

Education for Sustainable Development in Primary Schools: Contributions from the Development of a Teacher Training Program

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Introduction

In the world today, in which are evident profound imbalances, conflicts that disrespect human rights, and humans have to face multiple socio-economic-environmental problems, the proclamation of the Decade of Education for Sustainable Development (DESD) for the period 2005-2014, by the United Nations General Assembly in December 2002, comes as the maximum recognition of the situation of planetary emergency that humanity is facing, emphasizing education as "*an indispensable element for achieving sustainable development*" (Arima, Konaré, Lindberg & Rockefeller, 2004: 7).

At the beginning of this new century, the DESD launch the challenge of an education for solidarity, based on a correct perception of the planet situation and promoting responsible attitudes and commitments which are both socially fair and environmentally sustainable. Although education on its own is not sufficient to achieve these attitudes, it has come to be recognized in several documents under the responsibility of UNESCO (United Nations Decade of Education for Sustainable Development 2005-2014: Draft International Implementation Scheme (2004); Guidelines and Recommendations for Reorienting Teacher Education to Address Sustainability (2005); the United Nations

Decade of Education for Sustainable Development (2005-2014) ó contributions for its implementation in Portugal (2006); í) and by various authors (Fien & Tilbury, 1998; Freitas, 2006; Gil-Pérez & Vilches, 2005, 2006; Hesselink, van Kenpam & Wals, 2000; Hopkins & McKeown, 2001, 2005; Pedrosa & Leite, 2005; Pellaud, 2001, 2002, 2003; Scoullou, 2004; Tilbury, Stevenson, Fien & Schreuder, 2002; Varga, Kószó, Mayer & Sleurs, 2007; Vilches & Gil-Pérez, 2003), as an essential pre-requisite for the promotion of a change in individual and collective attitudes and, consequently, of the current critical situation.

To achieve the desired goal it is vital that Education for Sustainable Development (ESD) is implemented from the very early years of schooling, within a framework of life-long learning, in contexts of formal, non-formal and informal education, considering content, contexts, strategies and competences within a multi, inter and trans-disciplinary perspective and highlighting the interactions between the key areas of sustainability ó environment, society and economy (Hopkins & McKeown, 2001, 2005). In this way, all educators are vital to encourage understanding of the problems we face. The awareness of human beings responsibility in the current situation facing our planet and the importance of individual actions to reverse the situation, through the exercise of responsible citizenship, are important issues to work from the first years of schooling.

The importance of teacher training programs in the field of ESD can be seen in all the above-mentioned documents, and UNESCO has emphasized that "*the ongoing training of teachers should take into account professional skills in the field of education for sustainable development, recommending that all training (í) from 2010, should include an education module for sustainable development*" (UNESCO, 2006a:18).

In this context, the perceptions that teachers have are fundamental in their pedagogical practice regulation. However, in what the planet situation is concerned, these

perceptions have been fragmented and superficial, showing lack of understanding of the problem in a global context (Freitas, 2004, 2006; Ko & Lee, 2003; Martins, 1998; Praia, Edwards, Gil-Pérez & Vilches, 2001; Sá & Martins, 2005). On the other hand, being aware that ESD should begin from the very early years of schooling and continue throughout life and in the various contexts of learning, a research involving a training program for primary teachers focusing on ESD was conducted.

This chapter presents the mentioned research, the conception and development of the teacher training program, as well as its implementation and evaluation, and shares some conclusions.

1. Research presentation

The main purposes of this research were: to identify primary school teachers' conceptions concerning science and technology, citizenship and sustainable development; to conceive, develop and evaluate a primary school teacher training program focusing on ESD; to conceive and produce didactical resources, based on ESD guidelines and recommendations and to identify primary school teachers' training needs concerning ESD practice (re)orientation.

To pursue these aims, the research was organized in four phases, as presented in Table 1.

Table 1 ó Research phases

During Phase I, national and international ESD guidelines were analyzed and compared. Besides establishing a theoretical framework, this analysis allowed a national primary school curriculum review searching for ESD orientations.

Phase II focused on the identification of primary schools teachers' conceptions concerning science and technology, citizenship and sustainable development. Participating primary school teachers' conceptions were identified by inquiry. For this particularly research, a questionnaire was conceived and validated in order to identify the referred primary school teachers' conceptions. The aim was to obtain the same information from all the research participants.

The conceived questionnaire had twenty-three multiple choice questions, organized in four groups. The first group of questions intended to characterize the participating teachers regarding aspects as, for instance, age or academic degree. The second, third and fourth groups of questions aim was to identify primary school teachers' conceptions about, respectively, science and technology, citizenship and sustainable development.

This questionnaire was administered to one hundred primary school teachers. An interview was done to eight of the one hundred primary school teachers who responded the questionnaire. The interview purpose was to clarify some of the conceptions identified during questionnaire data collected analysis.

Phase III focused on the teacher training program conception and development. To achieve the stated intention, the theoretical framework (Phase I) and the identified primary school teachers' conceptions (Phase II) were considered. The themes, strategies, didactical resources and activities that integrated this teacher training program were defined according to the two previous research phases and will be presented in section 2 of this chapter.

Phase IV was committed with teacher training program implementation and evaluation.

The training program was implemented with a group of primary school teachers in a private educational school. This group was composed of eight members, seven female and one male. Their ages were between twenty-four and forty-nine years and only two had less than five years of service. For each year of schooling in this primary school, there were two classes and, consequently there were two teachers allocated to each year (one per class): two taught 1st year, two taught 2nd, two taught 3rd, and two taught 4th. Their initial training was of a diverse nature: three out of the eight teachers were graduated in Elementary Education ó Primary or equivalent; four received their vocational training through a Primary Diploma course and one completed secondary school and obtained a diploma for education in the private sector.

