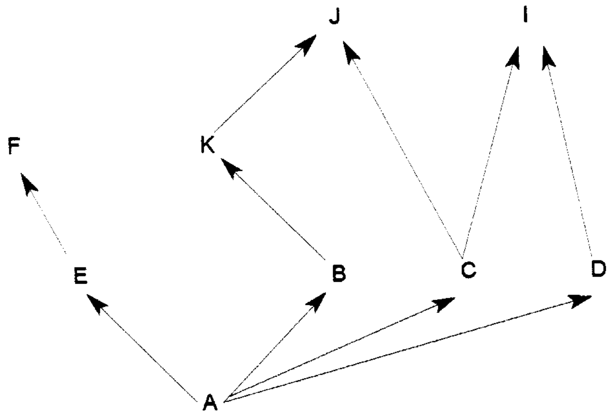

Figure 2. A sample food web. Each letter denotes a component population of the web.

As is well known, establishing to what extent the increase or decrease of a population affects another in a real-life situation is an arduous and occasionally impossible task. However, by using students' comments as a guide to other similar questions developed in class, the categories of analysis and marking established for the second section of the question were: A = 5; B = 4; C = 3; D = 2; and E = 1.

Category A covers those answers by students that marked the possible routes along which the sudden increase in Population I affects Population K. The two routes that can be seen at the end of the diagram where Population K passes through the variations of all the populations placed at intermediate levels. In one particular case, the sharp growth of Population I would affect Population C, which would decrease to a greater or lesser extent. As a consequence of this, Population J, a potential predator of Populations C and K, would affect the latter and cause a decrease. Another possible route was one where the growth of Population I reduced Populations C and D. This decrease would favor the growth of Population A and, consequently, an increase in Populations B and K. An example of this type of analysis is an answer given by one of the students of the sample group:

> If I grows, C and D, which serve as its food supply, decrease. C is also a food source for J. On diminishing C, J looks for its food in the other source, K. So K will diminish. On the other hand, D, which had decreased, does not require so much food from A, its food source. So A will grow; B and K, as well. The first and second routes counteract each other.

Categories B and C included the way in which Population K is affected by Population I by means of only one of the routes. In both cases, we felt the choice to be correct, although incomplete. As Category A indicates, Population K is affected by the changes in Population I through two simultaneous routes. The most frequently chosen route is that which explains the decrease of K in response to a reduction in Population C. We included these answers in Category B because the diagram presents a complex network of two chains. An example of response was:

> K decreases. As I feeds off C and D when it grows, C and D decrease. J feeds off C and K. As C decreases, it has to resort to feeding more off K, which decreases.

Category C, as in the previous category, includes those students' explanations which show in which way Population K is affected by the growth of Population I. Here, too, the students chose only one route, but in a much smaller proportion than that of the previously mentioned route. The conclusions derived from their option are opposite the previous ones—that is to say, K increases. The student's comment below is an example of this option:

> If I grows, C decreases in number and A grows when C decrease because they have less to feed, and when A grows, B grows and when B grows, K does, too.

In Category D, we grouped together answers that had also chosen just one route to explain in what way K is affected by the growth of Population I. All the answers included in this category indicate the route of Populations C and J to K. In this respect, there is a similarity to the alternative in Category B. However, they indicate the decrease of Population J as a consequence of the reduction of C before Population K is affected. The result is therefore the growth of K, which is a consequence of this explanation. According to our understanding (and we emphasize that in real-life circumstances it would be very difficult to determine the outcome of an occurrence such as this), there would need to be a reduction in Population K before any noticeable decrease in Population J could come about. Here is an example of a student's answer:

> I grows and so C decreases. But J also feeds off C, and when it decreases, J decreases. And as J decreases, and being the one that eats K, K will increase.

The answers in the final category include explanations with mistakes in the alimentary sequence, in the meaning of the transference or misunderstandings of the statements. An example is given below:

> Nothing bad will happen to Population K. In fact, it will get more food because A fed the chains that went to I.

Some of the students' ideas that appeared in the analysis of food chains (Fernández-Manzanal & Casal Jiménez, 1995) also appeared in the study of populations in more complex circumstances. Although many students (as can be seen in the results of each category) interpreted the network in terms of a food chain, the way they expressed the effects of the change was less dramatic, perhaps because the symbols used were a better representation of each link as a collective of individuals of the same species. Another possible reason is that the network offers the possibility of using more resources and offers less drastic solutions than the ones normally thought of within the narrow confines of the food chains.

