Environmental education favours values that are conducive to a greater respect for and knowledge of the environment. The meaningful learning theory is widely recognised as a basis for fomenting the learning experience within the educational process. This article summarises the results of a research project involving joint application of environmental education knowledge, meaningful learning and museology in Navarre University's Natural Sciences Museum (Museo de Ciencias Naturales). Fruit of this research was the proposal of a teaching unit geared towards children aged 11-12 to foment learning of the value «respect» and the meaning of the term «biodiversity» by means of a museum visit, using learning tools such as Cmap Tools, webquest and m-learning, together with the new information and communication technologies.

By FERNANDO ECHARRI and JORDI PUIG I BAGUER

In recent decades mankind has come to realise that the current development model has adverse effects on the environment, such as overexploitation of natural resources and pollution. But these consequences are not only to be seen in the environment. Overproduction and overconsumption also have effects in the social sphere. It is often claimed, for example, that a model of society has been promoted in which “having” is valued more highly than “being.”

At the start of the nineteen seventies the UN, concerned about the worsening of some environmental problems, organised the United Nations Conference on the Human Environment (Stockholm, 1972), in a search for principles that would inspire and guide efforts towards the conservation and improvement of the environment. This forum gave birth to the concept of environmental education as the educational response to environmental problems, a concept that has then become fleshed out over the following years. In Spain, 1999 saw publication of the White Paper on Environmental Education in Spain (Libro blanco de la educación ambiental en España) which reflected, among other aspects, the need of introducing environmental education into the education system (1999: 71).

One of the most interesting inputs for environmental education purposes was Novak’s «theory of education» (1977, 1990, 1998), proposing teaching techniques that build on the meaningful language theory (Ausubel, 1968). One of the key features of these techniques is the use of concept maps during the educational process. The theories of Novak and Ausubel have proven to be useful tools in increasing learners’ knowledge and influencing their conduct. They are based on the theory of constructivism and propose an educational system for fomenting changes of conduct, attitudes and values, which is one of the main purposes of environmental education.
Education is heavily influenced by its venues. Museums, for example, can tap into motivations and living experiences based on the presence of real objects; this enables museums to design and carry out educational activities in their own right. Their holdings can be used to pass on bang up-to-date scientific knowledge to all types of visitors. Navarre University’s Natural Sciences Museum, recently set up (1998), offers the opportunity of designing and applying educational programmes from and in the university, geared towards visitors from all walks of life, university students or otherwise. The nature of its holdings allows the museum to incorporate into its activity the objectives and measures proposed by environmental education and meaningful learning. It can also harness the possibilities offered by the new information and communication technologies (NICTs) by using interactive learning-facilitating resources and methodologies such as m-learning and webquest.

Bringing together all these «stakeholders», and after educational design and research work, a draft syllabus has been drawn up in the form of a teaching unit that aims to foster higher-quality, longer lasting and more truthful environmental-science learning processes, which have a positive influence on the learners’ environmental conduct. This syllabus focuses on the concept of «biodiversity» and the value of «respect», as laid down in the formal educational legislation for the third cycle of primary education.

In sum, the aim of the research project dealt with in this article is to analyse Ausubel and Novak’s constructivist theories of meaningful learning in the theoretical framework of environmental education and use them to develop a coherent teaching unit geared towards schoolchildren aged 11 and 12, using as educational resource the material available in Navarre University’s Natural Sciences Museum and today’s scientific knowledge. The teaching unit has also been designed to make the best use of educational advances in the field of the new technologies and aims to improve the environmental attitudes of learners.

**Environmental Education**

Although there are many definitions of environmental education, one of the most oft-quoted ones is the definition proposed in the Intergovernmental Conference on Environmental Education (Tbilisi, 1977). This definition extends its concept of environmental education to take in the social perspective, speaking of social relations, culture and values: «the process whereby individuals and communities come to understand the complex nature of the natural and the built environments resulting from the interaction of their biological, physical, social, economic and cultural aspects, and acquire the knowledge, values, attitudes, and practical skills to participate in a responsible and effective way in anticipating and solving environmental problems, and the management of the quality of the environment» (Tbilisi Conference. Final Report, 1977).

Environmental education is generally considered to have been born in the United Nations Conference on the Human Environment, held in Stockholm in 1972. According to principle 19, environmental education is to be understood as an education in values, an aspect that will be stressed in the following section.

The concept of environmental education has undergone far-reaching changes over the years, as progressively developed in the United Nations Conferences held in Belgrade, Tbilisi, Moscow, Río de Janeiro, Thessalonica, Johannesburg, etc. These changes are largely a reflection of the parallel changes in the scientific, political and social spheres. As originally conceived, the overriding aim of environmental education was to conserve the
environment; increasing importance was thence given to the social aspect underpinning the way of interacting with the environment.