The teacher training program evaluation involved the researcher-trainer and the participating teachers. This evaluation was done in two distinct moments (during the teacher training program implementation and at its end) and supported by different assessment techniques and instruments. The documents used for this analysis were, mainly, notes from direct observation of the workshop sessions and participating teachers' answers to a questionnaire. Evaluation issues will be further developed in section 3 of this chapter.

2. Teacher Training Program: Conception and Development

To conceive, plan and develop this teacher training program the recommendations of recognized authors, scientific associations and national and international organizations were analyzed with reference to the role of basic education in the promotion of ESD, as well as the guidelines recommended for teacher training. In addition, educational policy guidelines regarding ESD as applied to intended curricula, primary school programs and textbooks for this level of schooling were also considered.

In addition to the educational policy guidelines, primary school teachers' conceptions about science, citizenship and sustainable development were also identified and analyzed.

The results of this analysis gave rise to the definition of both the orientation of the training program, as well as the content, strategies and resources to focus on.

2.1 Recommendations for ESD implementation

As far as the recommendations put forward by national and international documents for the ESD implementation are concerned, there can be noted a large degree of consensus about the principal guidelines. In short, a problematic approach, within a framework of ESD, should:

- i) promote the approach of the content within a multi, trans and interdisciplinary perspective (Arima, *et al.*, 2004; Morin, 1999; Summers *et al.*, 2005; Scoullos & Malotidi, 2004; Tilbury *et al.*, 2002; Vargas, 2000);
- ii) be based and guided by values of respect, solidarity and cooperation (Arima, *et al.*, 2004; Ospina, 2000; Tilbury *et al.*, 2002);
- iii) be supported by diverse methodologies, favoring active methodologies which are diversified and suitable for the contexts, and topics to be worked on (Arima *et al.*, 2004; Ballantyne *et al.*, 2001; Hopkins & McKeown, 2005; Huckle, 2006);
- iv) be guided by democratic principles and processes (Fonseca, 2000; Imbernón, 2007; Imbernón *et al.*, 2002; Santos, 2005a; Santos, 2005b);
- v) promote scientific and technological problem dimensions understanding (Pedrosa, Gonçalves, Henriques & Mendes, 2003; Pedrosa & Leite, 2004; Vega-Marcote, Freitas, Álvarez, Suárez & Fleuri, 2007);
- vi) encourage questioning and debate (Arima *et al.*, 2004);

vii) make available didactical resources which are relevant and suitable both for the topics to be worked on as well as for the targeted population (Arima *et al.*, 2004; Hesselink *et al.*, 2000).

With regard to teacher training programs, recommendations are: provision and/or creation of didactic resources to accompany topics of relevance; demonstration of strategies that promote the development of decision-making capacities and encourage the formulation of questions; challenge students to be pro-active and participate in decisions which affect them; include the discussion of issues related to social equality, tolerance and discrimination, and provide students with opportunities to reflect on their own daily values and attitudes, as well as the impact they have at both the local and global levels (UNESCO, 2006a, 2006b).

In Portugal, since 2001 there has been a concern for curriculum (re) structuring based on guidelines oriented towards ESD.

The document which lays down the curricular guidelines for primary education ó National Curriculum for Primary Education ó Basic Competences (ME-DEB, 2001) ó details ideas and principles which underlie ESD (Pedrosa & Leite, 2004) recognized in various national and international documents, and which are summarized above. This document, as well as demonstrating that *"an integral part of curriculum is the approach of themes which cut across several disciplinary areas, particularly in the context of education for human rights, environmental education and health education and welfare"* (ME-DEB, 2001: 10), defines the topic "Sustainability on Earth", as one of four organizing themes of science teaching in the three cycles of basic education. This clear growing importance of the theme is reinforced when the document outlines the intention that it is associated with: *" In the third theme ó Sustainability on Earth ó it is intended that students become aware of the importance of taking action with regard to*

the system Earth so as not to cause imbalance, and in this way contributing to a careful management of existing resources".

Total autonomy is also given to the teacher with regard to curriculum management, and teachers from different subject areas are encouraged to do joint lesson plans.

2.2 Primary school teachers' conceptions

Data collection about primary school teachers' conceptions regarding science and technology, citizenship and sustainable development was done by two instruments - a questionnaire and an interview ó designed and validated within the scope of the research that is being presented.

The analysis of the data collected has allowed us to identify the issues that the teacher respondents considered appropriate for working with their students, as well as how to characterize their conceptions. Thus, regarding:

i) Science and technology. Most teachers surveyed, 90%, consider working with students on issues related to science and technology. The aspects most emphasized by teachers in the survey, both in the questionnaire and in the interview, concern the advantages and limitations of science and technology use. The increase in comfort and quality of life offered by the use of knowledge and scientific-technological tools was the most often cited advantage, and the environmental impact of their use was the most emphasized limitation.

However, these same teachers expressed a belief in the possibility of science and technology unlimited use in addressing the major problems of today, which once again, focus on the environment. Its use in the control of environmental contamination and in the search for alternative energy sources were the examples most mentioned. This duality reveals a paradox in science and technology image shared by these teachers:

science and technology are at the same time both the cause and the solution to our most serious current problems.