We would also like to make a brief reference to the evaluation of the conceptual maps (CMs). They were graded in accordance with the evaluation system made up of different aspects using the criteria laid down by Novak and Gowin (1984), Stuart (1985), Akinsola (1990), and Wallace and Mintzes (1990). Added to this was a condensation of the total of the previous scores. The seven evaluations carried out in each student's maps were:

- Branching. A score of one is given for every concept node. All the ramifications and branches included on the map were evaluated, both those that derived from the fundamental concept (ecosystem) and the ones that developed gradually from other nodal concepts. Maximum score = 6.
- General to specific. If a concept was more general than those branching from it, the measurement of this differentiation was expressed by the number of concepts that showed this distribution order. Maximum score = 5 (90–100% of concepts showed a general to specific pattern).

- Technical terminology. We considered the number of correctly used terms to be an indicator of the degree of comprehension of the subject. As nine terms appeared in the statement, for the purposes of this evaluation only new concepts were considered. Maximum score = 10.
- Relationships. Relationships appear by means of propositions that interlink different concepts. Each correct relationship given along the connecting line between two nodes (concepts) scores one point. A total of 16 propositions were established with which it was possible to see relationships marked by each of the students, e.g., “herbivore takes food from producer.” Maximum score = 16.
- Hierarchy. This depends on the number of levels that are included on the concept map. The levels should be presented with clear relationships of subordination. Maximum score = 6.
- Closed units. These indicate the degree of integration of concepts as they show the relationship between the concepts of one branch of the concept map and those of another branch. Closed units are formed by a conjunction of concepts which when interconnected form a complete unit. Maximum score = 8.
- Evaluation of the meaning of ecosystem. Expressed by the sum of the partial results of each of the previous aspects. Maximum score = 50.

More details about the evaluation of this question appears in Fernández-Manzanal and Rodríguez-Barreiro (1995).

Bearing in mind that the reduction of the data to numbers generally simplifies a substantial part of the information, we resorted to the analysis of the class diary and interviews. As Cook and Reichardt (1979) stated, these tools enabled us to obtain and extrapolate information that is not obtained by other methods. For an analysis of the answers, we followed the recommendations of Taylor and Bogdan (1984) and Goetz and Lecompte (1988) on how to work with these data. If attitude can predict the consequent behavior, as Ajzen and Fishbein (1980) stated, through the oral explanations of the students it would be possible to see in what way they interpret the effects of a perturbation in the ecosystem that was studied and how they would be disposed to protect it. Throughout the study, no problem of this nature had been put forward. We paid special attention to the following idea: One had to learn to look for subjects by examining the information and the details in every way possible. Thus, in the case of the interviews, we tried to find similarities and differences between the two groups of pupils when they discussed their interrelated suppositions, concepts, and propositions that made up their particular vision of the problem. By following the clues in these ideas, we were able to recognize several themes that the pupils used when determining whether the ecosystem showed important alterations. The themes or topics were: water (Topic I), dead organisms (Topic II), analysis of the area or surroundings of the ecosystem (Topic III), observation of debris associated with human presence (Topic IV), and soil and atmospheric analysis (Topic V). After subjects’ recognition, a classification typology was were developed as the interview progressed that differentiated between the aspects of each subject by using letters of the alphabet. From there on, key concepts and words used by the pupils were extracted and the propositions deriving from the ideas and concepts put forward were recognized. When several terms were used to comment on any of the typologies, these were differentiated by means of subindices followed by the letter which expressed the procedence of the comments: experimental group = E, or control group = C. A result of this detailed analysis was the elaboration of different tables for each theme with the concepts, typologies, and propositions from the experimental and control group. (See Theme III in the Results section. Some of the concepts in Topic III that are not visible in Table 1 had been selected in previous topics.)

Results

First Question: What Are the Differences in Learning between the Initial Stages, before Tackling Ecology Studies, and the Final Stages?

The initial situation of the two groups of pupils was established by means of the pretest. Table 1 shows that there were no differences between the two groups in the concepts explored. Thus, we can establish that the groups of the sample were equivalent.

