Project “Early Technical Education”: an opportunity to implement practices of curriculum innovation

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Abstract:
The European project “Early Technical Education” seeks to promote technical education for children, encouraging them in the understanding of scientific-technological phenomena.

To this end, it was endeavoured to develop children-targeted pedagogical material to be applied in the initial and continuous training of Pré-primary and Primary Education teachers and duly based on teaching-learning methodological approaches that comprise the fields of Education and Technology. As a result, a digital manual was prepared with didactic resources on-line (http://www.earlytechnicaleducation.org).

In this article, besides introducing the Project and the site, we also refer to case studies which have taken place in Portugal, namely the evaluation of some of the options indicated in the manual.

Keywords:
Teaching-learning methodologies, Science and Technology, Early Technical Education, Innovation.

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INTRODUCTION

The project "Early Technical Education"[1] (ETE) was inscribed in Sócrates-Comenius 2 and resulted from application by six institutions of different nature from four countries of the European Union[2], allowing producers of knowledge and producers of pedagogic material to be placed at the service of research, in the terms of "innovation/production of pedagogic materials".

In this way, the ETE project (See Veiga Simão, Cabrito & Rodrigues, 2003a) facilitated the sharing of knowledge and experiences of institutions of diverse vocations, from the training of pre-school and primary school teachers to the development of educational technologies, through to curriculum improvement, evaluation in education, and the creation of materials and artefacts destined for use in pedagogical practice.

This application was justified by the need felt by many to contribute towards the development of youths' scientific and technological thought and it was based on three fundamental assumptions:

a) without undervaluing other areas of knowledge, experimental and technological sciences are indispensable to the development of society and knowledge;

b) in the European community, there is an ever increasing search for knowledge in the social science and humanitarian areas to the cost of the scientific and technological fields;

c) the predilection for science and technology and the development of scientific thought starts in early childhood.

Cumulatively, the project is further based on the alleged gender-driven different inclinations of children for scientific and technological activities. In fact, boys are usually attributed with a greater feeling and capability in these fields than girls. Being a somewhat marginal question in the case of Portugal (and also Spain), in view of the growing process of feminization of teaching in all scientific areas, it continues, however, to be a concern in some European countries, especially in central Europe, where there is still a low participation of girls in the scientific, technical and technological fields.

In this way, the evolution of the project unfolded without any gender discrimination yet with the aim to develop experiences, activities and pedagogic materials in the scientific-technological field which would be liable to be appreciated by all children, so as to promote the liking for science and technology from an early age and awareness of the need to assume a strong and critic position when faced with the different phenomena.

In the context of assumptions and aims already evoked, this project's target populations were children of both sexes, between the ages of 3 and 10 years old, as well as the professionals working with them (Pre-school and Primary School teachers). The aim was to provide them with suggestions and reflections contributing towards the development of Early Technical Education.

After reaching an agreement on the basic assumptions of the project, namely the pedagogic, didactic and psychological concepts that would guide the research, the "division" of tasks and responsibilities was carried out together with the planning and design of the didactic and pedagogic approach to be followed, the artefacts to be produced and results to be accomplished. The creation of a collaborative platform where provisional products could be posted, jointly with the analyses/criticisms and suggestions of each partner, allowed for project monitoring founded on daily cooperation and preparation of work sessions of the various teams.

In tune with the theoretical framework, Early Technical Education (ETE) was defined consensually in the following way: "(…) sensitises children to scientific and technical phenomena. It creates opportunities to develop and support children's interests in, and their understanding of the basic principles of science and technology, by promoting experiences and furthering abilities. It is designed for the age range from 3 to 10 and for both sexes, and takes place in the context of the social, cultural and emotional world of children. It takes account of a variety of teaching concepts, processes, materials and methods" (http://www.earlytechnicaleducation.org).

Within the scope of this cooperative effort, the end product was an on-line manual for/about the teaching of science and technology to children of the above mentioned age range, which can be used by any teacher and which can serve as a tool for the training of teachers in this scientific field.