In Spain’s case the objectives of environmental education are laid down in the *Libro Blanco de la educación ambiental* (1999: 28), and respond to those set forth in the final report of the Tbilisi Conference of 1977. The aim is to foment, among others, the following aspects in the learners: a critical sense, decision-making skills, a change of behaviour, problem solving abilities, citizen participation, interdisciplinary openness, the perception of the environment as a diverse and complex whole, understanding environmental education as a permanent process, understanding the role of scientific and educational research and an education in values.

Environmental education calls for training activities to achieve its ends. This is to be understood as the instruction of people to improve them as human beings and agents of social change. Instruction is needed in concepts, capacities and skills so that attitudes and values are renewed in each learner, promoting the desired change.

**Environmental Education and Education in Values**

Caduto (1992: 1) argues that the crisis of personal and environmental values is one of the causes of environmental problems. This idea has been especially important for the design of the teaching unit proposed as a result of the research project, seeking, through the diverse programmes of environmental education «to foster a change of values, attitudes and habits in the interests of drawing up a code of conduct in relation to environment-related questions» (UNESCO, 1978).

As regards the relation between values and behaviour, Kluckhohn (1957: 403) states that: «Any act is seen as a compromise between motivation, the conditions of the situation, available resources and goals interpreted in terms of values». For their part, Sureda and Colom (1989: 126) stress that «values and decision-taking are two aspects that are closely bound up with each other». Decision-taking can express changes in behaviour brought about by environmental education.

According to these ideas, it would seem logical to assume that encouragement of the values proposed by environmental education could bring about changes in attitudes and behaviour. These values might be encouraged by means of constructivist teaching methods based on meaningful learning.

**Environmental Education and Meaningful Learning**

Environmental education aims to change the population’s behaviour, but over the years this has proved to be an elusive object, as recorded in the *Libro Blanco de la educación ambiental en España* (1999: 4). One of the causes might be defective teaching methods, which need to be improved to bring about the desired attitude changes. Knowledge of the human learning process might favour these changes. The study thereof has been deemed to be fundamental in this research work. Hence the attention paid to Ausubel’s meaningful learning theory (1968), to which a specific reference is made in the book *Educación ambiental: principios de enseñanza y aprendizaje* (1993: 31), although no explicit mention is made therein of its relation with environmental education.
The encouragement of the values proposed by environmental education could bring about changes in attitudes and behaviour. These values might be encouraged by means of constructivist teaching methods based on meaningful learning.

The meaningful learning theory (Ausubel, 1968) is a theoretical framework that has proven its effectiveness in improving learning processes (Mayer, 2004). Ausubel's theory is reaffirmed and considered as the central thrust of the education proposed by Novak (1977; 1990; 1998). This latter theory is based on epistemology, which studies how knowledge is acquired and the human learning process in general. But the most interesting aspect of his thinking for our purposes here is reflected in his paper *A theory of education as a basis for environmental education* (1978), where Novak presents an explicit and developed relationship between environmental education and his theory of education. Novak presents his theory as a pedagogical tool promoting the knowledge, skills, values and attitudes posed by environmental education.

The basic tenet of the meaningful learning theory is to eschew incomprehensible knowledge. This means that all new concepts learned should always be brought into coherent relationship with the concepts already forming part of the learners’ cognitive structure so that these learners can always discover a meaning in them. Meaningful learning is diametrically opposed to mere rote learning, in which learners can lend no meaning to what they are trying to learn. The theory stresses the importance of the learners’ active role, taking on responsibility for their own learning process.

Novak’s particular input was to further involve the learner by means of an affective component (Novak, 1978). The underlying hypothesis is that more meaningful learning processes, integrating an affective factor, will make it easier to promote the attitudinal changes sought by environmental education. This would encourage an educational process properly integrating «thought, feeling and action» (Gowin, 1981: 11).

Novak (1998: 22) identifies five elements that impinge on education: the teacher, the learner, the content, the context, and evaluation. He argues that all these must factors must be focused at first on the learning of concepts. He therefore considers it to be essential, in curriculum planning, to analyse the subject first and identify the most meaningful concepts. But at the same time he considers that in the planning of the instruction the pupils also play a key role. All these factors have been taken into account in the design of the teaching unit built up from the results of the research project.

The appearance of the meaningful learning theory has led to a detailed study of techniques and variables that may facilitate the learning process. Table 1 pools those that have been considered in the research project, based on Mayer’s proposal (2004)1.

**Table 1. Techniques and variables that might facilitate meaningful learning**

- Give productive feedback to pupils
- Provide hands-on activity and familiarity.
- Explain with examples.
- Guide the cognitive processing during the learning process.
- Foment learning strategies that favour «learning how to
learn», such as the concept map.
- Foment problem-solving strategies.
- Open-ended work.
- Motivation.
- The setting.
- Creativity.

