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Chapter 19

Evaluation of an Environmental Education Action about Water Resources Conservation

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Abstract

An evaluation of an action of environmental education about water resources conservation was developed in a student population between 9 and 11 years old. The project Conservation of Lage Riverside is integrated in the subject 'Project Area' of the 5th grade, in a school in Portugal. This environmental education action was developed in the school year 2001/2002, and included classroom and field activities. The evaluation instruments used were questionnaire surveys with a scale of attitudes towards environmental in general and water resources conservation and an examination of the knowledge acquired. To evaluate the behaviour a two week saving was used, which consisted of measurement of the students' homes water-meters, during the environmental education action. The questionnaires were also applied in a control class. The final results showed no significant difference between the attitudes of target and control classes, whereas the study on the target class before and after the project produced more positive attitudes towards environmental. The main difficulties that this project faced were the lack of articulation between the project planning and the school timetable. Nevertheless, it was still possible to achieve positive results, in which the students took an active part with good will.

Introduction

Of all catastrophes that threaten the Earth and that were highlighted during the recent Johannesburg summit conference, the most significant of all is, without a doubt, the lack of drinking water (Ramonet, 2002).

One of the more effective ways to raise levels of awareness and change attitudes and behaviour about the problem of water is through environmental education action. Schools can then be used for environmental education that will be truly effective.

tive in changing society and the environment. However, the difficulties arise when choosing and evaluating the most appropriate environmental education method. If it is generally agreed that the development of responsible behaviour towards the environment constitutes the main goal of environmental education, there are divisions in deciding which educative models to implement in order to reach that goal. Thus, different authors may hold contradictory positions about the relative importance to attribute to cognitive and attitudinal domains, but also with regard to the possible relations between these two domains (Hungerford and Volk, 1990; Dillon and Gayford, 1997; Bogner, 1998). A common line of thought about these questions is based on the presupposition that knowledge acquisition leads to the modification of attitudes, and that this leads to the modification of behaviours, though results from investigations may not sustain a direct relation between knowledge acquisition and modification of behaviours (Hungerford and Volk, 1990; Dillon and Gayford, 1997). However, Bogner (1998) considers that, where the influence of knowledge on behaviour towards the environment is questioned, the importance of a cognitive basis in ecology may not be considered, and where there is direct contact with nature this may positively influence students' attitudes and behaviour towards environment. Also, in practice, it is very difficult to obtain coherent information about behaviour. This is why attitudes are often deduced from to what is said. Interviews and attitude scales are examples of widely used techniques in this case (Tuckman, 1978)

So, there are different positions concerning environmental education, and several environmental education teaching models have been developed, which illustrates the divergence of points of view still existing in this domain, 25 years after the Tbilisi conference in 1977, where environmental education goals were established.

Environmental Education Projects

Environmental education is practical, problem solving and can be applied to the diversity of subjects aimed at community integration, hence the most appropriate pedagogy in environmental education is project pedagogy (Giordian, 1996; Raposo, 1997; Souchon and Giordian, 1997). Also, environmental education projects are a useful vehicle to promote greater concern for the environment, natural resources conservation and other ecological concerns (Jacobson, 1991; Louro-Alves, 1998).

Despite the progressive improvement in quality and quantity of environmental education projects, one of their weak points is self-evaluation. However, this is the most important stage in the sequencing of the project, since it allows understanding of its impact (Souchon and Giordian, 1997).

Ideally, the evaluation should be conducted throughout; from implementation, during development and after completion. Therefore, planning, process and final

product can be evaluated, and the resultant information can have two purposes: to assist the aims of the project and understanding of the project's results (Jacobson, 1991; Giordian, 1996; Souchon and Giordian, 1997). Souchon and Giordian (1997) emphasise that during the evaluation, we can distinguish two modalities: the evaluative and the descriptive. The evaluative takes place through investigations with the participants. For that, it is possible to resort to various approaches, but Souchon and Giordian (1997) suggest the pre-test method / post-test method, because it is simplest: using the help of instruments, such as questionnaires and interviews, we can locate views of the target population before and after the activity. Descriptive modality occurs in the course of the project, depending upon continuous observations of the activity. These observations, after being analysed, can lead to adjustments and alterations, as necessary. After the project has finished, questions identify attitudes and behaviours concerning the environmental problem, and in relation to the utilization of knowledge in practical actions, as well as whether the main goals were met. In order to give answers to these questions, pre-project and post-project views can be compared.