Next, we will present the theoretic assumptions of the project, the manual that was built and we will also provide a description of the case studies carried out in Portugal with the aim of evaluating some of the proposed didactic activities.

THEORETIC ASSUMPTIONS OF THE PROJECT "EARLY TECHNICAL EDUCATION"[3]

To satisfy the conditions of a development-based education, technical education should encourage: *self-confidence* so that the child eventually feels that s/he is mastering the technique, where activities are carried out according to the rhythm and level of the age group and where work with the technique leads to experiences of success; *self-control* so that diverse activities directed by different styles of learning and with different interests, can be carried out with pleasure and in safety; *curiosity*, designing tasks which are close to childhood experiences – stimulating, exciting and provocative.

The ETE project assumes that education should be orientated towards development, starting with ludic activities subtly transformed into (meaningful) learning activities. This type of education acts on three levels: basic characteristics (emotional freedom, curiosity, self-confidence, etc.), global development (being active, taking the initiative, communication and language, self-expression, understanding of symbols, etc.) specific skills and knowledge (motor skills, conceptualization, use of tools and techniques, etc.).

The challenge for ETE is to look creatively at technology and scientific and technical education and so as to adapt them to a global concept of general objectives for the development of the child. The starting point is the child's natural curiosity about the world, so that it is absolutely imperative to take questions seriously (How? Why? What? Who?). On taking advantage of the inborn creativity of this age-group regarding scientific or technical phenomena, these questions should form the basis for learning according to the principle of "learn by doing".

In effect, as Pucket and Black (2000) remind us, younger children have an innate need to know and are, therefore, conscientious learners. Avid for knowledge, they themselves initiate and develop their own learning processes in a secure and stimulating environment, they build knowledge in interaction with adults, with their peers, with meaningful situations and materials, thus developing physically, emotionally, socially and intellectually, at different times.

Keeping these assumptions in mind, the technical and scientific experiences of the project were designed to satisfy the child's curiosity, to encourage his/her attempts to make sense of the world, to develop his/her ability to plan and act autonomously and to be responsible for his own learning process. As for the learning environment, it is felt that it should provide the child with space and opportunities, investing in experimentation and challenging him/her to find answers to his/her questions.

But, to meet the challenge of integrating Technical Education into the school curriculum, it is important that a pre-school or a primary school teacher accepts the assumptions that : a) teaching is centred on a child's learning and not on the curriculum or on competences; b) teaching recognises and reacts to the ever- increasing knowledge in the various curriculum subjects; c) teaching takes place in individualized situations (learning) and in small groups; d) teaching accepts different cultures and unique learning methods; e) attention must be paid to gender concerns in the learning process.

From this point of view, educators have to develop skills in seven fields (Vreugdenhil, 2003): pedagogic; scientific in the subject(s); interpersonal relationships; organizational; cooperation with peers and cooperation with their environment and, finally, reflection on their own professional development. These competences, together with new developments in psychology of learning, are indisputably relevant to the field of ETE. To this end, teachers should have: self-control, autonomy, curiosity, a positive attitude towards new developments, self-confidence, scientific technical skills in the field of ETE and openness to the questions and needs of children and peers (nationally and internationally).

When describing teacher's tasks, Vreugdenhil (idem) states that the teacher should: stimulate and develop motivation and performance in the child's learning; motivate the pupil to further his/her development; plan teaching by externally defined objectives, development-based, through games, and learning-centred through task fulfilment; plan means adapted to each child and to the differences among them; understand the essential elements of the subject and relate them to the experiential and emotional world of the child, and finalise and adapt educational resources to the child's needs and learning styles, according to the aims of teaching.