The results of the initial and final situations showed significant differences in the following areas: preliminary concepts such as “animal,” “plant,” “nutrition plant,” and ecological concepts such as identification of trophic levels and food chains. A Wilcoxon *t* test for matched groups showed statistically significant differences between the initial and final scores in the experimental and control group ($p < .001$ in these questions). At the same time, significant differences did not appear in these concepts between the experimental and control groups, although in all the questions except for food web (Skill 6) fulfillment of achievement in the experimental group was better than that the control group, as the means rank demonstrates. Special attention in this section must be applied to the meaning of “food chain.” After studying the unit, the meaning of alimentary relationships appears to have moved away from the doomwatch model obtained in the pretest. That is to say, a change in one link does not lead to a domino effect in the disappearance of the other populations, even when the proposed change is that of a large reduction in numbers of a given population. The results obtained are shown in Table 2.

Second Question: How Does Field Work Contribute to the Learning of Ecological Concepts and What Part Does This Knowledge Have to Play in an Attitude of Defense Toward Ecosystems?

As we stated earlier, we were interested in defining how fieldwork affects the learning of principles of ecology—that is to say, what new things does this kind of activity contribute? Is all the effort involved in organizing this type of activity really worth it? Table 3 describes the types of response and percentages of student choices in two questions in the posttest which show significant differences. Likewise, we include the final assessment of the CM (also with significant differences) which summarizes of the overall scores of the map. Some conclusions drawn from these results are the following.

Table 1
Values of Mann–Whitney U statistic to each pretest question

Question	U*	W*	$z^{\dagger}$	*p*
a. Animal	503	1064	0.7759	0.4378
plant	503	1064	0.7619	0.4461
b. Nutrition plant	480.5	1202.5	1.0624	0.2880
c. Autotrophic-heterotrophic	495	1056	0.9390	0.3477
d. Trophic levels	518.5	1164.5	0.5779	0.5633
e. Food chains	534	1095	0.4191	0.6752

Note. No significant differences between the two groups appeared ($n = 67$).
*U: sum of the ranks in the lower group; W: sum of the ranks in the larger group.
†Corrected for ties.

Table 2
*Results of application of Mann–Whitney U in posttest questions and conceptual map of experimental (EG) and control group (CG) (*n *= 67)*

Question	Mean rank			
	EG	CG	*U*	*z*
Meaning of animal	35.22	32.74	519.5	0.5306
Meaning of plant	36.81	31.11	465.5	1.2240
Nutrition plant	34.25	33.74	522.5	0.1144
Autotrophic-heterotrophic/ trophic levels	36.50	31.79	488.0	1.0474
Food web (Skill 6)	33.79	34.21	554.0	0.0966
Food web (Skill 9)	40.10	27.21	354.5	2.7812**
Cycle of elements	39.24	28.61	384.0	2.2720*
Conceptual map				
Branching	38.99	28.86	391.5	2.2136*
General to specific	39.15	28.70	386.0	2.3408*
Technical terminology	36.63	31.29	471.5	1.1531
Relationships	38.63	29.23	403.5	1.9877*
Hierarchy	40.94	26.85	325.0	3.0773**
Closed units	37.43	30.47	444.5	1.4874
Meaning of ecosystem	39.13	28.71	386.5	2.1923*

Significant differences: $^{*}p < .05$, $^{**}p < .01$.

Concepts of Ecology. Similar fulfillment in both groups appears in the scores of the technical terminology in the CM. We consider this to be the result of having nine terms already set to answer this question. However, the students belonging to the experimental group were significantly better at expressing the organization of ecological concepts. Thirty-two students were located in the first categories, in comparison to 20 from the control group. The branches and the overall organization of the CM concepts also demonstrated differences in favor of the group that had carried out the field trip.

Trophics Relationships. The pupils in the experimental group showed greater ability to recognize varied ways in which diverse populations are affected by the variation of another, and therefore more efficiently resolved the problems caused by the interaction of various species. As we stated before, students in both groups had amplified the meaning of food chain to food web. In addition, for the most complex relationships, six students for the experimental group were placed in Category A, in comparison to two from the control group.

Relationships between Ecosystem Components. Experimental group students established a higher number of connections than the control group in the section on CM relationships. This measure is an indication of the propositions seen by learners. We established that 16 relationships were the maximum score for this aspect in the CM. Twenty-one pupils in the experimental group presents more than eight relationships. In this section, 12 pupils were in the control group.