**Concept Maps**

Concept maps are a pedagogical «knowledge-representation» tool (Novak, 1998: 21) that is particularly interesting for our purposes here. In general, concept maps are used for promoting a more meaningful learning process, helping to systematise and structure the information. According to Ballester (2002), the concept map «is the best instrument for producing a meaningful learning experience, since the concepts are presented in a properly connected and coherent way».

*Concept maps are a pedagogical «knowledge-representation» tool (Novak, 1998: 21) used in general for promoting a more meaningful learning process, helping to systematise and structure the information.*

Learning, to be meaningful, has to assimilate new concepts, phasing them into the existing cognitive structure and reorganising them, instead of rote-learning isolated concepts that are finally forgotten. In concept maps the concepts are united forming propositions that are unique for each individual. This is why they are also used to check whether meaningful learning is actually occurring (figure 1). Concept maps have several advantages described, among others, by Ballester (2002) and Aguirre and Vivas (2006). Here we highlight the following:

- They improve education quality.
- They improve academic performance.
- They help pupils become more aware of what they are learning, motivating them in turn to learn more.
- They facilitate cooperation and teamwork.
- Pupils themselves are involved in the process of drawing them up.
- A participative and democratic climate is created in the classroom.
- Pupils learn how to learn and can therefore extrapolate their learning further afield.
- They can be used as an assessment instrument and technique, by ascertaining whether or not the concept taught has been properly grasped.

Concept maps, moreover, can be a staunch ally in the pursuit of several objectives of environmental education, such as education in decision taking (González and Novak 1993: 95), in problem solving (Novak, Gowin and Johansen 1983, in González and Novak 1993: 96) and the encouragement of attitudes proposed by environmental education (Edward and Fraser 1983, in González and Novak 1993: 96; Brumsted 1990, quoted in González and Novak 1993: 96).
Navarre University’s Natural Sciences Museum

Navarre University’s Natural Science Museum, opened in 1998, boasts several showcase displays of preserved specimens of living beings, shells and minerals of varied origin, with a total of 9014 exhibits. It has been set up with an educational and awareness raising purpose, so it is accessible to all people who may wish to visit it.

The decision to use these holdings as an educational resource for the teaching unit presented herein called for a previous study of museology as a theoretical conceptualisation framework. Integration of the three inputs of museum science, environmental education and meaningful learning has pinpointed a set of concepts, characteristics and proposals held in common by these three theoretical frameworks, as set forth in Table 2.

Table 2. Points held in common by the theoretical frameworks of Museology, Environmental Education and Meaningful Learning.

<table>
<thead>
<tr>
<th>Museology</th>
<th>Environmental Education</th>
<th>Meaningful Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interactivity, hands-on contact with the object, freedom of movement promoting experiential and affective education.</td>
<td>Learner participation promoting experiential education.</td>
<td>Promotion of active and experiential methodologies. The affective component might boost meaningful learning.</td>
</tr>
<tr>
<td>Activities to familiarise society with the contents of science and technology.</td>
<td>Contents geared towards a better knowledge of the environment.</td>
<td>Activity-based learning.</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Consider the target age bracket of the museum programmes.</td>
<td>Consider the target age bracket of the environmental education syllabi.</td>
<td>Consider the target age bracket of the education syllabi.</td>
</tr>
<tr>
<td>Work from the visiting public’s knowledge.</td>
<td>Work from the population’s socio-cultural context, adapting contents thereto.</td>
<td>Work from the learners’ previous stock of knowledge.</td>
</tr>
<tr>
<td>Concept of intangible heritage, including the values.</td>
<td>Education in environmental values.</td>
<td>Education in values, including environmental values, sometimes through the hidden curriculum.</td>
</tr>
<tr>
<td>Encourage information searches by displaying exhibits without labels or with incomplete information.</td>
<td>Information search and critical discrimination thereof.</td>
<td>Each person builds up his or her knowledge by selecting the information that is meaningful to them.</td>
</tr>
<tr>
<td>Museum as facilitator, furnishing users with information.</td>
<td>Environmental educators as facilitators and promoters of environmental knowledge.</td>
<td>Teacher as learning facilitator.</td>
</tr>
<tr>
<td>Seductive, powerful and thrilling learning processes.</td>
<td>Learning of environmental content and changes of content are favoured by motivation.</td>
<td>Meaningful learning is favoured by motivation.</td>
</tr>
<tr>
<td>Use culture in the learning processes, integration of science in culture in a holistic and multidimensional way.</td>
<td>Integral and interdisciplinary nature. Contents of integration with the social and natural environment.</td>
<td>Integral contents could favour the transfer or generalisation thereof and the detection of conceptual errors.</td>
</tr>
<tr>
<td>Fun-based learning. Context of fun, inspiration, creativity.</td>
<td>Use of simulation games as methodology.</td>
<td>Play as a an educational methodology. For example, «treasure hunt». This</td>
</tr>
<tr>
<td>------------------------------------------------------</td>
<td>--------------------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Field of action: formal, non-formal and informal education.</td>
<td>Field of action: formal, non-formal and informal education.</td>
<td>Field of action: formal, non-formal and informal education.</td>
</tr>
<tr>
<td>Local-based and universal learning.</td>
<td>Think globally, act locally.</td>
<td>Seek contents from the learners’ immediate setting and then generalise them.</td>
</tr>
<tr>
<td>Learning subjectivity to suit each personal experience and cognitive structure. «Favour the capacity of critical thinking» (Hernández, 2004).</td>
<td>Personal critical spirit determining decision-taking procedures.</td>
<td>Learning subjectivity to suit each personal experience and cognitive structure.</td>
</tr>
<tr>
<td>Importance of communication processes.</td>
<td>Environmental educator as communicator.</td>
<td>Tap into the learners’ centres of interest.</td>
</tr>
<tr>
<td>Public studies.</td>
<td>Studies of behaviour, perceptions of the environment.</td>
<td>Studies of constructivist applications. Knowledge of previous ideas.</td>
</tr>
<tr>
<td>Adaptation to the age of the public.</td>
<td>Adaptation of environmental syllabi to the age of users.</td>
<td>Adaptation to the learners’ psychological development.</td>
</tr>
<tr>
<td>Adaptation to the</td>
<td>Adaptation to</td>
<td>Personalisation</td>
</tr>
</tbody>
</table>
**NICTs as an Educational Resource**