In the face of this very wide range of duties, it seems natural to us that obstacles to the development of a fitting attitude will arise regarding the implementation of ETE, as was shown during the project and which we will proceed to enumerate.

a) cultural barrier: methods of teaching having roots in the national culture which are very difficult to change. Sometimes it is necessary to wait for a more propitious opportunity. With this project, we believe that we now have this opportunity and that the involvement of the teachers (with all due back-up) in this and other projects where innovations can be tried out, can lead to change;

b) general attitude of people: a culturally determined attitude of what is right for boys and what is right for girls and what they themselves think about this;

c) underlying pedagogic theories: about the way children develop and at what age they can start being stimulated to reach new developments. For this purpose, it is important to know about the "zone of proximal development" (Vygotsky, 1991);

d) knowledge (or lack of): apart from knowledge, teachers also feel the lack of experience. As teachers are active people, they learn by experimenting or observing colleagues working with children. This strategy is motivating and can be a very efficient professional training process. However, the need for the acquisition of theoretic knowledge can never be emphasized enough:

e) lack of new input: we believe that, after initiating a project in the field of technology, teachers need backup and new ideas and, clearly, also an exchange of experiences. This sharing of ideas is very important and it is essential to be in contact with good practices;

f) absence of a period dedicated to ETE in the curriculum: we think that ETE can and should be included in other activities/subjects/projects so that the globalising perspective characteristic of nursery and primary education is not lost. It is essential to organize the curriculum in a global and integrated way, and not fall into a subject-based logic.

To remove these obstacles, ETE needs to be introduced not only in the training curriculum of the professionals, but also in their daily practice. It is in this sense that we will summarise some guidelines in a prospective view of the project: a) the self-confidence and the willingness of a teacher dealing with technology increases the possibilities of practical experience; b) it is fundamental to stimulate the child's development; c) we have to find basic conditions to encourage curiosity, self-confidence and self-control; d) we have to promote flexibility, that is, take into account the uniqueness of each child; e) technical education can be better carried out if it is related to other subjects so that it makes more sense to the child; f) technical education must have a clear place in the learning process, be revolutionary and open up to the creativity of pupils and teachers.

Thus, we feel that being involved in short-term projects is not enough to change the attitude of educators and children and make them more positive when faced with technology as there is no opportunity for the consolidation of skills. Therefore, the products of ETE project were designed to be used over an extended period.

PRESENTATION OF THE ELECTRONIC MANUAL

To fulfil the central aim of the project – to promote early technical education – one of the main objectives established was the development of didactic materials fit to children from 3 to 10 years old and applicable in the training of nursery and primary school teachers. To attain this assignment, it was agreed to produce an electronic manual which would also integrate the projects or concrete activities to be developed. Bearing in mind the concern already mentioned of the need for prolonged use of the materials produced, on-line support was favoured so as to facilitate and diversify access to all participants in the educational process.

This manual fulfils several functions, namely:

a) it is a tool of/for the training of teachers and educators in fields as varied as the child's learning process, the planning and preparation of educational practices or the selection of didactic methods and curriculum development;

b) it is an attractive tool for teachers and educators by virtue of a design which makes it easy to use;

c) it can be used practically anywhere (classroom, garden, etc.);

d) it can be used for the practice of technical education, presenting a large variety of proposals for experimental activities which can be carried out at different levels of difficulty and with children of different age groups;

e) it encourages citizenship education, especially by the strategies proposed and by the nature of the resources that can be used in fulfilling the experiments proposed.

Besides describing activities, the manual also refers to available resources, possible pedagogic strategies and expected results. The activities have already been tested with different groups of children from participating countries and one of the chapters gives an exact account of how these activities were carried out and the results obtained.

It must be pointed out that the proposed working methods are not exclusive nor are the materials used, being only examples for each educator to adapt the proposed experience to its context.

After analysis of the national teaching curricula of the different participating countries and reports of some dissimilarity not only with the content but also with the methodological options and pedagogic contextualization, we opted to structure the projects according to topics (Chapter III). The Project is available on site: http://www.earlytechnicaleducation.org.

