CHAPTER 1. Educational proposals in science.

1. What is science?

The nature of science

Science is concerned with the development of knowledge and understanding of the natural world in their biological, chemical and physical aspects.

At the same time, science means a way of working-conducting research: the scientific method.

In teaching, both have to adapt to the students´ levels. This process is called "Didactic Transposition", that means the process of going from "knowledge as produced" to "knowledge taught".

Natural sciences must limit themselves to look for knowledge and explanations about the natural world.

Science is a human enterprise that depends on the creativity and imagination of scientist people, who display these elements on the specific methods they apply as they develop their researches as well as on the descriptions of the laws, theories... that they produce.

Scientific knowledge's components: Processes and Products

Processes

Doing science is exploring the natural universe in a specific way that involves different processes such as defining hypothesis, collecting data (to observe, to measure) analyse data, verify, conclude...).

In looking for reaching an understanding of the general principles underlying the functioning of the universe, scientific people have developed what is called the "Scientific methodology" which includes the application of a series of different processes, such as:

a) Observation of specific facts or phenomena. Scientific observation includes measuring, so it is necessary to establish units of measurement (distance, force,

mass, volume, time, temperature...) and the use of various devices, such as thermometers, dynamometers...

b) Production of explanatory hypotheses relating to phenomena that must be tested using further research.

c) Formulation of generalisations about the nature of such phenomena (laws and theories).

Products

Scientific work must develop theories and uses them to explain phenomena or to predict events. They are part of the products of scientific work.

Scientific ideas and theories are subject to review and change as new evidence comes to hand. The following are examples of definitions of some scientific products:

Fact: Is observation of something that has happened and repeatedly confirmed that could be defined.

Hypothesis: Is a statement that contains a prediction about some aspect of phenomena of the natural world which can be proved or disproved through the development of scientific research.

Law: Is a pattern or generalisation about how some aspects of systems from the natural world behave under stated circumstances. Frequently, mathematical expressions define scientific laws.

Theory: Is a well-substantiated explanation that can contain and connect among them facts, laws, inferences, tested hypotheses, conclusions... of a series of scientific researches.

These results must undergo revisions by many scientists before being accepted as valid by the scientific community. In doing their tasks, scientific people can only deal with events or things that can be measured, observed or detected. Scientific methodology cannot be used to investigate another kind of questions. For example, beliefs about questions such as the meaning of life or the existence of supernatural powers cannot be addressed from science research because scientists do not have the means to manage these issues. Frequently, disciplines such as religion, philosophy or similar ones try to give answers to these kinds of questions.

Aims of science education

A broad and balanced scientific education must be concerned with teaching and learning

of a body of scientific knowledge and with the provision of opportunities for children to work scientifically to acquire experience on fundamental aspects of how scientists investigate the world.

In helping children to become scientifically literate, the science in the school curriculum aims to foster their positive attitudes to science, developing their appreciation of the contribution of science and technology to our personal and social wellbeing. They must gain awareness that science and technology can contribute to the education of every citizen providing learning opportunities such as:

a) Stimulate their curiosity, interest and concern about the natural environment through the experience.

b) Understand themselves and the world around developing knowledge and understanding of basic science topics.

c) Develop skills, habits of mind and attitudes necessary for scientific inquiry.

d) Develop the habit of using scientific knowledge and methods in making personal decisions.

e) Develop their appreciation of how science influences people and the environment.

f) Develop their understanding of a variety of properties and interactions in the physical universe.

g) Develop their scientific skills for investigating and exploring the natural world.

h) Develop positive attitudes to science and their appreciation of the contribution of science and technology to society.

2. Designing teaching units. Principles and criteria

Systematic planning by the teacher will be crucial for the success of a science program. Such planning should cover the acquisition of knowledge, the development of skills and attitudes and the use of appropriate assessment.

In designing teaching units, the teacher should give special consideration to the following criteria:

1. Select the topic from the strands and strand units outlined in the science curriculum and have in mind that the topics should ensure continuity, progression and links between what is the pupils´ actual knowledge and our new proposal.

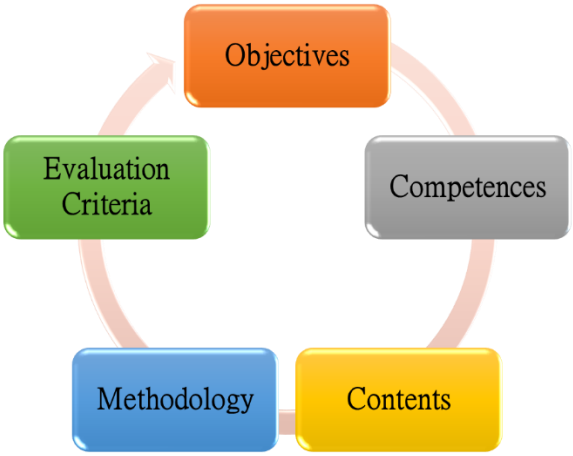
2. To know the previous learning experiences of the children. The learning experiences and the scientific concepts and skill developed by the children so far should be the starting point for the teacher´s planning in science. The teacher should help the students to test their predictions and have opportunities for changing their ideas to fit the evidence better. The review of children ideas will provide the teacher with useful information when planning schemes of work. Consulting the former class teacher; reviewing the pupil profile cards and class records and asking directly to the students about their ideas about central concepts of the topic will provide the teacher with crucial information about where the mind of students are and what are their misconceptions.
3. To identify and define the learning outcomes, aims, goals and objectives to be achieved by learners as results of working this unit. It will provide the basis for selection of the contents, the activities, the teaching and the assessment organisation.
4. To clarify and identify the specific content cover in the unit. It will specify the concepts, skills and attitudes that children should develop.
5. To consider the teaching approaches that can be employed (teacher explanations; individual, pair, small group working; reading; writing; lab activities; videos...)
6. To design a scheme of work focus on a wide range of activities and to outline the science activities that the children will undertake and place them in the sequence that can contribute most in the development of students skills attitudes and concepts. In general terms, these learning activities should: a) arouse curiosity and stimulate exploration and investigation and b) give opportunities to interact with materials and a range of ideas from other children, from adults and a variety of secondary sources, such as books, videos and other media.
7. The plan of work should incorporate continuing activities that children may experience daily or weekly, such as recording the weather or taking care of animals and plants in the classroom.
8. Teachers should also plan some activities that small groups of children can undertake without adult supervision. For example, investigation tables may also be set up in the classroom with associated questions on cards, such as daily temperature, humidity of the atmosphere, wind direction...