The resources to be used in teaching any syllabus are without doubt a key educational aspect. Regardless of the methodology employed in each case, a shrewd use of resources will favour the most meaningful learning experience, kindling creativity and motivating pupils.

One of the hallmarks of today’s society is the progressive implementation of the new information and communication technologies (hereinafter NICTs). This widespread implementation has spawned the term «information society» to refer to this situation, as coined by Bell and Touraine in the seventies of last century (Cabero, 2007). Although the term NICTs was already used as far back as the sixties with the appearance of the audiovisual resources (television) in the sixties (Chacón, 2007), NICTs per se are considered to have really taken off with the appearance of internet in 1969 (Cabero, 2002a) and the development thereof from the nineties onwards (Bellido, 2001: 64). From then on internet has been rapidly incorporated into many aspects of daily life, both social and individual.

In recent years NICTs have been phased into many cultural and social fields, such as museology, education and leisure. Bellido (2005) believes that the new technologies will continually gain ground in the museum field, because they give society exactly what it wants: «easy assimilation, entertainment, learning and surprise». Almazán and Álvarez (2005) consider that the appearance of NICTs has boosted spectator participation and interactivity.

NICTs in a museum context need to be properly used as part of an overall pedagogical project, otherwise they might even be counter productive and distract learners from the educational purpose in view. Furthermore, NICTs can help not only to improve the educational process but also «to rethink the teaching process and seek new ways of tackling, designing and developing it» (González, 2007: 219). The irruption of NICTs offers teachers a new modus operandi as «learning facilitators», another expression proper of the meaningful learning theory.

The teaching unit proposed as a result of the research project harnesses some of the educational possibilities offered by the NICTs. The specific resources used are: Cmap Tools, m-learning and webquest.

<table>
<thead>
<tr>
<th>diversity of the public.</th>
<th>the diversity of the public.</th>
<th>of the learning.</th>
<th>Divergence of contents.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence of real objects.</td>
<td>Real experiences can boost a favourable attitude towards the environment.</td>
<td>Real experiences can boost motivation, emotion and meaningful learning.</td>
<td></td>
</tr>
<tr>
<td>Didactic exposition: facilitates the learning process.</td>
<td>Didactic: facilitate the learning process by example, with experiential education.</td>
<td>Techniques for learning how to learn, such as concept maps.</td>
<td></td>
</tr>
</tbody>
</table>

En la unidad didáctica propuesta como resultado del proyecto de investigación se incorporan algunas de las posibilidades educativas que presentan las NTIC’s. En concreto, se han
utilizado los siguientes recursos: Cmap Tools, m-learning y webquest.

**Cmap Tools**

Internet educational resources have also been brought into the field of concept maps. These maps, already outlined above, are spinoffs from the meaningful learning theories. Several computer programmes exist to help build them (Rovira, 2005). From among this software a choice was made of the programme developed by Florida’s Institute for Human and Machine Cognition (IHMC), as the one most cited in the bibliographies dealing with meaningful learning.3.

*Cmap Tools* taps into the World Wide Web to provide new learning and collaborative knowledge possibilities. Should map builders desire, their concept maps may be «seen» by other users from any part of the world; these users may also be entitled to make modifications and inputs.