Teachers in the survey have established a rather vague relationship between science and technology use and the possibility of resolving or minimizing the impact of the main problems we currently face. The sense of responsibility that they attach to science and technology for the serious and widespread impact of economic growth is well known. This assigning of blame leads to a lack of individual and collective responsibility through our contemporary society's consumer choices and their impacts. There appears to be a lack of awareness that the use of scientific and technological artifacts on a massive scale is carried out by human beings and that we make our own decisions on the basis of a benchmark social paradigm, which underlies the framework of values that guides attitudes and choices. This handing over of responsibility, seen in many other studies, is an easy simplification of the role we humans play in our current situation on the planet. By pointing the finger at science and technology, human beings offload all sense of blame, and as a consequence, all responsibility of both the current situation as well as its resolution. In this way, there persists the belief in the possibilities of resolving current problems that science and technology will discover at some stage in the future.

Through the alternatives chosen by the teachers in the questionnaire and the replies given during the interviews it was also possible to perceive the coexistence of naive conceptions about the nature of science and scientific knowledge with conceptions which are closer to the current paradigm. The teachers' group considered Science, at the same time: i) a knowledge in construction; ii) a product of human activity, which influences and is influenced by contexts; iii) an objective knowledge, constructed on the

basis of the application of the scientific method and iv) a knowledge based on evidence and which leads to the truth.

ii) Citizenship. Most teachers surveyed, 98,8%, considered to use lesson strategies that encourage students' participation skills. The most common engagement strategies referred to by these teachers were the selective separation of waste material, the implementation of measures to save water and the holding of class assemblies, identified as an opportunity for dialogue about solving problems (the "problems" most mentioned by these teachers refer to student behaviour issues and need for conflict management). These results coincide with those found by Thomaz (2007), where there could be seen a growing importance given by future primary teacher trainees and their supervisors to teaching strategies and hands-on education for citizenship framed within an experiential approach. The strategies which were more reported by teachers participating in the above-mentioned study (Thomaz, 2007) are consistent with those that we found, and refer mainly to: i) democratic classroom rules; ii) class assembly; iii) shared management and resolution of conflicts through teacher/student and student/student dialogue; iv) daily plan; v) group work; vi) project work and vii) debate. In this study it was also possible to identify among the teachers questioned, through questionnaires and interviews results triangulation, a clear sense of the growing importance of contributing to environmental protection. These data support results emerging in the context of other research: on the one hand, the recognition and valuation of environmental issues, reflecting a fragmented view of reality, which in itself represents an obstacle to the necessary holistic and systemic approach to current issues (Freitas, 2004; Gil-Pérez *et al.*, 2000a; Gil-Pérez *et al.*, 2000b; Gil-Pérez *et al.*, 2003; Gil-Pérez and Vilches, 2005; Gil-Pérez & Vilches, 2006; Martins, 1998; Praia *et al.*, 2001). On the other hand, this overvaluation also reflects a concern that teachers

have in relation to the environment and the damage to which it is liable. This concern towards the environment amongst teachers has also been found in studies carried out by Borges, Duarte & Silva (2007).

However, the majority of teachers in this survey did not make any reference to teaching strategies planned specifically to encourage: i) awareness of students to some of the problems existing locally and/or globally; ii) consideration of the interactions that are established at various levels of the problems identified; iii) reflection on their causes and consequences and iv) discussion and implementation of measures appropriate both to the problem in question and to the development and autonomy levels of the students involved.

We, therefore, conclude that Education for Citizenship is not reflected in a cross curricular way, but is dealt with sporadically and remains on the sidelines of the remaining course contents. On the other hand, the prospect of participation resulting from the discourse of this group of teachers is circumstantial (because it is occasional), locally limited (focuses on school) and is decontextualized.

iii) Sustainable Development. The current problems that teachers surveyed acknowledged as being most serious and related to sustainable development concept have essentially to do with environmental issues. Widespread pollution, water shortages, ozone layer depletion and the greenhouse effect were some of the most common problems referred to by these teachers, both in the questionnaire as well as during the interviews. However, issues such as population growth and distribution and imbalances in consumption were not mentioned by any of them at all.

These results coincide with those of other research mentioned in the literature. For instance, a low percentage of teachers point aspects such as over consumption in developed societies, population explosion in a planet which is limited and finite in terms

of space and resources or human rights (Edwards *et al.*, 2001; Gil-Pérez *et al.*, 2000; Gil-Pérez *et al.*, 2003; Praia *et al.*, 2001). On the other hand, teachers tend to show fragmented and incomplete perspectives of current problems that society faces, in most cases focused almost exclusively on issues of environmental contamination and depletion of natural resources (Edwards *et al.*, 2001; Freitas, 2004; Gil-Pérez *et al.*, 2000; Gil-Pérez *et al.*, 2003; Praia *et al.*, 2001).

After the identification and characterization of educational policy guidelines present in international and national documents which regulate ESD driven pedagogical implementation, and characterization of primary school teachers' conceptions about science and technology, citizenship and sustainable development, we come to the development of the training program itself. This presentation will be carried out on the basis of defined stages, selected strategies and resources which have been designed and put into practice.

2.3 Teacher training program stages, strategies and resources

The teacher training program took the form of a workshop and was held over three distinct periods or stages: i) the first Stage was, essentially, one of raising teachers' awareness about the need and importance of ESD; ii) the second Stage offered a context which was oriented towards the (re)construction of ESD knowledge, and iii) the third Stage was for participating teachers to implement ESD resources and methodologies with their students. The first two stages involved only the researcher-trainer and the teachers surveyed. In the 3rd Stage these teachers implemented with their primary school students, participated in an activity related to ESD.

The following table sets out the didactic procedures and strategies adopted in the different stages of the teacher training program.

Table 2 ó Procedures and learning strategies adopted in different stages of the teacher training program

In accordance with the considered guidelines, and following the nature of the training program, a methodological pluralism with regard to learning strategies was implemented. In all the workshop sessions, strategies such as debate, discussion, individual and group reflection and group work were used when carrying out the activities. The choice of these strategies was based on the principle of giving participants the opportunity for conceptual (re)construction based on previous experiences and knowledge.