Studies in Portugal about attitudes of school age children towards the environment are scarce, and are concerned with the environment in general and the recycling of matter. Thus, according to Martins (1996, quoted in Duarte and Borges, 1996) the few studies done in Portugal refer to change of attitudes in children of the 7th, 9th and 11th grade (Martins, 1996), 4th (Duarte and Borges, 1996) and 1st cycle (1st to 4th years) (Aldeia, 2001). In these studies, attitude evaluation instruments were applied, without the use of practical activity. The few studies that have developed practical activities are about recycling materials, for example Gonçalves (1997) with students from the 6th grade.

The main goal of this work is to evaluate an environmental education action about water resources conservation, developed in a student population of 9 and 11 years old. The project Conservation of Lage Riverside is integrated on the 5th grade, in a school in Portugal.

Case Study

Pollution of water streams in Portugal is a great problem. Pollution principally results from domestic sewers, industrial collectors and garbage dumped on riversides. Despite the attempts to clean Estoril's Coast, Oeiras's riversides still have some pollution, Lage Riverside being one those cases. Lage Riverside Project was integrated in a 5th grade Area Project, in the Conde de Oeiras School, close to Lage, before it flows to Tagus River. Oeiras is an important city near Lisbon with a high population density. The choice of this case study was influenced by the efforts of the local authorities in improving this watercourse.

Methods

The sample includes 47 individuals, ages between 9 and 11 years old (average 10): 27 in the target class and 20 in the control class. The selection criterion of the sample was convenience, since it is the closest school to the case study: Lage Riverside. To compare pupils' responses, a control group of the same school year and school, but which wouldn't participate in the Lage Riverside Project was chosen.

This environmental education action was developed in the school year of 2001/2002 and included classroom activities such as: use of video, transparencies; bibliographic research and educational games; field trips to the Lage's riverside with practical activities and further laboratory work; a two weeks of water saving; and study visits to a waste water treatment plant. All these activities were developed during the whole school year, about 2 hours each week.

Evaluation instruments

Evaluation of attitudes

The instrument used for the attitude study was based on two scales: attitudes regarding the environment in general (E), and attitudes regarding the conservation of water resources (WR).

The first attitude scale (E) was adapted from Martins (1996), including closed questions with a Likert scale of 5 points, which was adapted to the target population. The second attitude scale (WR) was developed in the present study. Through a literature research, we selected items concerning frequency and importance of the environmental issues of this theme. They were organized in a Likert scale with 5 points (I totally agree – 5 totally disagree). After development of the questionnaire, a pre-test was done to validate the scales after relevant adjustments. To evaluate the reliability of the items in the questionnaire the statistical data were computed. All statistical analysis were developed using Statistica 6.0 Software; Version 5.

A loyalty study was carried out through the coefficient of Cronbach Alpha. Whenever the Alpha value increased with the removal of one item, the item was excluded. In this present work, we considered that Cronbach Alphas bigger than 0.60 are indicators of the scale's consistency and its psychometric validity. To factors with only 2 items, we calculate the correlation between them, in which $p < 0.05$. The selected factors are listed in Table 1.

Table 1- Factors regarding attitudes

Scale of attitudes to environment in general
EK - Environmental knowledge
SENS - Sensitiveness regarding all beings
CONS - Conservation Behaviours of natural resources
VAL - Rules and environmental valorisation
DEP - Difficulties in environmental protection
IP - Inefficacy perception
Scale of attitudes regarding water resources' conservation
WCQ - Water conservation and its quality
AVII - Anthropocentric vision of hydric resources
CRL - Preoccupation with the cleaning of the riverside landscape
PPB - Preoccupation with the preservation of all beings
GPI - General pollution impact on water resources
WC - Behaviours importance on water conservation
MC - Man's role on the water cycle.