Due to its hypermedia concept *Cmap Tools* can make links between the concepts of the map drawn up and other resources such as «photos, images, graphs, videos, letters, tables, texts, WWW websites or other concept maps» (Novak and Cañas, 2004) located in any site in internet. The links to these resources appear as icons below the concepts making up the concept map, so that users can decide which link they wish to examine. The links are lent meaning by their inclusion in a concept map; this avoids the problem of users who are uncertain about where to go, what they are going to find in the new site and which related paths they might visit. Browsing progress is along the lines proposed for the forthcoming Web 3.0.

**Webquest**

Webquests were invented in 1995 by Dodge and March (Dodge, 2001). As the name suggests4, a webquest is a learning tool that uses, at least partially, internet information-search resources and then «organises it and transforms it into new information» (Adell, 2004) (Figure 2). The answer «is not ready made on the net and it needs to be sought, it needs to be built up» (Barba, 2002). Dodge (2001) points out that the methodology used is «inquiry oriented» and also seeks an efficient use of pupil time to develop «their thinking in the levels of analysis, synthesis and evaluation». It also embraces cooperative work, whereby Barba (2002) believes that it exercises «the pupil’s cognitive capacities». He also claims (2002) that webquests can be applied as an educational tool at «all levels and for all subjects».

Garzo (2004) reckons that the webquest methodology has a series of significant advantages:

- Integration of NICTs in the pupils’ curriculum, with the possibility of replacing or complementing other methodologies in relation to some subjects.
- Easier motivation by teachers for some subjects that are difficult to tackle.
- Possibility of creating its own subjects to suit the interests of teachers and pupils.
- Allows multi-tier teaching to suit different pupil learning speeds.
- Facilitates stricter information access than «free» searches.
- Enables the work difficulty and complexity levels to be pre-selected.
- Enables the pupils’ various conclusions to be pooled and compared.

**m-learning**
This is the learning activity that uses mobile technology resources such as mobile phones, PDAs or tablet-PCs (Figure 3). Correa and Ibáñez (2005) predict that «mlearning technology using handhelds is about to take off in a big way in the museum field». These authors (2005) consider that it has several advantages:

- Handheld access to internet possibilities.
- Permits technological applications in the knowledge-building process.
- Allows interactivity between learners and knowledge objects.
- Improves and develops the museum’s mediation task.
- Lends itself to individual and cooperative work.
- Can work inside and outside closed environments.
- Allows personalised responses to be given to each visitor’s enquiries.
- Allows integration of the virtual context and real place.
- Gives just-in-time information that goes beyond mere object observation.

These two educational resources (m-learning and webquest) can be integrated in the syllabus, together with the use of Cmap Tools. As proposed by Correa and Ibáñez (2005) and Bottentuit et al (2006), this integration is effected coherently with the research process leading to the knowledge acquisition. In the case of the syllabus proposed by the research project dealt with herein, m-learning is used for access to a webquest. The variation on a traditional webquest resides in the integration of mobile technology. According to Bottentuit et al (2006) this circumstance provides «a higher mobility than personal computers, enabling the pupils to work collaboratively and allowing them to take the handhelds to the species found to compare theory and practice».

**Proposed Teaching Syllabus: Meaningful Teaching Unit «Respect and Biodiversity»**

In this research project the joint application of the abovementioned theoretical frameworks has materialised in a specific teaching proposal, developed in the form of a teaching unit designed for the 11-12 age bracket, corresponding in Spain to the third cycle of Primary Education as laid down in Spain’s formal education system under the Education Act 2/2006 (Ley Orgánica de Educación: LOE).

The main reason for choosing this age bracket was to seek the greatest educational efficiency. Two prestigious authors like
Piaget and Inhelder (1980: 151) argue that there is a change in mental structures at the age of 11-12 from «concrete operations», based on inductive thought developed by using concrete objects, to a new structure built up from the former, called «formal operations», which will then continue «throughout adolescence and adulthood» (Piaget and Inhelder, 1980: 151). This stage is characterised above all by the development from inductive to deductive thinking and from concrete to abstract thinking. Precisely for this reason, this could be a good time to steer a child’s education towards the construction of his or her own value system.

Our teaching proposal has chosen a basic value that must be learned for living harmoniously together: respect, together with a very meaningful concept for the environment: biodiversity. The value «respect» is sometimes expressed as «respect-tolerance» (Bolívar, 1995, Lucini, 1994: 143, González, 2000: 58), and it should be the source of specific attitudes of respect-tolerance, reflected in «situations, objects, events or persons» (Coll, 1987: 139).

The contents comprised in the term «biodiversity» have been chosen due to their attractiveness for pupils. Zabala (1997) stresses how it motivates them to find out about their immediate environment and some of the major environmental problems such as the loss of biodiversity.

This specific environmental problem can be addressed from a local perspective but may also be tackled from the complex and holistic standpoint as a global problem of the whole planet. The holdings of Navarre University’s Natural Sciences Museum lend themselves to both approaches. From a local standpoint pupils can be encouraged to find out about the living beings closest to them. From a global standpoint the museum can also draw on its preserved specimens of living beings from around the planet.