Analysis, reflections and discussions were carried out by the working groups with a basis on theoretical texts (e.g. Gil-Pérez & Vilches, 2006) and teaching resources designed and produced for this program (e.g. Courseware SeRe. This digital didactical resource was developed by a multidisciplinary team, integrating several software typologies within the educational activities. This courseware allows teachers to work energy related issues with their students.).

Another strategy used was the systematic exposure of facts and arguments about a few topics included in the program (in particular the concept of sustainable development and its implications; the current situation on our planet; the ozone layer; the greenhouse effect and ESD), as well as the relationship established between them. This strategy choice is justified by the novelty of the focus of this program and also by the complexity of a holistic adoption perspective by these teachers in relation to the program and to its use. Participants felt the need to include in the program opportunities to share information in a structured and systematic way. These occasions have enabled

the exchange of views between the group of teacher trainees, as well as between them and the researcher-trainer; the acceptance or rejection of what was being discussed; the arguments to defend points of view, and the questioning, and fundamental procedures leading to understanding and acquiring information.

The use of Information and Communication Technologies (ICT) was another strategy used. New technologies have been used not only for courseware SeRe development, but also in the search, selection and organization of information in the activities involving research (for example, regarding the ozone layer depletion).

Demonstrations were also used throughout the program, especially in Stage 3, when teachers implemented the program activities with their students. It was intended to demonstrate how resources could be used with primary students, clarifying what teachers can do and for what purpose(s). We believe that using modelling and exploiting didactical resources in some training situations was not limiting for teachers. It is important that teachers can see how to make use of didactical resources that were not conceived by them, and which use call for a change in their teaching practices. *"In the training program curricular materials play a central role; they are extensively used for the purposes of demonstration and practice. These materials act as a means of support for teachers to view the change that is desired, and not as something that will limit or control them"* (Berg, 1997: 4).

Another training strategy used was the provision of books, journals, articles and websites related to ESD and to the topics arising from each of the workshop sessions. It was felt that in this way it would facilitate teachers' access to sources of information while respecting individual interests and training requirements.

Didactical resources development enables a dialogue between theory and the innovative practices that are aimed at (Praia & Cachapuz, 1999). It is essential to include the

design, production and exploitation of didactical resources during the teacher training process if a change in teaching habits is the goal. This is supported by Martins (2000), who considers that teacher training programs "... *should include pathways of exploration into the design, development and evaluation of didactic resources and teaching strategies, ...*" (p. 107). Also Ellis (1995 in Vieira, 2003) believes that teachers should have the opportunity to explore new materials and teaching strategies. However, he emphasizes the need for individual monitoring in the classroom.

In this study the didactical resources were designed and developed by the researcher-trainer, whose primary aim was a contextualized, appropriate and creative approach of the issues defined for the teacher training program. Flexibility of use with regard to the context and the exploitation, were also factors taken into account in the design phase.

The design of these resources, as well as their use, were founded on a holistic and dynamic perspective of the sustainable development concept, whereby this is understood as a process of change driven by a set of values and/or principles in which the interdependence between human and non human nature aspects is recognized.

As each didactical resource was developed for a specific theme of the teacher training program, they will be presented with direct reference to the corresponding session. The following table identifies the didactical resources used:

Table 3 6 Identification of the didactical resource according to session topic

2.4- Teacher training program organization

The teacher training program in question was based on teacher training guidelines, on reflection purposes definition for each workshop session and on didactical resources exploitation as a starting point for the work to be done with the teachers. For each

session, activities were defined, training strategies were selected, resources were developed, and support documents for each topic were selected and/or created. All these decisions were based on the analysis of teaching practice guideline documents and on the identification of the conceptions and needs of the participating teachers mentioned above.

Each session followed a similar structure: first the topic to be worked on was put into context, and then the activity which has been planned and prepared by the researcher trainer was put into practice, and finally, there was a synthesis/reflection stage which takes place in a large group and is mediated by the researcher-trainer.

In fact, to promote participation, the contextualization provided the opportunity to raise teachers' conceptions about the ongoing topic, as well as an opening for working sessions in an environment of sharing, dialogue, openness and trust. After the contextualization of each topic an activity was proposed aimed at stimulating the involvement of every teacher, whether it was through personal involvement (individual work) or through interpersonal relations necessary for the development of a working group (in a small or a large group).

Activities were organized based on the didactical resources designed for each session and/or the analysis of available documents. This should be done individually or in a small group at an early stage of the session, and then, later, in a large group they should discuss not only the procedures adopted by each one, but also the conclusions reached. All sessions ended with a time of synthesis/reflection involving the whole group and were moderated by the researcher-trainer. The primary objectives of this moment of reflection were: to emphasize the meanings of those ideas that had come from the sessions; to reflect on the conceptions manifested by teachers before and after the activity conclusion; to establish relationships between the subject worked on during the

session in question and those covered in previous sessions; to discuss the suitability of the themes and teaching resources used amongst primary students and discuss alternative ways of using these resources.

The teacher training program was devised in such a way as to bring out the permanent interactions between human beings and the planet by choosing consumption as the interface/mediator of this interaction. Our aim was to highlight the impact of growth and unequal distribution of the human species on a planet which is limited and finite in terms of space and resources, using consumption and its impact as evidence of the growing pressure to which human beings are subjecting our planet.

To initiate the teacher training program with a session dedicated to the characterization of the current planetary situation allowed, in addition, to make teachers aware of the severity of the situation, for them to think about cause-effect relations of the problems identified and the general nature of their impact. In addition, the analysis of documents, discussion and organization of information gave a suitable context to the teacher training program and in this way emphasized the dimensions of the problems being dealt with and the extreme situation that we face.