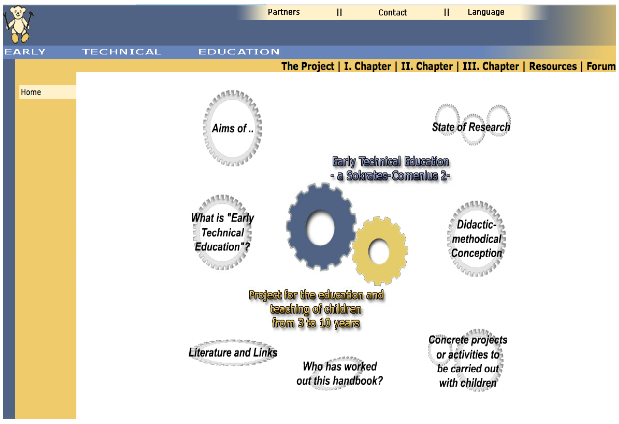

Figure 1 – European Project (http://www.earlytechnicaleducation.org).

Thus, educators and teachers will have the opportunity to come into contact with didactic suggestions and try new materials. On the other hand, with the insertion of a Forum on the site, it is hoped to motivate discussion on the application of the proposed materials with the consequent extension of the ETE and the improvement and adaptation of these materials, taking into consideration different contexts and pedagogical situations.

Starting with the potentials of the hypermedia format, the user is invited to choose the projects wanted according to one of the criteria: age of the children or subject.

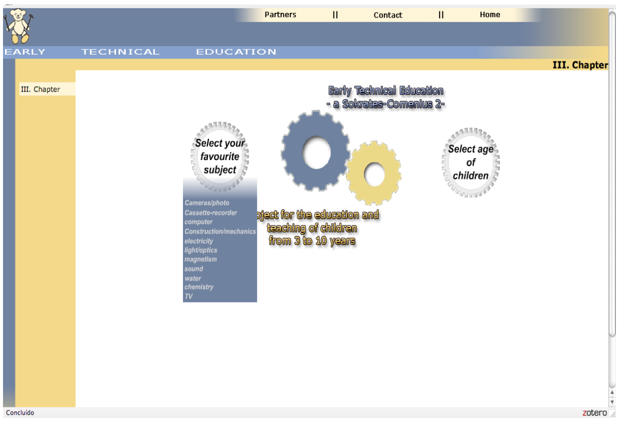

Figure 2. ETE Project /III. Chapter – Activities and materials.

In the first criterion, two categories are considered; ages 3 to 5/6 or ages 5/6 to 10, including in each one proposals for each of the age groups considered. As for the subject, the topics are organised in the following categories: Cameras, Cassette recorders, Computers, Construction/Mechanics, Electricity, Optics/Light, Magnetism, Sound, Water, Chemistry, TV. Some of these categories correspond to the presentation of a project, comprising a set of activities subordinate to a theme. However, others integrate more than one project. The following categories correspond to the first case: Cassette recorders, Computers (children and computers), Electricity (electricity, electromagnetism), Magnetism, Water, Chemistry (in the wake of the criminal), TV. The rest of the categories are subdivided in the following way:

• Cameras: camera; the tree in our Nursery School;

• Construction/Mechanics: cardboard village; making a boat; how to make a tower of marbles; sand pit; "storyline (thematic approach)"; "teddymobile"; "Harry Potter"; Pianola (sound, music and mechanics);

• Optics/Light: miracle of light and colours; light; light, mirrors and images;

• Sound: (what is sound?), relating hearing and vibration.

In general, besides considering methodologies, pedagogic and scientific grounds and contexts, the presentation of each of the projects is essentially a detailed description of a sequence of activities. For these, the chosen format was a grid designed according the answer to the following questions: What? Why? Where? Who for? How? Thus, each one is represented on the grid, with the answer to the items which we transcribe below:

Name of the activity (subject); Category (scientific topic); Where (physical context); Time (duration); What? (objectives); Who for? (age group and number of pupils); Preparation (material, …); Steps (detailed description of the evolution of the activity); Backup information (scientific explanation, some bibliography); Notes (drawing attention, care to be taken when undertaking the experiences or relating to the adaptation to the context).