**Objectives proposed by the teaching unit**

The objectives proposed, among others, are the following:

- Find out in detail about the loss of biodiversity occurring around the planet and look into the possible causes and solutions.
- Seek and interpret information on biodiversity and encourage critical thought about legislation, criteria and decision-taking procedures that might help to solve environmental problems.
- Foment environmental education through environmental contents, such as those involved in the concept «biodiversity» and in the value «respect».

**Structure of the meaningful teaching unit**

The meaningful teaching unit (Figure 4) is structured as a concept map, based on the proposal of Ballester (2002).
Contents of the Teaching Unit. The Educational Climate

The general contents of the teaching unit are «respect and biodiversity», broken down and classified in Table 3. The design of the teaching unit pays special attention to the educational climate in the interests of efficiently fomenting the attitudinal content «respect». The term «educational climate» refers to the «the cultural and organisational characteristics that define each teaching centre» (Bolívar, 1995: 194). By extension it may be applied to the climate generated by each teacher in particular.

Table 3. Contents of the teaching unit “Respect and Biodiversity”

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Evolution.</td>
<td>• Information search on living beings and their living conditions.</td>
<td>• Appreciation of all lifeforms in our environment and respect for same.</td>
<td>• All pupils are equally respected.</td>
</tr>
<tr>
<td>• Living beings in our local environment: flora and fauna.</td>
<td>• Awareness of the importance of thoroughgoingness in the observations of animals and plants and in preparing the corresponding work.</td>
<td>• Understanding, accepting and respecting others and their fundamental rights.</td>
<td>• Teachers treat all pupils as people in their own right, not merely as pupils.</td>
</tr>
<tr>
<td>• The habitat.</td>
<td>• Use of techniques based on teamwork.</td>
<td>• Listening and dialoguing skills are to be honed as the fundamental climate in</td>
<td>• Teachers show due respect for each other.</td>
</tr>
<tr>
<td>• The ecosystem.</td>
<td>• Apply interview techniques.</td>
<td></td>
<td>• Pupils feel that the teachers are not</td>
</tr>
<tr>
<td>• Human action on the ecosystem.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Biodiversity.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Loss of biodiversity: causes and</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>possible solutions</td>
<td>which the interpersonal relationships are to be forged and disputes resolved.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• PDA expertise.</td>
<td>• Sensitivity, openness and flexibility towards the inputs and opinions of others.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Expertise in using webquest.</td>
<td>• Interest in and respect for diversity and rejection of all types of personal discrimination.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Expertise in using internet browsers.</td>
<td>• Acceptance of people we rub shoulders with, respecting their identity, traits and qualities.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Critical selection of information.</td>
<td>• Rejection of verbal and gestural aggressiveness in our relations and in any conflict situation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Decision taking.</td>
<td>• Respect, consideration and care of the goods and services we receive, especially the wherewithal of the school and museum.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Problem solving.</td>
<td>• Responsible participation in group decision taking.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Drawing up concept maps.</td>
<td>• Defending own ideas.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Defending own ideas.</td>
<td>• All pupils will participate in all school activities, their individual inputs being valued without discrimination.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Personal opinions or points of view will always be respected.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<against them> but rather <with them>. Trust is built up seeing that words are borne out by actions. Pupils are confident that teachers are ready to listen to their points of view. Teachers strive to make their pupil's learning a thrilling experience. Pupils feel they are taken into account in the school. Whenever any problem crops up there are procedures for solving it. Pupils are encouraged to be creative rather than bound by routine. The school is a pleasant place because I feel loved and needed. Most of the school's personnel are friendly.
It is not frequent to find aspects of the «climate» explicitly reflected in a teaching unit. Neither is it easy to discern whether the climate consists of content to be transmitted or only a methodology for ensuring the adoption or learning of the conceptual, attitudinal and procedural contents. But there is no doubt that the educational climate might impinge directly on the learning of some contents, especially attitudinal contents. Zabala (1997: 86) argues that special attention should be paid to the teacher-pupil and pupil-pupil relationships set up within the educational community, on the grounds that these relationships help to create the school «climate» and could be «one of the key pieces in shaping the personal attitude and values», insofar as these relations could help to mould «models» of specific attitudes for the pupils.

**Methodology**
The following methodologies, principles and educational approaches have been proposed for this teaching unit, as extracted from the theoretical frameworks mentioned in each of the following points:

- From environmental education: the education will be active, tapping into the pupils’ living and affective experiences, solving problems structured in a «practical work project» (Porlán et al., 1992: 37), where «the contents are organised around the study of a problem situation for pupils» (Mena, 1999: 26). The experiential component, in this case, includes a museum visit designed for primary education (Gervilla, 1997: 47).