In previous sessions we had identified the human population explosion as one of the most serious problems we face today, due to the ensuing environmental, social and economic impacts; thus the theme of population growth and inequalities in the distribution of the population and in the levels of consumption became essential for a reflection on the "quality of life" and the possibilities for "development". The change in our levels and patterns of consumption as well as the guarantee of the respect for human rights thus emerged as inseparable from the promotion of more sustainable ways for the future.

To understand the relationship between human beings and the planet, consumption plays a very important role, both in respect of the need to exploit the planet's natural resources, as well as the consequent impact such as poisonous gas emissions, contamination and desertification of land or the natural resources depletion. The discussion of the ecological footprint concept showed that each living being needs a minimum amount of natural, productive soil and water in order to live. The survival of human beings depends on the existence of food, a energy source, the capacity of various waste products to be absorbed, as well as availability of raw materials for the production processes. The didactic use of the ecological footprint concept led to reflections about imbalances in the possibilities of consumption, addressing the relationship between the various categories of consumption and the fertile soil available, different lifestyles and their environmental impact.

The products life cycle analysis facilitated the understanding of the environmental, social and economic impacts that products we consume have, starting with the exploitation of necessary raw materials and ending with waste disposal. Polluting gas emissions during the various stages of the product life cycle provided the necessary context for the sessions dealing with the ozone layer depletion, global warming and acid rain. The relationship between human activity and the consequences raised awareness of our individual responsibility in the present situation. Education thus emerged as an essential tool for more conscious and responsible actions towards promoting more sustainable ways for the future.

2.5 Teacher training program activities

The organization of this program was based on a set of activities using didactical resources designed and produced for this purpose. Although didactical resources have

been designed to be used at the primary school, it was considered important to offer the participating teachers the same pathway of reflection that they would eventually give to their students. For this reason resources, strategies, discussions and exercises used in the training program were the same ones that the teachers were expected to use later with their students in the classroom context.

The following table lists the activities carried out in each workshop session, as well as the resources used (in the case of sessions focusing on the use of a resource produced for this purpose) and the expected work sequence.

Table 4 ó Activities suggested for each training sessions

3. Teacher Training Program: Implementation and Evaluation

3.1 Teacher training program implementation

Work sessions were held at two different times, defined by the stages of the teacher training program and availability of those involved: the 1st stage took place during the school year 2005/2006, between the months of February and July and the second Stage took place in the next school year, between October 2006 and May 2007.

Sessions had an average duration of 90 minutes each (from a little over an hour to more than two hours). For issues that needed more time, two more working sessions were used. Sessions devoted to the greenhouse effect and the ozone layer depletion amounted to a total of six hours, twice what had been initially assigned for each session.

During Stage 3 preparation meetings were held between the participating teachers who chose the same activity and the researcher-trainer. Thus, four preparation meetings were held, the same number as the activities chosen, to review teachers' doubts concerning using the resource exploitation and/or topic in question.

Some of the work sessions took more time than anticipated and one of the sessions contained in the initial schedule did not take place. This is justified by the difficulties that arose during the teacher training program implementation and the consequent restructuring, which were part of the ongoing discussions between the researcher-trainer and involved teachers.

3.2. Teacher training program evaluation

It is important to point out that the data, interpretations and inferences presented in this section are a result of content analysis and triangulation between the data collected during the direct observation of the work sessions (in the case of the assessment carried out by the researcher-trainer), data collected through administration of questionnaires at the end of the second Stage of the teacher training program (in the evaluation of the program done by participating teachers) and the data from the instrument for analysis and characterization of the teaching practices of these participants, designed and validated as part of this research. For this analysis, the objectives set for each one of the training program's set topic sessions and the aims on which the program is based were also considered as a reference.

To this end, the teacher training program evaluation was carried out in two distinct moments, at different levels and using various assessment techniques and instruments, which are normal in the qualitative research context. The aim of this procedure was to ensure the validity and accuracy of the assessment of the training program.

Regarding these moments, the assessment was done throughout the implementation of the program (continuous evaluation) and at the end (final evaluation). The process of continuous evaluation in which all those involved in the training program participated allowed:

1 ó Altering the sequence of work sessions after analysis and discussion of the training plan with the trainee teachers;

2 ó Matching the time allocated to each of the themes included in the program to the real needs of the teachers' group. Initially it was planned that the time devoted to the topics ozone layer and greenhouse effect would have the duration of one session (approximately 90 minutes). However, awareness on the part of participating teachers and researcher-trainer that the group needed more time on the content involved in these issues led to a readjustment of the established plan and so each one of these topics was attributed twice the time originally allocated. Thus, there were four sessions dedicated to the topics ozone layer and greenhouse effect, which took up approximately 360 minutes of classroom attendance;

3 ó Adjusting the use of topics which had been worked on with teachers to the needs of primary school students. This cross-matching was done in two phases: i) during the thematic sessions, where the methodologies adopted by the researcher-trainer and teaching resources designed and used were discussed with the teachers' group. These discussions were based on the suitability of the topics, teaching resources and methodologies for those participating in this program: primary school teachers and students and ii) at classrooms interventions preparation meetings;

4 ó Adjusting, in each session, content and methodologies according to the needs and difficulties experienced by the teachers.

To carry out this evaluation we used multiple techniques and instruments: participative observation by the researcher-trainer; a record of interpretations/reflections, carried out by the researcher-trainer on the basis of observation; the opinions voiced by the participating teacher in relation to the educational and didactical strategies which had been developed and the topics underlying the program; the video recording of the

sessions and later transcription; the teachers' answers to the questionnaire as well as individual and collective teachers monitoring.