From statistic treatment on the pre-test scales, we accomplished a final questionnaire that was applied before and after the Lage Riverside Project on target and control classes (fig. 1).

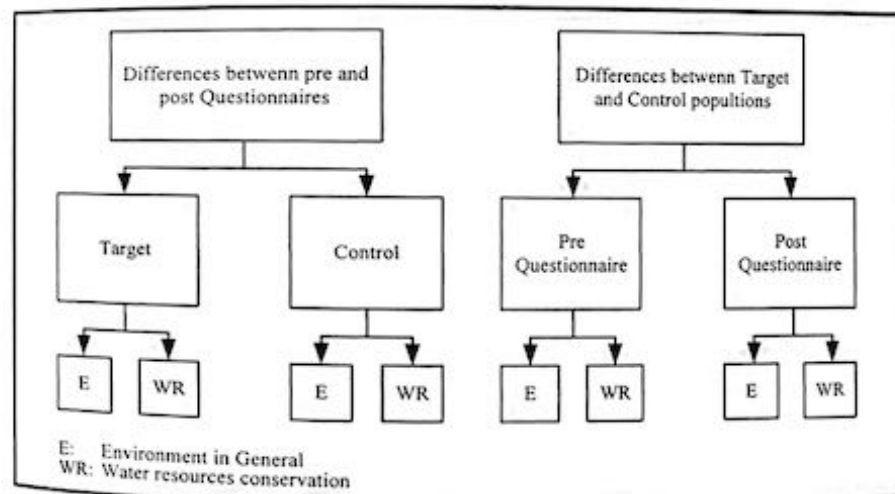


Fig. 1: Questionnaire application scheme for attitude evaluation.

Knowledge acquisition evaluation

Only the WR knowledge acquisition was evaluated, since it was the main goal of this study. To determine knowledge acquisition, a questionnaire was elaborated with 14 questions of closed answers, with a scale of 4 answer options: 1- correct; 2- incomplete; 3 - incorrect and 4 - I don't know / I haven't learned it yet. This was applied to both target and control class.

Behaviour evaluation

The behaviour found in WR was analysed through weekly water consumption results by the individual's family, obtained through the register of the water-meter (values in water cubic metres). Before the measurements, several activities were done with the target class about water saving.

Statistical analysis

A 't' test for dependent variables was computed in order to evaluate the differences between the first and in the second application of the questionnaire in the target and control class. Through the comparison between the average values before and after the experiment, we obtained 't' values for the factors, which are statistically significant when $p \leq 0.05$.

In order to evaluate the project in terms of attitude and post-test distribution of the data, a 't' test was carried out to independent samples and compared with the target class, which took part in the experiment, and with the control class, which did not participate in the project.

A Wilcoxon matched pairs test, was carried out to evaluate ranking differences between pairs of data points of the acquisition / non acquisition of knowledge between the target class and the control class, after the Lage Riverside Project. Since the number of students was not the same, we made a random selection of 17 students of the target class.

Results and discussion

Evaluation of attitudes

Test for dependent samples:

A 't' test, for dependent samples, applied to the target group, concerning attitudes towards E, revealed the following factors with significant differences: environmental knowledge, sensitivity to all living things and rules and environmental importance.

In all these factors we have observed an improvement of their respective attitudes to the environment in general (see table 2). Regarding the attitudes to-

wards WR, only factor WCQ (water conservation and its quality) had significant differences and a negative aspect, since the students presented contrary attitudes in relation to what was claimed through the action after the project (see table 3).