- From education in values: this is promoted by means of learning based on practical activities (Caduto, 1992).

- From museology: museum exhibits and their potential are harnessed to promote a living educational experience in the museum based on the affective component of learning.

- From the NICTs: the webquest resource is used for solving a problem calling for information searches. An active methodology is therefore proposed, fuelled by this resource, including collaborative work, research, heuristic and fun-based activities.

- From meaningful learning: a problem is posed to set up a «discovery learning process» (Ausubel, 1976: 75), in which the pupils «intentionally and substantially bring problems into relation with their cognitive structure» (Ausubel, 1976: 75-76), to seek new responses to the problem that are significant for him or her. Use is also proposed of the modified Piagetian interview and concept maps, firstly for diagnosing the pupils’ previous knowledge and subsequently for assessing their learning process. Within meaningful learning, special mention must be made of the methodology surrounding the use of concept maps, which is still under investigation (Novak and Cañas, 2006).

**Concept Maps**
Novak and Cañas (2006) propose three different methodologies
for working with concept maps, of which joint use is to be made:

- Focus question: the concept-map-based investigation of a topic might begin by answering an appropriate «focus question». The maps may therefore be built up not only from topics but also from these questions, which can facilitate the start and subsequent map building. Novak and Cañas (2006) saw them as the map’s «starting point». These authors also argue that the focus question «helps pupils to focus on the map».
- Parking lot: the starting point here is a list of important concepts that the teacher wants to ensure that all pupils use in their map.
- Expert skeleton maps: these are basic maps that have been previously prepared by an expert in the topic, containing chosen concepts and ensuring that both pupils and teachers build up their knowledge on solid foundations. They may facilitate the learning process, as shown by O’Donnell et al. (2002).

Novak and Cañas (2006) propose the combination of two of these methods. In our case all three methods are combined. To build up the map proposed for the teaching unit arising from the research project, the pupils start with a focus question on the topic in question. As well as the focus question pupils are given a skeleton concept map as a working base. This skeleton map has been adapted from one drawn up by an expert and it has to comprise a set of pre-selected parking lot concepts that pupils have to locate and learn. This initial map can then serve as the basis for seeking more information and learning about a topic (Carvalho et al., 2000) or other related topics that the pupil deems to be of interest.

![Skeleton concept map for the teaching unit «Respect and Biodiversity»](image)

Before introducing the topic in the teaching unit, therefore (Mena, 1999, Novak and Cañas, 2006), pupils are asked to complete a skeleton concept map, adding on another five parking-lot concepts (Figure 5), then to be expanded by pupils into a map containing between 12 and 20 concepts (according to Novak and Cañas, 2006, Molina, 1994: 337), with the aim of assessing pupils’ previous knowledge. The skeleton concept map will be newly filled in at the end of the teaching unit to assess the knowledge acquired by the pupils during the learning process by comparison with the starting situation, as proposed by Vitale and Romance (2000) and Guruceaga (2001).

In sum, the methodologies, principles and educational approaches described above, drawn from different and complementary theoretical frameworks, are brought together in a teaching unit that represents for pupils practical work of interest in the museum and requires them to seek information using NICTs.
The methodologies, principles and educational approaches described above, drawn from different and complementary theoretical frameworks, are going to be brought together in a practical teaching unit in the museum, which is of interest to pupils and implies a search for information using NICTs.

Planning: Teaching Unit Phases

The planning of the objectives, contents and methodologies of the teaching unit has been adapted from the proposal made by Zabala (1997: 58). This author considers his proposal to be applicable to the science teaching of the last years of primary education. Zabala proposes several phases in the implementation of a teaching unit, set up as a research process for pupils. The proposed phases are properly coordinated by means of the «hands-on» methodology, topped up with a webquest (Figure 6) (Dodge, 2001), designed for our case as an environmental education working project.

The three phases, obviously preceded by the requisite collaboration agreement between the school and museum, are the following (Table 4):

   - Presentation by the teacher of a problem situation in the chosen topic.
   - Posing of problems or questions: Zabala (1997: 96) argues that «it is essential for pupils to be given the chance to express their own ideas». A time is therefore set aside for pupils to come up with intuitive answers to each of the problems and situations posed.

   - Explanation of intuitive responses or suppositions.
   - Proposal of information sources: the pupils, aided by the teacher, propose the most suitable information sources.
   - Information search: data is gathered, selected, classified and displayed (Figure 7).

3. School. Post museum visit follow-up work.
   - Drawing of conclusions.
   - Generalisation of conclusions and summary.
   - Assessment.

Learning assessment plans to use, among other methodologies, mainly programmed concept maps at the start and end of the teaching unit.