In the two moments of evaluation mentioned above different levels were taken into account: the researcher-trainer evaluation, concerning the program impact on the participating teachers and the evaluation of these teachers with regard to the relevance and suitability of the training program.

3.2.1 Evaluation by the researcher-trainer

The training program implementation always included the identification of conceptions, ideas and opinions of participating teachers in respect of various issues that would be addressed throughout the program. To this effect:

1 - Regarding the current situation on the planet, teachers identified the greenhouse effect, global warming, the ozone layer depletion and widespread pollution as the main problems. Even though some referred to hunger and war as serious problems, the main emphasis was placed on our current environmental issues.

Population growth, current consumption levels and patterns and imbalances in the population were not recognized by these teachers as serious problems.

The image of our current world situation emerging in this study is fragmented and characterized by a lack of awareness of its true severity which hinders both the construction of a holistic and systemic vision of the planet and its systems as well as the recognition of the urgency for action. These difficulties were also reported in several studies previously conducted by other authors on teachers' conceptions about the current situation on our planet (Edwards *et al.*, 2001; Gil-Pérez *et al.*, 2000; Gil-Pérez *et al.*, 2003; Praia *et al.*, 2001), all of which emphasize the need for implementation of training

courses for teachers to encourage reflection on the current situation on Earth, the responsibility of human beings in this situation and our role in finding a solution.

2 - The teachers who participated in this teacher training program showed vague ideas about sustainable development. Advanced definitions are based on key ideas such as "balance" and "maintenance" to define the relationship between consumption and the use of natural resources. In other words, the need for environmental protection and management of natural resources was acknowledged, but always with reference to the possibility of maintaining levels and patterns of consumption which are close to them. Thus, the idea of sustainable development shared by this group was based on a conception of nature as a resource; they took into account only the consumption levels and patterns close to their own reality, which are not widespread or generally applicable to world human population, and so this conception is limited in time and space because it is based on personal, present day and local interests.

These teachers also showed a strong belief in the future and the possibility of future generations solving the problems we currently face through the use of knowledge and scientific-technological artifacts that they will have at their disposal.

This imprecise idea of the concept of sustainable development and the over-stressing of the environmental domain corroborates the results achieved by Freitas (2004) in a study conducted in the context of initial teacher training, about future teachers' conceptions of sustainable development.

3 ó Regarding world human population participating teachers showed a lack of knowledge about its absolute value and current distribution on the planet. Although they identified China and India as the most populated regions on the planet, these teachers did not show any awareness of the real percentage that these countries represent in terms of the world's population. They were also unaware how the rest of the world's

population was distributed, with the continents of Africa and Oceania generating the greatest controversy. The African continent, by having more population in absolute terms than expected, and Oceania due to its relatively small number.

With respect to the ratio between the current human population distribution and the possibility of access to basic goods, teachers were able to confirm some of their ideas and compare others with the real figures: a) although the group considered North America as the planet richest region, compared to the others, this region was in fact richer than their initial expectations; b) Europe's population, compared to North America, has fewer resources available than the group imagined; c) Latin America proved to be poorer than initial expectations and d) in Oceania there was more money than they first thought, but less water and less food.

4 ó Products life cycle analysis allowed us to conclude that these teachers did not consider the environmental, economic and social impacts related to each stage, from products production to disposal.

The members of the group only recognized the environmental impact of products after the moment of purchase, and even this impact was limited to the packaging of products. All the raw materials necessary for the products we need and the impact associated with their extraction; the place of origin of the products and greenhouse gas emissions, the working conditions of all those involved in the production chain, the raw materials necessary until final waste disposal, or the impact of individual choices in the economy (local and global) were aspects that these teachers did not consider in their consumption choices.

It is essential to promote reflection on the social and environmental impacts of each stage in the life cycle of the products we eat so that the act of consuming becomes an ally in the promotion of more sustainable ways of development.

5 ó The concept of ecological footprint was unknown to all members of this teachers' group. The relationship between consumption and the need for fertile soil to sustain it was not a concern for this group. Consumption impacts were interpreted, above all, at the economic and environmental level, and even these only after the product is purchased.

There was, among the participating teachers, an awareness of the relationship between consumption and utilization of fertile soil, on the one hand, and between the impact of imbalances in consumption levels and the access to land use, on the other. It wasn't until the end of the session that there was some reflection on the fertile space currently existing on the planet and its *per capita* availability, and the consumption of a few, which is sustained by a disproportionate use of available soil and water. Only after this activity exploitation and debate was it possible for these teachers to establish the relationship between consumption (products and services) and the use of fertile soil and drinking water, the imbalances in both consumption and in soil use, and between over-consumption and increased emissions of greenhouse gases.

3.2.2 Evaluation by the participating teachers

Participating teachers considered that the methodology adopted by the researcher-trainer was "very good", and was one of the most valued aspects throughout the program implementation. Other aspects emphasized by the group were: the importance of starting the sessions with their own ideas, the availability of a variety of resources; the diversity of the methodologies adopted, and the constant encouragement for participation in different moments of the sessions.

The didactical resources were identified as an asset and the thematic worked on were considered "very relevant".

All participating teachers considered that the frequency of the program contributed towards increasing the knowledge of the topics that had been studied in the course content. The sessions focusing on the distribution of world human population and the ecological footprint were identified by the group as excellent opportunities for awareness rising. The issues most valued by the group of teachers were the greenhouse effect and ozone layer depletion.

The most negative aspect referred to by these teachers was the lack of time to work on the themes at more depth level. This may be considered an indicator of the growing awareness and motivation of participating teachers about the importance of education in this area.