Table 2: Target population: attitudes to the environmental in general

Variable	mean	t	p
EK pre	13.296		
EK post	16.296	-5.287*	0.000016*
SENS pre	11.704		
SENS post	12.556	-2.015*	0.054304*
CONS pre	8.037		
CONS post	8.407	-1.154	0.258954
VAL pre	8.815		
VAL post	9.444	-2.769*	0.010232*
DEP pre	12.185		
DEP post	11.741	1.130	0.268945
IP pre	4.111		
IP post	4.296	-0.895	0.379154

*statistically significant values.

Table 3: Target population: attitudes to the conservation of water resources.

Variable	mean	t	p
WCQ pre	17.111		
WCQ post	12.518	8.770*	0.0000*
AVH pre	12.556		
AVH post	13.111	-0.895	0.3791
CRL pre	9.111		
CRL post	8.815	0.712	0.4829
PPB pre	7.704		
PPB post	8.407	-1.589	0.1241
GPI pre	20.333		
GPI post	21.111	-1.262	0.2182
WC pre	12.889		
WC post	13.370	-1.539	0.1359
MC pre	7.704		
MC post	7.815	-0.277	0.7837

*statistically significant values.

On the whole, we observed that the factors more related to attitudes that imply greater interest or pro-environmental activity were the ones where we did not observe a significant change of attitudes.

Environmental educators endeavour to teach students environmental concepts and principles with the intention that they also become more active in problem resolution (e.g. Martins, 1996). However, Martins (1996) demonstrated that in general, people may have views about the environment but prefer decisions and actions that do not restrain their own freedom of movement. This fact may explain, to some degree, why the factors that imply direct action from the students were those in which we did not obtain a change of attitudes.

Thus, according to Chagas *et al.* (1994), environmental education should be grounded on a solid cognitive basis and should be started early, before children develop stereotypes and reinforce their attitudes. This environmental education perspective is based on psychological principles about thought development processes in children. During this environmental education action, the new information received by the child is, therefore embodied in the conceptual structure existent, which is quite powerful and resistant to change (Ausubel, 1968).

However, the fact that there were no positive change of attitudes towards water resources may be due to the lack of effective actions with the target population in order to improve the quality of the riverside in question. These actions, although planned, were not integrated in school activities because of problems such as, timetable planning and resources available to the project team (students and teachers), as well as the school itself. For this kind of population, i.e. children, these kinds of actions are essential.

Active and interventional strategies are those in which the pupil is not a mere spectator of the teacher's intervention, but in which he/she is actively involved in the process. It is during an environmental education action developed in this active form that we will obtain the best educational results, with the maximum efficacy regarding attitude change (Louro-Alves, 1998). The study carried out by Raposo (1997) about the school EB 2,3 Vieira da Silva project, in 1994/95, is a good example of that efficacy.

As to the control group, regarding E, only one factor showed positive significant changes. Regarding the scale of WR we observed negative significant changes in attitudes regarding water conservation and its quality and the behavioural importance of water conservation (Table 4 and 5). This negative behaviour could be explained by fact that this control group was involved in no effective action to improve the quality of the riverside, or participate in any of the activities of the target class.

Table 4: Control population: attitudes to the environmental in general

Variable	mean	t	p
EK pre	14.235		
EK post	16.529	-4.474*	0.000384*
SENS pre	12.941		
SENS post	12.588	0.7651	0.455355
CONS pre	8.588		
CONS post	8.353	0.675	0.50936
VAL pre	9.000		
VAL post	9.353	-1.065	0.30276
DEP pre	12.000		
DEP post	11.529	0.602	0.55564
IP pre	4.118		
IP post	4.529	-1.281	0.218557

* statistically significant values.

Table 5: Control population: attitudes to the conservation of water resources

Variable	mean	t	p
WCQ pre	17.882		
WCQ post	12.353	11.950*	0.00000*
AVH pre	11.471		
AVH post	12.059	-0.727	0.47778
CRL pre	8.941		
CRL post	8.588	0.793	0.43939
PPB pre	7.647		
PPB post	8.000	-0.728	0.47697
GPI pre	21.000		
GPI post	19.882	1.024	0.32088
WC pre	13.294		
WC post	12.235	2.314*	0.03428*
MC pre	7.176		
MC post	6.765	0.778	0.44770

* statistically significant values.