As an example, refer to the project "Children and computers" which includes the following items:

• Preliminary reflections on the use of computers in the Nursery School;

• Duration;

• Objectives of the Project;

• Target Group;

• General Planning of the activities:

1. How does a computer work?

2. How does a printer work?

3. What's inside the box?

4. Handling the computer (WORD text processing).

5. Using a design program and recording of data.

6. Using CD-Rom.

7. Using the computer to transfer knowledge.

8. Insertion of images with Clip Art.

9. Insertion of digital photographs.

10. Elaboration of a computer manual (transversal activity)

And also as an example, the description of one of these activities follows:

Table 1 – Activity: How a computer works

Activity: How does a computer work?		Category: AV-Media, Computers
Where: in a separate room, in the hall.	Time: approx. (1 Hour)	What? "Role play": How a computer works
Preparation Material A computer (CPU, monitor, keyboard, cables), a large cardboard computer. Sheets of paper (small and large) with letters (different colours, identical with identical colours), poster showing the components of a computer, paper and pens.		Steps The components of the computer are in the centre of the room. The children describe these components and understand that a computer can only work if there are cables connecting the individual parts. They connect all the parts with the teacher's help, if necessary. They describe the order the data is transferred (with help from the teacher, if needed). The children themselves become a computer by magic and go to the big cardboard computer with the teacher. They check that all the parts and connections are there and imitate the transfer of data using different phases – "input" of the different coloured letters on the cardboard keyboard – transferring the letters to a CPU and from this to the screen. Each child introduces his/her name and transfers the printed letters until it appears on the cardboard screen. The teacher shows a poster with the computer components and a child adds the connecting cables, designing them and explaining the path they take. *The teacher explains that they are going to make up a computer manual so that the Nursery School children can learn how a computer works, too. The children plan and design the first page showing the components of a computer and the path the information takes.*
Backup Information: A computer is made up of a keyboard, a CPU (Central Processing Unit), a screen and connecting cables. The data is entered with the help of the keyboard, a cable transfers it to the CPU – where it is processed – and then passes through a cable to the screen which shows the information. The CPU and the screen are switched on, pressing the button to start.		

By means of the site mentioned before, in Chapter III of the Manual, it is also possible to access the illustrated reports (with pictures and films) of putting the activities with children into practice accomplished by participants in the project. Included in this area are the sections called "Impressions" and integrated in the projects: cardboard village, sand box, storyline, teddymobil, and Harry Potter.

Some reports of the experiments carried out, including some conclusions, suggestions and reflections regarding future developments and the pursuit of objectives, can be consulted under the headings "Test" for themes such as "cardboard village", "how to make a tower of marbles", "storyline" and "teddymobil".

CASE STUDIES

During the school year of 2005/2006, twelve case studies[4] were carried out in authentic contexts (diverse formal and non formal school contexts), sustained by diverse teaching/learning devices, integrated in the respective curricula projects.

Table 2a – *Five Primary Schools*

Children Number	Age	Projects/ Themes	Technology Topics (ETE)
26	10 to 12	*"Optics and Light"* Optics/Light	Make a periscope; make a kaleidoscope; turn water into a magnifying glass and learn how a film works.
20	8 to 11	*"Great Little Artists"* Camera	Take and make photographs; know how a camera works; make a pinhole camera and a real camera.
21	9 to 11	*"Lisbon Lit Up"* Construction; Mechanics; Electricity	Research: technology in buildings and vehicles; elementary electricity. Design and make buildings and vehicles; apply electrical circuits; apply learning in Mathematics. Use knowledge of language; make up an illustrated technical dictionary regarding construction.
20	9 to 11	*" Master André's Little Friends"* Sound	Hear, make and feel sounds/noises. Make telephones from plastic cups; make music with glasses of water, with a wooden box, with strange jungle sounds.
27	6 to 7	*"Learn how to Listen"* Sound	Make telephones from plastic cups; make music with glasses of water and make a musical box.