Biotic and Abiotic Components and Cycle of Elements. The relationship between biotic and abiotic components of the ecosystem was explored by means of the answers to Posttest Question

Table 3
Types of responses to three posttest questions

Question	Category	Type of response	Percentages EG	Percentages CG
Food web (Skill 9)	A	Population K is affected through two routes. Students recognize all possible pathways.	17.64	6.06
	B	Students recognize one possible route with two food chains. Population K is affected briefly	55.88	36.36
	C	Students recognize one possible route with two food chains. Population K is affected in the long run.	0.29	0.30
	D	Students recognize one possible route with uncertain results.	11.76	12.12
	E	Others answers include mistakes in the sequence of populations.	14.70	42.42
Cycle of elements	A	The cycle of elements is shown with abiotic environment and tree groups of organisms: producers, consumers, and decomposers.	35.29	12.12
	B	The cycle of elements is shown with abiotic environment and two groups of organisms: productors (or consumers) and decomposers.	20.58	9.09
	C	The idea of cycle of elements does not appear. Students include organism consumers only.	8.80	6.06
	D	Inorganic materials come from refuse, without giving an indication of how.	2.90	30.30
	E	Inorganic materials come from rainfall.	17.60	21.21
	F	No response.	14.70	21.21
Conceptual map. Sum of partial results	A	40–49 points	11.76	3.03
	B	30–39 points	11.76	15.15
	C	20–29 points	52.94	33.33
	D	10–19 points	23.52	36.36
	E	0–9 points	0.00	12.12

Note. Percentages of responses in each group are shown.

e. In this question, categories range from A, whose students include the cycle of elements with the participation of the environment and three kind of organisms (producors, consumers, and decomposers), passing through intermediate categories which do not include any organism, to the lowest category, where there were conceptual problems. A significantly higher number of the experimental group students included the function of decomposing organisms when they discussed the cycle of elements, and did the same with dead animals and plants. They also recognized the important role of decomposers in the reversion of elements back into the system. Twelve experimental group students were in Category A, compared four in the same category in the control group.

Meaning of the Ecosystem. The meaning of the ecosystem was evaluated from the overall score of the different sections of the CM. When we analyzed the two ends of the evaluation of this section, we found that four experimental group students had scored between 40 and 50, while one of the control group was in the same category.

The interview contributions can be seen in the Tables 4 and 5.

Table 4

Concepts, typologies, and propositions that summarize the whole of comments in interviews in Topic III (aspects to be considered in analysis of area or surroundings of ecosystem)

Concepts		Typologies		Propositions	
EG	CG	EG	CG	EG	CG
Fields Phosphates		J. The nearby fields shed substances into the lagoon.		J1E. The fields contain phosphates that drain into the lagoon.	
Fertilizers Contamination Crops				J2E. The fertilizers used for the crops may be dangerous.	
Cultivation Factories Industries		K. The cultivation surrounding the lagoon are slowly encroaching.		K1E. We should be careful that the cultivation does not get closer and eat up the area around the lagoon.	
Residues Motorway	Outlets Waste products Factories Waste disposal	L. The residues from the factories are going to damage the ecosystem.	L. The residues from the factories damage the ecosystem.	L1E. The residues from the factories are destroying the lagoon.	L1C. The outlets from factories carry dangerous waste products.
				L2E. It is necessary to control the pollution from the factories that are near the lagoon.	L2C. We should watch out for waste disposal from the factories.
		M. The motorway produces contamination.		M1E. The contamination is caused by the motorways as well as the factories.	

Some of the concepts in the propositions that don't appear in this table had been selected in topic I and II.

Table 5
Subjects dealt with by pupils

Theme	Typology	EG	%	CG	%
I	Variations in water level	+	41.6	−	
	Control of water supplies	+	62.5	−	
	Analysis of dissolved salts	+	45.8	−	
	Identification of insecticides	+	66.6	−	
	Identification of poisons (in general)	+	79.1	−	
	Temperature	−		+	66.6
II	Recognition of dead organisms	+	62.5	−	
	Organism count	+	41.6	−	
	Determining if there is an excessive rise in the numbers of anorganisms	+	33.3	−	
	Care of trees in the area	+	25	+	83.3
	Sadness and disgust at the sight of dead organisms	+	66.6	−	
III	Consideration of nearby means of communication	+	62.5	−	
	Preventing nearby cultivations from taking soil away from the area near the lagoon	+	33.3	−	
	Control of fertilizers and salts used in nearby fields	+	29.1	−	
	Control of waste from nearby factories	+	75.0	+	37.5
IV	Respect for the fishing regulation	+	25.0	+	50
	Attention to litter left by tourists	+	45.8	+	83.3
	Fire prevention	−		+	66.6
	Regulation of access to visitors	+	25	−	
	To alert those responsible for the area	+	66.6		
V	Soil analysis	+	79.1	−	
	Air analysis	+	41.6	+	33.3

Note. + = dealt with; − = not dealt with, for the analysis of the problem set in the interview and percentages of responses.