Test for independent samples

Comparing attitudes about the environmental in general in the pre-questionnaire of both target and control population, we can observe that two factors present significant changes: environmental knowledge and conservation behaviour to-

ward natural resources. In all factors, besides DEP (difficulties in environmental protection), the control class always presented more positive attitudes towards E than the target class (Table 6).

Table 6: Attitudes to the environmental in general: Pre questionnaire

Factor	mean	t	p
EK target	16.630	-2.415*	0.01984*
EK control	18.150		
SENS target	12.444	-1.605	0.1154
SENS control	13.300		
CONS target	7.889	-2.532*	0.0149*
CONS control	8.900		
VAL target	8.667	-1.273	0.2096
VAL control	9.150		
DEP target	11.518	0.108	0.9148
DEP control	11.450		
IP target	4.111	-0.538	0.5930
IP control	4.250		

*statistically significant values.

This demonstrates that the populations in the study show differences regarding their attitudes to the environment in general, since the target class demonstrated a greater sensitivity towards the issue. Nevertheless, regarding the water resource conservation, the populations did not show any differences (Table 7).

Table 7: Attitudes to the conservation of water resources: Pre questionnaire

Factor	mean	t	p
WCQ target	17.111		
WCQ control	18.050	-1.875	0.0672
AVH target	12.555		
AVH control	11.600	1.487	0.1439
CRL target	9.111		
CRL control	9.050	0.162	0.8721
PPB target	7.704		
PPB control	7.700	0.007	0.9943
GPI target	20.333		
GPI control	20.700	-0.388	0.7000
WC target	12.889		
WC control	13.450	-1.104	0.2756
MC target	7.704		
MC control	7.250	0.960	0.3420

In relation to the pre-questionnaire, unexpectedly, there were no significant differences, either in terms of E or WR (see Tables 8 and 9). Although the changes are not significant, in relation to the WR and the factors analysed in both cases, we observed attitudes with a tendency to be more positive in the target class (see Tables 7 and 9).

Table 8: Attitudes to the environmental in general: Post-questionnaire

Factor	mean	t	p
EK target	16.296	-0.309	0.759
EK control	16.529		
SENS target	12.555	-0.057	0.955
SENS control	12.588		
CONS target	8.407	0.121	0.904
CONS control	8.353		
VAL target	9.444	0.336	0.739
VAL control	9.353		
DEP target	11.741	0.327	0.746
DEP control	11.529		
IP target	4.296	-0.999	0.323
IP control	4.529		

Table 9: Attitudes to the conservation of water resources: Post-questionnaire

Factor	mean	t	p
WCQ target	12.518	0.252	0.801
WCQ control	12.353		
AVH target	13.111	1.460	0.152
AVH control	12.059		
CRL target	8.815	0.426	0.673
CRL control	8.588		
PPB target	8.407	0.826	0.413
PPB control	8.000		
IPG target	21.111	1.288	0.205
IPG control	19.882		
WC target	13.370	1.931	0.060
WC control	12.235		
MC target	7.815	1.949	0.058
MC control	6.765		

This lack of significant changes may well be due to the fact that the control population, compared to the target class, demonstrated from the beginning a

more positive behaviour regarding the environment. Thus, in the control class, although it did not participate in the environmental education project, the thematic approached in the biology class coincided with the theme of the environmental education project. Also, the teacher, that was the same in both classes, was very sensitised towards these questions.

Knowledge acquisition evaluation

From the 14 questions, only in 4 did the target population produce significantly different answers ($p < 0.05$) from the control population (Table 10). Nevertheless, in general, the target population answered correctly a larger number of questions (62% compared to 45% in the control class, fig.2). Thus, the control population answered 'I don't know' in 20% of the questions, whereas in the target class answered only 4%.