Conclusion

The orientation towards ESD in lifelong learning implies that this should be (re)evaluated in terms of a new direction for teaching. The future involves a new educational culture, which goes beyond the bounds of the educational framework and promotes involvement in the community. This is the essence of ESD orientation. To educate in order to promote more sustainable ways of development is to educate for action on a planet which is clearly in crisis and characterized by uncertainty.

Teachers have a very important role in citizensø education for action in a world of complexity and unpredictability. To this end, we believe it is crucial that education with an ESD orientation includes three essential aspects: education about sustainable development; education in sustainable development and education for sustainable development.

For these three variants, training will have to become a special time for reflection, not only about working on the contents and the type of interrelations between them but, essentially, on how to put ESD approaches into practice.

1 - Education about sustainable development. Although we have taken ESD as an organizing principle of the curriculum and teaching practice, we consider it essential that teachers' education include the identification and consideration of their conceptions about the planet current situation and sustainable development concept. It is essential to introduce the idea of the complexity of the planet and its systems (interaction, unpredictability), otherwise fragmented conceptions about the real situation and about one's own knowledge might be reinforced. Based on the results achieved in this study we consider that all the contents worked throughout the teacher training program are fundamental; however, due to their organizing nature we would like to stress two:

i) Teachers' conceptions about the current planet situation. At the beginning of the 21st century it is completely unacceptable to have teachers with scant, naive and fragmented notions about our current situation. This perception of the state of the world, which Gil-Pérez and Vilches (2006) classify as spontaneous, is a barrier to their own understanding of the actual scale of the situation and, consequently, to the promotion of learning situations that might offer this awareness to others. One cannot share with others an awareness of aspects which he or she is not aware of. It is necessary that teachers understand current issues from a systemic and holistic perspective so that they can consciously think about their actions both as a teachers and citizens but, above all, as agents of change.

ii) The sustainable development concept and the controversy that this implies. To face up to the controversy surrounding the sustainable development concept and discuss

its meanings and implications for education seems to us an essential dimension when the aim is to instill ESD sensitivity in teacher trainees. We agree with Freitas (2006) who highlights the importance of maximizing the polysemous and ambiguous character of the concept for teaching purposes. It should be the training institutions (at all levels, albeit with varying degrees of appropriate depth of analysis) to create the conditions necessary to ensure that proper discussion and reflection is encouraged about the concept(s) of sustainable development, its strengths and limitations. We believe that, as far as the in-service teacher training is concerned, it is important to analyze the genesis and evolution of this concept, as well as identify the main dimensions, how these interact and the generalization of the impacts of these interactions. This exercise is important not only to encourage a holistic and systemic understanding of the world ó it is not possible to understand the sustainable development concept in all its dimensions by fragmenting the world and knowledge ó but also to develop strong convictions among the teachers involved, thus permitting the (re) orientation of behaviours and attitudes towards more sustainable means of development.

2 - Education in sustainable development. The right conditions will have to be created so that educational practice towards EDS can be experienced, discussed and reflected on by teachers during their education. In this context of practice as knowledge production, it makes sense to refer training as a way of sharing among equal partners, of joint construction between teachers and educational institutions, of collaboration for the resolution of problems, and of monitoring during the transformational phase of teaching practice. An ESD approach involves: looking carefully at documents that underlie educational practices in order to find ways to articulate ESD principles with the content of these documents; looking at textbooks, their contents and their guidelines; working carefully with materials from diverse areas of knowledge as this is a transversal

dimension to multiple areas of our daily lives; starting from problematic contexts that allow to make explicit the relationships between different dimensions of the problem under consideration (e.g. environmental, social, economic, ethical, í); resorting to methodological diversity in dealing with contents to be worked on; developing, validating, implementing and evaluating didactical resources during training; involving the immediate community in the training and in future action; rethinking the profile of trainers in training institutions. Trainers should accompany teachers at all stages of training, encouraging them to reflect on their practices in the sense of re-evaluating their practices.

3 ó Education for sustainable development. ESD is the ultimate goal of the dimensions mentioned above. Together, the various dimensions of ESD aim to promote the exercise of good citizenship which is geared towards the transformation of social-economic-environmental realities and their processes so that they become more sustainable.

ESD is related to citizens' attitudes and behaviors, as the promotion of competences is the best way of ensuring the future dimension that comes with the concept of sustainability. Individual decisions must be made in an informed way, namely: with knowledge about the environmental, social and economic implications; based on values such as solidarity, equity, justice as well as both inter and intra generational cooperation; promoting cultural and biological diversity and with respect for our planet production capacity.

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| Phase I | Phase II | Phase III | Phase IV |
|---|---|---|--|
| <p>Theoretical framework establishment</p> <p style="text-align: center;">↓</p> <p>Content analysis</p> | <p>Identification of primary teachers' conceptions concerning science and technology, citizenship and sustainable development</p> <p style="text-align: center;">↙ ↘</p> <p>Inquiry Content analysis</p> | <p>Teacher training program: conception and development</p> <ul style="list-style-type: none"> - Themes definition; - Didactical resources development and validation; - Strategies and activities selection | <p>Teacher training program: implementation and evaluation</p> <ul style="list-style-type: none"> - Researcher-trainer evaluation; - Participating teachers' evaluation. |