Differences also appeared in the interviews in terms of the contents used to deal with the problem. In Table 4, it is possible to contrast the opinions of students from both groups about Topic III. A combined summary of all the contributions can be seen in Table 5. In the interviews, there also appear to be differences when the students tackling topics we previously described. The arguments employed by the experimental group were greater in variety, as seen in the different subject types.

As the students' responses to the interviews were too varied to be placed within a table, below are some of the more notable aspects of their answers.

Cognitive Component of Attitude

We agree with Kinsey (1984), who stated that the support of information is the argument that everybody is able to use when evaluating a matter by means of valid principles. This support can be seen in the identification of facts, concepts, and alternative solutions. Bearing this in mind, and the arguments used in problem analysis, the following can be said.

Ten pupils in the experimental group insisted on the importance of abiotic components and variation of these components as a possible cause of the problem. At the same time, they considered it necessary to take data and samples with frequency to ascertain when and how variations occur. These features were not commented on by the control group except for allusions to water temperature, with no reference to the frequency of data or sample taking.

The same can be said for evaluation of the variations between the organisms involved. Fifteen pupils in the experimental group insisted on the importance of counting the number of organisms because, according to their comments, the disappearance of a species of organism is important for recognizing disturbance in a ecosystem. These comments did not appear in the control group. Ten students in the experimental group also pointed out that it is important to take note of the excessive increase in number of any particular species (this observation can clearly be seen in the observations made in the field trip about the proliferation of *Cyanobacteria* in some areas of the lagoon, which appeared in the class diary, as well).

It was seen in arguments put forward by the experimental group that they reaffirmed the importance of the abiotic components in the ecosystem for the maintenance of life. These ideas matched the evaluation of the posttest and the conceptual map, and left us feeling assured that their understanding of the ecosystem enabled them to maintain judgment by means of valid principles.

Affective Component of Attitude

When ascertaining the influence of fieldwork on the affective component of attitude, we summarize the class diary notes and interview evaluations. We have taken the following from the class diary.

On several occasions throughout the course, the pupils in the experimental group used information and experience they had obtained from the fieldwork. They used phrases such as “we saw that,” “as we saw at the lagoon,” and “I remember that in one part of the lagoon we saw . . .”

Examples that members of the experimental group used for the resolution of problems about trophic relationships were frequently taken from organisms observed in the field and in the laboratory. The control group referred only to the organisms taken from the water samples. The teacher in this group had to resort to slides to call attention to other components.

At the end of the course, the pupils in both groups were asked which aspects of the lagoon they would like to know more about if they had the opportunity to continue studying it. The different answers show different perceptions of the ecosystem that was studied. In addition to asking for another trip, the experimental group pupils wanted to know the nature of the insects that inhabited the water, what the cause was of the proliferation of water fleas in some areas, the variations in water quantity depending on the seasons, and what influence this had on the lifeforms there. The control group pupils asked whether there were boars in the area and what vegetation and reptiles were in the surrounding areas.

Some of the more interesting features from the interview evaluations are the following. Ten students commented on the new meaning the space had acquired for them after the study. They remarked that in a place so frequently visited (it is 5 km away from the city) with friends and family, they had never before noticed such a variety of distinct kinds of life.

Sixteen students expressed sadness and disgust at the sight of dead organisms (“There were dead carp. What a pity!”) and annoyance at the sight of the neglect and damage of signs indicating that the area was a natural reserve.

It is also worth mentioning that the experimental group pupils expressed unreserved pleasure at being able to spend some time in the country with their classmates.

Behavioral Component of Attitude

This component is mentioned to stress the meaning of an intention of behavior, which, on the other hand, is the only one we can comment through this work. Two examples are mentioned below.

Several pupils in the experimental group knew how to evaluate the results of observations made around the perimeter of the lagoon: recognition of dead organisms (15 students) and organism count (10 students). Thus, they could recognize possible routes of deterioration and propose the establishment of conservation mechanisms such as stopping cultivation from entering the area (8 students) and control of fertilizer use (7 students), and ascertain why there were dead organisms (15 students). They commented (16 students) that the most effective measure would be to alert those responsible for the area so that they could take the measures that we have mentioned.

One proposal was raised among the students in the experimental group, which was not to use bicycles near the surroundings of the lagoon, as this could disturb the nesting habits of some birds and impede them from hearing sounds.