Table 10: Wilcoxon test to evaluate knowledge acquisition

Question number and theme	Target population	Control population	
1. Chemical property of water	Correct	88.9	0
	Incomplete	11.1	0
	Incorrect	0	0
	Don't know	0	100
	Wilcoxon's test	Z = 3.5162 P = 0.0004*	
2. Water biota	Correct	55.6	47
	Incomplete	44.4	29.4
	Incorrect	0	5.9
	Don't know	0	17.6
	Wilcoxon's test	Z = 1.7821 P = 0.0747	
3. Pollution sources	Correct	81.5	82.4
	Incomplete	11.1	5.9
	Incorrect	3.7	5.9
	Don't know	7.7	5.9
	Wilcoxon's test	Z = 0.4045 P = 0.6858	
4. Water legislation	Correct	37.0	70.6
	Incomplete	55.6	11.8
	Incorrect	0	5.9
	Don't know	7.4	11.8
	Wilcoxon's test	Z = 0.3922 P = 0.6949	

Question number and theme	Target population	Control population	
5. Man intervention	Correct	55.6	76.5
	Incomplete	40.7	11.7
	Incorrect	0	5.9
	Don't know	3.7	5.9
	Wilcoxon's test	Z = 0.8451 P = 0.3980	
6. Water saving	Correct	63	35.3
	Incomplete	14.8	11.7
	Incorrect	18.5	29.4
	Don't know	3.7	23.5
	Wilcoxon's test	Z = 1.961 P = 0.0498*	
7. Water treatment	Correct	70.4	29.4
	Incomplete	25.9	17.7
	Incorrect	7.4	11.8
	Don't know	0	41.2
	Wilcoxon's test	Z = 3.0051 P = 0.0026*	
8. Water saving	Correct	59.3	35.5
	Incomplete	33.3	47.1
	Incorrect	3.7	11.8
	Don't know	3.7	5.9
	Wilcoxon's test	Z = 1.6004 P = 0.1095	
9. Water policy	Correct	14.8	17.6
	Incomplete	40.7	29.4
	Incorrect	44.4	52.9
	Don't know	0	0
	Wilcoxon's test	Z = 0.4394 P = 0.6603	
10. Water saving	Correct	74.1	52.9
	Incomplete	3.7	0
	Incorrect	22.2	47.1
	Don't know	0	0
	Wilcoxon's test	Z = 1.2677 P = 0.2049	
11. Water saving	Correct	77.8	41.2
	Incomplete	14.8	41.2
	Incorrect	7.4	5.9
	Don't know	0	11.7
	Wilcoxon's test	Z = 1.2159 P = 0.2240	

Question number and theme	Target population	Control population	
12. Water pollution	Correct	51.9	52.9
	Incomplete	22.2	11.8
	Incorrect	7.4	5.9
	Don't know	18.5	29.4
	Wilcoxon's test	Z=0.5591 P=0.5761	
13. Water pollution	Correct	92.6	70.6
	Incomplete	3.7	23.6
	Incorrect	0	5.9
	Don't know	3.7	0
	Wilcoxon's test	Z=1.5724 P=0.1159	
14. Water cycle	Correct	40.7	23.5
	Incomplete	37	11.8
	Incorrect	14.8	35.3
	Don't know	7.4	29.4
	Wilcoxon's test	Z=2.7118 P=0.0067*	

*statistically significant

Behaviour evaluation

From the results obtained and through weekly averages of water consumption in the family houses of the target population, we verified that there was favourable behaviour towards water conservation/saving. This fact is confirmed through the negative slope of the straight line, and by the high coefficient of the linear regression of water consumption throughout time (fig. 3). Nevertheless, we must interpret this result with care, since the evaluation of this behaviour was done in a short period of time and within the period of action of this project. As we have already observed in other studies, after some time, behaviour tends to come back to its original state (Raposo, 1997).