Table 1 ó Research phases

| | Stage 1 | Stage 2 | Stage 3 |
|----------------------------|--|--|--|
| Procedures | <ul style="list-style-type: none"> - Raising teachers' awareness of the importance of ESD. | <ul style="list-style-type: none"> - Teacher Training Program Implementation; - Analysis and reflection about consensual aspects related to pedagogical and methodological sessions of the Teacher Training Program. | <ul style="list-style-type: none"> - Knowledge transposition and mobilization for teaching practice. |
| Learning Strategies | <ul style="list-style-type: none"> - Reflection on the relevance of an ESD oriented teacher training program; - Discussion and reflection about the themes relevance - Analysis and discussion of issues to be included in the Training Program; - Reflection on the adequacy and relevance of the themes chosen for primary school. | <ul style="list-style-type: none"> - Debate activities; - Activities based on using teaching resources; - Documents analysis and discussion; - Clarification Sessions; - Group work. | <ul style="list-style-type: none"> - Debate activities; - Activities based on using teaching resources; - Documents Analysis and discussion; - Potential multiple resources exploitation demonstration; - Group work. |

Table 2 ó Procedures and learning strategies adopted in different stages of the teacher training program

| Theme/topic for the session | Didactical resource produced |
|-----------------------------------|-------------------------------------|
| Sustainable Development | The Bean Game |
| World Human Population | Us and the Planet |
| Human Rights | Human Rights Cards |
| Ecological Footprint | What is the size of your footprint? |
| Life Cycles Analysis | Let's have a picnic? |
| Human Impact on Natural Resources | Courseware SeRe |
| Ozone Layer Depletion | Ozone Layer Kit |

Table 3 ó Identification of the didactical resource according to the session topic

| Activities proposed for each training session |
|--|
| <p>1st Session: characterization of the current situation on the planet</p> <ul style="list-style-type: none"> a) Thematic contextualization; b) Survey of teachers' conceptions about the current major problems; c) Discussion about the main problems identified and the interactions between each other; d) Discussion of ideas emerging from the previous discussion; e) Reading and analysis of documents relating to the characterization of the current situation on the planet; f) Reflection in group and synthesis of results. |
| <p>2nd Session: The Concept of Sustainable Development</p> <ul style="list-style-type: none"> a) Exploitation, in small groups, of the educational resource "The bean game"; b) Reflection in extended group, about the meaning of the various stages of resource exploitation and the results that each group produced; c) Presentation, reading and discussion of documents relating to the concept of SD and the context in which it arises; d) Summary of the analysis of those documents and conclusions resulting from the activity; e) Critical analysis of the didactical resource used. |
| <p>3rd Session: The Growth of World Population</p> <ul style="list-style-type: none"> a) Contextualization of the activity to be carried out, relating it to the previous one; b) Exploitation of the didactical resource "Us and the Planet"; c) Discussion of teachers' ideas concerning the distribution of world population in conjunction with the |

actual current distribution;

- d) Analysis and reflection on the imbalances in the distribution of the population and the possibility of access to basic essentials;
- e) Discussion, in extended group, about the global impact of imbalances in exploitation;
- f) Synthesis of the results of exploitation and whole group discussion;
- g) Critical analysis of teaching resource used.

4th Session: Human Rights

- a) Contextualization of the activity to be carried out based on the previous activity;
- b) Exploitation of the didactical resource "Human Rights Cardsö;
- c) Discussion about the various generations of Human Rights and the impact of the lack of access;
- d) Reading, analysis and discussion of documents concerning human rights;
- e) Reflection on possible relationships between human rights and more sustainable ways in the future;
- f) Critical analysis of the teaching resource used

5th Session: Ecological footprint

- a) Contextualization of the activity to be undertaken, establishing relationships between levels and patterns of consumption, imbalances, and fertile soil and drinking water;
- b) Exploitation of the didactical resource "What is the size of your footprint?";
- c) Analysis and whole group discussion of what it means to use this resource;
- d) Reflection on the relationship between imbalances in access to consumption, fertile soil and drinking water needed to maintain current levels and patterns of consumption and fertile soil available;
- e) Analysis and discussion of documents relating to the ecological footprint;
- f) Critical analysis of teaching resource used.

6th Session: Life Cycle Analysis

- a) Contextualization of product life cycles;
- b) Using the activity "from raw material to waste";
- c) Analysis and reflection on the inputs and outputs of the life cycles of products;
- d) Discussion of the relationship between life cycles, imbalances, levels and patterns of consumption and human rights;
- e) Summary of the analysis and reflection carried out;
- f) Critical analysis of the teaching resource used.

7th Session: Ozone Layer

- a) Contextualization of the activity by means of the relationship between some outputs of life cycles under analysis and their environmental impact;

| |
|--|
| <ul style="list-style-type: none"> b) Survey of teachers' conceptions about the depletion of the ozone layer and its impact (use of cartoons); c) Preparation and carrying out of experiments in small groups (using a planning chart); d) Analysis, comparison and discussion of results obtained by each group; e) Synthesis of the key features of this session. |
| <p>8th Session: Greenhouse Effect</p> <ul style="list-style-type: none"> a) Identification of teachers' conceptions about the greenhouse effect; b) Reading, analysis and discussion of various documents about the greenhouse effect; c) Reflection and synthesis of the main aspects of the session. |
| <p>9th Session: Acid Rain</p> <ul style="list-style-type: none"> a) Identification of teachers' conceptions about acid rain; b) Reading, analysis and discussion of various documents about acid rain; c) Reflection and synthesis of the main aspects of the session. |
| <p>10th Session: Human Impact on Natural Resources</p> <ul style="list-style-type: none"> a) Courseware SeRe exploitation; b) Reflection about the results and conclusions emerging at each stage of using this courseware; c) Critical analysis of the resource used. |
| <p>11th Session: Education for Sustainable Development</p> <ul style="list-style-type: none"> a) Discussion about the importance of education in promoting more sustainable ways in the future; b) Analysis and discussion of the implications of the sessions of the training program in teaching practice; c) Reading, discussion and analysis of documents relating to education for sustainable development. |

Table 4 ó Activities suggested for each training session