Table 4. Classification of activities by type and timing. (Martínez and Martínez, 1995). Teaching unit «Respect and Biodiversity»
| A1. Welcome to the world of respect. Do you want in? | Initiation-motivation. | 45 | Monday |
| A2. I ask you for help...but with respect! | Initiation-motivation. | 45 | Monday |
| A4. My commitment to the rules. | Initiation-motivation. | 15 | Monday |
| A5. The bio-whatsitsname map? | Ascertainment of previous knowledge. Assessment. | 60 | Tuesday |
| A6. Interview. | Ascertainment of previous knowledge. Assessment. | 60 | Tuesday |
| A7. The four researchers. | Enlargement. Development or application of new ideas. | 45 | Tuesday |

### PHASE 2

| A8. Help me with biodiversity! | Enlargement. Development or application of new ideas.. | 15 | Wednesday |
| A9. «Webquest: How would you solve the problem of animals that are becoming extinct?» | Enlargement. Development or application of new ideas. Restructuring of ideas. | 150 | Wednesday |
| A10. «Learn what you want ». | Enlargement. Development or application of new ideas. Restructuring of ideas. | 60 | Wednesday |

### PHASE 3

| A11. «Point in common ». | Enlargement. Development or application of new ideas. Restructuring of ideas. | 45 | Thursday |
| A12. «Creation of a natural park ». | Enlargement. Development or application of new ideas. Restructuring of ideas. | 45 | Thursday |
| A13. «I take decisions too ». | Development or application of | 45 | Thursday |
Conclusions

- The research work dealt with herein has been conceived and carried out with a synthetic rather than analytical approach, seeking to unify the most representative aspects of several disciplines to develop an educative idea. The synthesis carried out goes beyond a mere superficial or even in-depth study of separate disciplines. It involves pinpointing common criteria and contents between environmental education, education in values, meaningful learning, museology and the new information and communication technologies (NICTs). All these fields of knowledge have a clear educational potential, adding up to more than the sum of their parts when studied in common. Their integration has enabled a specific educational programme to be developed, conserving coherence with the aspects and educational criteria furnished by each field separately. In sum, this article reflects the groundbreaking character of its underlying research, bringing together different fields of theoretical, practical, conceptual and applied knowledge and tapping into their synergies.

- The social environment is changing and any educational syllabus has to innovate constantly to keep pace with these changes. At the same time, the design of trailblazing syllabi needs to work from tried and tested knowledge that underpins any new educational idea. The theoretical and practical synthesis of the disciplines studied generates a new, groundbreaking and coherent base for designing many changing educational syllabi. The specific syllabus presented herein is conceived as a first step down many possible paths, opening the way for those that may be defined in the future on the same research basis, even using educational resources other than the holdings of Navarre University’s Natural Sciences Museum.

AUTHORS

Fernando Echarri Iribarren. aged 42 (24.11.65).
Graduated in Biology from Navarre University. Has worked in the education field since 1997, in the Granja escuela Ilundain, an environmental education farm school. Associate Professor of Navarre University in 2004 in the subjects of Ecology and Environmental Impact. Navarre University is the organisation for which he carried out this work. This article is a summary of the work he is going to present as his doctoral thesis.

Jordi Puig i Baguer. aged 41 (05.08.1967).
Graduated in Science (Biology) from Navarre University. Doctored in Biology from the Universidad Politécnica de Madrid. Professor
of Environmental Impact Assessment in the Navarre University’s Zoology Department since 1996. He has been visiting professor at University of California, Berkeley, USA (2002-2003) and of the University of Manchester, United Kingdom (2004).

TO FIND OUT MORE


   http://tecnologiaedu.us.es/revistaslibros/tics.htm , [Date of access: 10.09.2008].


Legend

1 Ballester (2002) reports the fall in classroom disturbances recorded in several experiences of meaningful learning in schools. Among other causes this may be due to the change in the teacher’s authority status from one of position-based authority (I’m the teacher, you’re the pupil) to one of knowledge- and help-based authority (I’m here to help you if you wish).

2 Internet publication of the museum and its catalogue is done by means of a direct link («Museo de Ciencias») in Navarre University’s website http://www.unav.es

3 This software goes under the name of Cmap Tools (Cañas et al., 2004) and is available at the website: «http://cmap.ihmc.us»; it is free, open-source software. Its very nature of shared or «free» software means that it can be presented as fruit of the values that the syllabus is also keen to get across as part of environmental education, such as fellowship, freedom and cooperation (Adell and Bernabé, 2007).

4 [Nota de traductor: este pie de página no hace falta tratándose de lectores angloparlantes, Se puede quitar]

5 Caduto (1992: 33) argues that 11 to 12 year olds (though there may be a transition phase) mark the limit of «morally dependent» pupils, namely those «who have not yet developed a cognitive and moral reasoning capacity or a personal ethical system».

6 In any case the teaching unit has been designed to be effective for the target public, whether or not this chimes in with the teachings of Piaget and Inhelder.

7 The focus question could be the same research question proposed in webquests