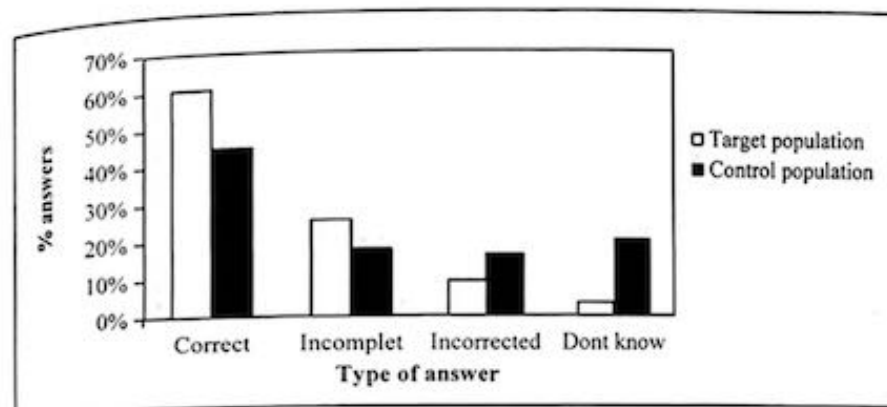


Fig. 2: Total percentage of type of answers between target and control population.

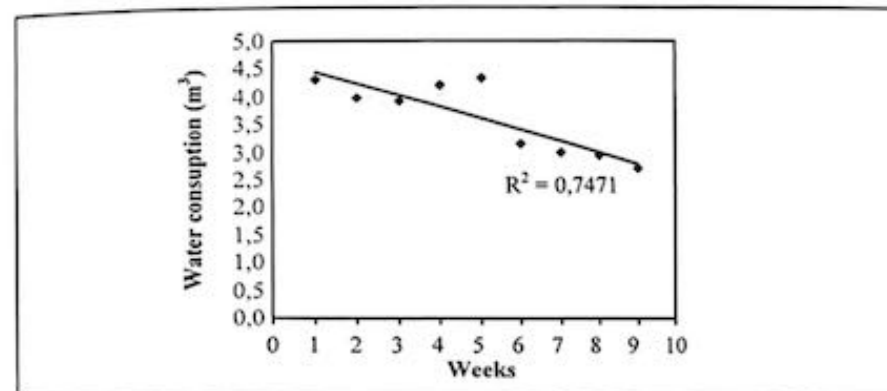


Fig. 3: Water consumption average of the target class throughout the action.

Conclusions

From the results of this project, we can see that there was a positive influence regarding attitudes towards the environment in general.

In relation to the water resources, a change of attitudes was not observed; only a change of behaviour in a short period of time. The target class had the opportunity to observe and analyse Lage's Riverside water, but it wasn't possible to engage in actions of prevention and improvement. This fact may explain the lack of attitude change in positive attitudes regarding water resources. This problem is partly due to the incompatibility of the project's planning with the school's organisation, that. It may also be due to a feeling of inability and helplessness in the target population, which could explain the negative attitudes observed, as

environmental protection difficulties, cleaning of the riverside area and water conservation and quality.

However, investigations about changes of attitudes have produced diverse and sometimes contradictory results. This is due to the difficulty that exists in evaluating the various components of attitudes, but also due to the fact that the theoretical models used are quite diverse (Martins, 1996).

The control population used may not have been the most suitable for the study because:

1. The biology teacher that participated in the project was the same in both control and target classes, and therefore was sensitised to the question in study.
2. The themes in the biology class were in the same area as those of the project.
3. There has been a great deal of sensitisation in the school in the study, regarding the environment
4. The control population from the beginning were more sensitised to these kind of questions.

These factors may have influenced both classes' development regarding their attitudes towards environment in general and to water resources in particular.

The study demonstrated the difficulty in integrating projects of environmental education in the formal school system. To overcome this, a consolidated evaluation process and careful and integrated planning with the school's activities is essential. The evaluation instruments used were adequate for this kind of study. Nevertheless, they are best used within a longer period of time, before and after the action. A study of target and control populations must also take into account a number of factors, such as: the, in socio-demographic and cultural history of the population, the pupils and teachers; their school progress; and the school agenda. Also, to achieve valid comparison, the characteristics of the target and control populations should be as similar as possible, but it is important that the subject of the environmental education project is not taught in their classes.

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