Table 2b – *Three Kindergarten Schools*

Children Number	Age	Projects/Themes	Technology Topics (ETE)
24	3 to 6	*"Sound, Water and Colours"* Sound; Water; Light	Sound: hear, make and feel sounds/noises; the sound may be piped; the sound is a wave. Water: the art of evaporation. Miracle of colours: separate the colours.
22	3 to 6	*"A little wooden house and a model of the ideal neighbourhood"* Construction; Mechanics; Electricity	Project and design of buildings and vehicles. Construction of a wooden house; making of interior finishings; electrical installation of the house.
15	3 to 6	*"My first experiences"* Water; Electricity and Electromagnetism.	Water: glasses in movement – floating and sinking; Sugar and ink – which is dissolved first? Electricity: bouncing electrical models; making an electromagnet.

Table 2c – *Four "F.T." Free Time Activity Centres (A.T.L.)*

Children Number	Age	Projects/ Themes	Technology Topics (ETE)
6	3 to 5	*"From Hearing to Vibration"* Sound	Hear the sound of the trees: sound or noise? Acoustics; sound; air resistance. Make telephones from plastic cups; make music with glasses of water, with strange jungle sounds.
10	6 to 7	*"The Adventure of Sound"* Sound	What is sound? hear, make and feel sounds/noises. Make telephones with plastic cups; make music with glasses of water, make a musical box.
10	5 to 6	*"Learn to Think"* Water	Water: moving glasses, floating and sinking. Mixture of water; the taste of water; is water hard? Water is a solvent. Sugar and ink: which dissolves first?
12	6 to 10	*"Pint-sized Scientists"* Water; Sound; Electricity and Electromagnetism.	Water: moving glasses, floating and sinking; is water hard? Electricity: bouncing electrical models. Sound: make telephones from plastic cups, hear strange jungle sounds.

Procedures

In the various experiments, active self-regulated learning, development of disciplinary and transversal competences, option for tutoring, collaborative work, problem solving, project work and university/context liaison are the main guidelines for the projects referred to.

In these twelve case studies, we have dealt mainly with the professionals' interpretation of the way intervention was carried out, following the interpretive paradigm because "the events can only be understood if we have made sense of the perception and interpretations of the people who take part in them" (Tuckman, 2002, p. 508).

The data was gathered via semi-direct interviews of the professionals involved (three nursery school teachers, five primary school teachers, two headmasters and two monitors), and studied through content analysis (Bardin, 1997). We would point out that, apart from these interviews, in all twelve case studies we used a large collection of means for gathering the data, namely diagnostic questionnaires and diagnostic knowledge tests, active observation during the activities and the reflections of the university students.

The interest in carrying out these case studies emerged from the direct contact with the professionals (Nursery School Teachers, Primary School Teachers, Heads of Institutions, Monitors of Free Time Activities) involved in accomplishing the twelve interventions in an educational context (diverse formal and non-formal school contexts) with children from 3 to 10 years, having the backing of the international *ETE* project (Early Technical Education).

Based on evidence of different attitudes of the professionals regarding the technological/technical field, four general questions were defined which formed the starting point for the accomplishment of this study outline:

1 - What are the professionals' opinions regarding the interventions carried out in the field of technology/technique? What are the opportunities created by these interventions?

2 - What are the questions of ethics arise for the professionals' reflection with the introduction of technology/technique in their daily practice?

3 - How do the teaching/learning devices implemented (tutorial, collaborative work, solving of problems and project work) contribute to the development of skills in the field of Technological/technical Education and encourage interaction with the development of other skills (reading, writing and social aspects)?

4 - How far is it possible to transfer learning identified by the professionals to their pupils, to themselves and to the university students who participated in the interventions?