Discussion and Implications

As Leeming et al. (1993) and others stated, it is imperative to change behavior and attitudes to preserve the quality of the environment. However, to achieve this, one has to find relevant information—in this case, ecology—which is directly related to the type of attitude that one wishes to promote. A conceptual framework is needed that leads to an understanding of the reasons that justify the defense of the environment, and also to make patent the importance of doing so. Regarding this study, the following points should be mentioned.

The majority of the sample students (experimental and control group) as well as those in exploratory phase who studied the lagoon modified their knowledge and beliefs about the importance of the components of the ecosystem and its relationships. These students identified the components of the ecosystems and trophic levels in terms of ecological theory. Of particular interest to EE is the understanding of trophic relationships and recognition of the function of plants. One could thus talk of amplification of initial conceptions of the learners. The repeated examples of trophic chains studied in class, using samples from the lagoon, as well as the microscopic study of the planktonic organisms may well have had a lot to do with this change. Thus, one sees a favorable outcome caused by the change of initial ideas and conceptions. This change was referred to by Hewson (1981), Jiménez-Aleixandre (1992), and Posner et al. (1982), who said that learning constitutes a process in which knowledge schemes are changed by integration of old and new ideas when there is no contradiction between them. Also, these new knowledge schemes appear to be more solidly acquired in the experimental group. This was proven by the results of the posttest, which was carried out a month before the interview.

The students who had visited the lagoon acquired a deeper, more solid understanding of the components of the ecosystem and the relationships within it [similar results to those of Lisowski and Disinger (1991)]. The same students showed greater skills in interpreting the relationships between the components (biotic–biotic and biotic–abiotic). The range of skills necessary for the understanding of trophic relationships when confronted with variation of the population of a species, an approach applied by Griffiths and Grant (1985), is most effectively expressed by dealing with more complex problems. The experimental group were more successful in handling these tasks. It is our opinion that the field trip gave the pupils concrete data which fit in with the information that was imparted later in the course. The frequent references made by the experimental group pupils in classroom activities to what they had observed in the field trips led us to this conclusion.

The pupils who participated in fieldwork analyzed set problems with a wider variety of arguments than those in the control group. This was the case for the types of concepts employed and the kinds of analyses used by the experimental group, who showed a greater understanding of the aspects that had to be studied to resolve the problem. We would say that the fieldwork helped the pupils understand concepts because, during the studies of different aspects of the ecosystem in the classroom, they were able to draw on their experience in the field as a known point of reference and support, as something that they had directly experienced. Preparation in the field and the information obtained there were used for ecology studies and helped in the incorporation of the new concepts. To some extent, this work follows that developed by Orion and Holfstein (1994), and like them, we feel that the field trip should focus mainly on concrete interaction between the students and the environment. These experiences in the habitat bring about collateral perceptions which form part of the affective component such as forming relationships with classmates, recognition of new sounds, observation of living creatures in their environment, etc. Fieldwork enables the learner to interpret the complex framework of ecological relationships, with the proviso that the elements should be chosen carefully so that the learner is not confused and overwhelmed by the variety of questions that the ecosystem raises. All activities in the field should therefore be carefully prepared.

It is our belief that the affective component is a factor that aids in the definition of attitude. This could be seen throughout the course (the diary) as well as in the interview. In both cases, we noted comments which expressed aesthetic beauty of the area in general, or for some organisms in particular. There were also unhappy comments about the most adversely affected aspects of the ecosystem. We agree with Yount (1992), who said, “perhaps the way in which study of a subject is undertaken has an influence on the attitude which results (or does not result) from the studying” (p. 1076). However, we also found that both the experimental group and the pupils who had performed the fieldwork in the exploratory phase used relevant information taken from the theme to define their environmental attitude. Consequently, we are able to state that at least with students 14–15 years of age, with no previous knowledge of the subject, the results are not in accordance with the previously quoted results of Kinsey or Yount. Perhaps this is because, as Kinsey and Wheatley (1994) pointed out, “the attitudes of college-age students are affected only minimally by additional environmental knowledge” (p. 682).

Finally, it should be mentioned that if attitude influences behavior, this does not mean that it determines behavior, and even less so over the long term. It is important to remember that the conclusions mentioned in this article are valid for the study of an ecology unit using the data and samples taken from a filed trip to an ecosystem with students 14–15 old. As EE is interdisciplinary, it would be of some importance to find out if such attitudes are augmented, as greater knowledge in this and other areas develops.

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