The potential

All the professionals who participated in the twelve case studies pointed out the interventions' potential in the field of technology/technique relating the to the following reasons:

1. *integration of the contexts in the curriculum projects*, which was considered "most opportune as they can be included in the Educational Project of the class and of the School, and many of the subjects broached were emphasized in other lessons/sessions by other similar experiences";

2. *good scientific support*, strengthening the relevance of projects such as ETE, being aware of the difficulties arising in this field regarding the complexity of the concepts broached and the need to make them suitable for 3 to 10 year olds because the "objective of these projects in the field of technique/technology is to make the first contact with scientific methods possible and motivate the children towards technical-experimental phenomena" and because, "besides this, there is a need to carry out activities connected with Science to encourage an investigative attitude in children" (…) "contributing to the use of scientific vocabulary";

3. *stimulate active participation of pupils*, who "really committed themselves a lot, bringing about a positive interaction both between themselves and with the teachers and because "the motivation shown by the pupils' actions was notable", revealing "how good it is for the children to do things with their own hands, to know the whys and wherefores of things, how they reached a certain result, to have to search and reorganize information and work in groups";

4. *contribution towards learning and development of skills in different areas*, which "is, in general, confirmed by the learning achieved by pupils, by the increase in technical competence, (…) in gaining scientific knowledge related to the activi-

ties undertaken (also acquiring vocabulary), in the increase in reflection skills (in as much as the pupils were inspired to reflect) and in the increase of intrapersonal valuation (by strengthening the autonomy and self-confidence of the pupils";

5. *trusting teaching/learning devices* (tutorials, collaborative work, solving of problems and project work) which promote the autonomy of the learner, mutual help and a scientific attitude "enabling the children to explore their surroundings, satisfying their curiosity, avoiding forcing them, as so often happens, and hindering them from being spontaneous in the search for answers to their questions".

The need for reflection was widely referred to regarding the impact of using technologies in children's development, *questions of an ethical nature* being put forward. For example, one of the aspects highlighted was tied up with uncontrolled access to the Internet which could "transform our children into people who think that access to information automatically makes them connoisseurs of reality", as well as the inherent dangers, which makes it necessary to "accompany the children during their incursion (…)". One worry running through the professionals' comments is to do with the reflection on the role technology plays in the questioning of values, as one of the teachers declared, putting emphasis on awareness and reflection, highlighting "the great urgency for children to be made aware of the need to respect the environment for their own survival and the common good. Through experimentation and construction techniques, they can get to know the advantages and the potential or permanent consequences of a technological world, in the short or long term".

Teachers' commitment to the project is also linked to the fact that "dealing with technology as a subject as well as a learning tool" can "encourage mutual respect, responsibility, taking into account the development of the children". On the other hand, another advantage of the Project is the fact that it allowed the pupils to *understand the vast field of technology*, making them realize that "technology is not only the computer (…) but is to do with technical domains in the various fields".

The need felt by the professionals to *innovate methods of teaching* also led them to value the introduction of teaching/learning devices (tutorials, group work, problem solving and project work), giving emphasis to their contributions towards the development of other skills in the field of Technological/Technical Education, considering its potential to interact with the development of other skills (reading, writing and social aspects). One of them stated that the project "developed the skills required by scientific method, the capacity for observation, attention, concentration, questioning, reflecting on what they see, dialogue among themselves, research, mastering the Portuguese language and other important working areas" and another showed satisfaction because "the children managed to explain certain phenomena and concepts, they were able to question, observe and reflect", because it is "stimulating for them to go further and not take reality as granted", and because it enabled them to "bridge the gap between experiences and writing, the written reports in groups or individually and between reading, writing and drawing". The emphasis on the importance of reporting played an important role in some of the projects, because as one teacher says, "it makes it possible for the children to reflect on what they have done, regarding the process (…)".

With reference to the *transfer of learning* arising from the interventions and the continuation of this work, we can be certain that there is agreement among the professionals regarding the principles, the need, even indispensability, but there is evidence that for the majority, "the implementation of such projects implies that the teacher is willing and able to modify her/his teaching habits and routines", which does not always happen due to a multiplicity of factors (routines, lack of scientific and pedagogic training, lack of resources, inadequate space …). One of the heads "regrets that teachers do not use this type of activity more in their subjects. This could be extremely advantageous for the pupils as the level of motivation (…) increases when these activities are carried out" (…) and "shows how possible it is to work a concept in a palpable form", emphasising that, sometimes, "school culture is not sufficiently permeable to this type of activity".

To sum up, the usefulness and flexibility of the selected activities, the adaptation to a group of children and to school curriculum projects, concern about children's activity, interconnected with scientific precision, the fact that this project has been an opportunity for professionals to up-date their scientific methodological knowledge and for university students to combine theory and practice, all of these can be considered the main contributions of this type of intervention.

We can also report that students taking a degree in Educational Sciences who were involved in these case studies could consolidate, deepen and apply the knowledge of pedagogy, research and presentation. They have acquired knowledge in the fields of curriculum development, the Education System and experience-based teaching methods, thus becoming more sensitive to the importance of technical education, to questions of gender and to the relevance of a constructive perspective of scientific knowledge to be developed with the children.

As far as the children are concerned, it can be concluded that, generally, they all learnt the target concepts, showing curiosity, interest and motivation in and for the activities and experiences which contributed to the stimulus for inter-activity and creativity, as well as for the development of skills in techniques of logical and scientific reasoning. It was also possible to witness the evolution from their first intuitions (alternative conceptions) to more scientifically correct conceptions.

CONCLUSION

From the above said, we can conclude that the ETE Project fulfilled its objectives. In fact, starting with a consensual characterization of ETE, an edition was made available on-line of a manual which can easily be used by any educator in his/her daily activities. We believe that this is certainly one of the most valuable contributions: an easy-to-use manual which makes an inventory of the problems educators and teachers face in their daily work and at the same time proposes activities which are very easy to perform and adaptable to different contexts, resources and the ages of the children.

Therefore, the manual is a tool for self- and hetero-regulated education, as it may be used simultaneously by the educator, who learns to do and reflect on his own path, and by the teacher trainer who can find suggestions for reading and activities in it which give rise to and strengthen their reflection with the students.

Considering that one of the aims underlying the project was to make of it a teacher training device, we appreciate the work carried out, which became a formative itinerary for those who helped to produce this manual by experimenting with some of the proposed activities. Besides this, the success of (or lack of) field work enabled us to better assess the pertinence of the pedagogic, didactic and psychological approach guiding the development of the project and to better adjust the proposal to the target populations.

In our specific case as researchers, the ETE project contributed to deepen our reflection on the theme of scientific, technical and technological education as well as on the use of *science* and the demands for *precision* in educational practice, from the first years of a child's life. It was reflection that gave substance to a set of activities and nourished them, crystallizing a process of research in and for action.

Endnotes

1. European Award for Lifelong Learning (Bronze Medal).

2. The ETE project took place between 2002 and 2004 and had as partners: the Richard-von-Weizsäcker-Berufskolleg de Lüdinghausen School for Social Education (Germany, which shouldered the general coordination); the Berufsbildende Schulen IIV –Department of Social Matters (Germany); the University of Haag, The Hague (Holland); the Department of Didactics in Mathematics and Sciences of the University of Barcelona (Spain); the Faculty of Psychology and Educational Sciences of the University of Lisbon (Portugal) and Volkswagen Coaching Gmb , Wolfsburg (Germany).

3. See Veiga Simão; Cabrito & Rodrigues, 2003b.

4. The studies involved undergraduates from FPCE-UL (University of Lisbon) taking a degree in Educational Sciences, who, in this way, had the opportunity to participate in an enriching experience.

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