9. To use a range of teaching approaches and methodologies will ensure the balanced development of knowledge, skills and attitudes.
10. To provide a differentiated proposal to fulfil the social and learning needs of individual pupils. They should plan activities that all children should complete as well as providing support activities for the less able child or more able child. The teacher should also consider organising the children in groups and the possible extra help and tuition that some children may require during the learning activities.
11. To identify the resources required for the topic and the equipment in the school. Teachers in the same school should manage to share the available resources to maximise the use of specialised equipment, such as thermometers, nature viewers, magnets, bulbs and batteries.
12. To specify the methods of assessment to be used.

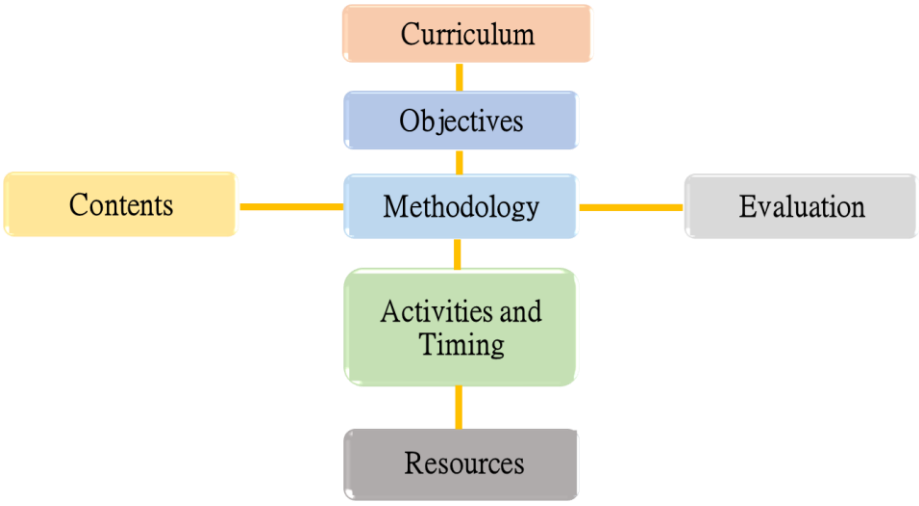
In planning activities that are appropriate to the different children´s levels of ability and experience, teachers can consider:

a) To use a combination of whole-class teaching and focused group work.
b) To provide opportunities for further work for the abler or less able.
c) To plan units of work based on especially familiar contexts.
d) To provide opportunities for interacting and working with other children in small groups.
e) Allow children to work with concrete materials

In definitive, the teaching unit is the set of objectives, competences, contents, methodologies and evaluation criteria of the different areas of knowledge, together with the contribution of these areas to the acquisition of basic competences:



A deep relation between all the components of a teaching unit could be:



In fact, during the design of a teaching unit, we can consider a series of questions such as:

- **Why teaches Science?**
- **Which science to teach?**
- **How to teach science more effectively?**

Next, we are going to look at each of these questions:

Why teaches Science?

Specifically, it has to satisfy the following questions: Why teach science to citizens? Moreover, Is science learning that all must undertake? The answers are the guide to make decisions on the other issues of teaching:

What strategies?

What capabilities?

Which activities?

What contents?

In definitive, it relates directly to the Aims of Science Education (educational intentions):

Objectives

Competences

Objectives

We can define them as:

- They indicate the goals towards which to direct the school activity.

- They facilitate the selection and organisation of the necessary teaching.
- Mark and make possible the criteria and contents of the evaluation.

Key competences

One of the main purposes of the primary education is the acquisition of competences, so, in that sense, Students will acquire the necessary tools to understand the world around them and become a person capable of actively and critically intervening in society.

Which science to teach?

It relates to the knowledge and the main aspects worth to be included in the curriculum, namely, the **contents**. Traditionally, contents were a selection of scientific knowledge, structured in academic disciplines that gave us the ability to offer us an adequate understanding of the world. Currently, there has been a change of form that by contents can be understood more than a selection of knowledge belonging to different fields of knowledge developed and formalised and that relates to a conception of the school as an agency of cultural transmission and the curriculum as the cultural project of society.

Within the new curricular approaches, it is the movement on Scientific Literacy of Citizenship that has had the most significant influence since the 1990s, although its concrete contents and questions have not been resolved.

If we understand that being scientifically and technologically literate means being able to read and understand the scientific languages of the social communication media, it would be necessary to analyse what contents it poses to the scientific education given in school.

How to teach science more effectively?

It is related to how to bring to the classroom the contents that are included in the curriculum, **methodology**. Three significant factors influence the methodology: the role of the teacher, the learning and context and the role of the student.

Role of the teacher

Any curriculum carries with it, implicitly or explicitly, a way of conceiving the role of the teacher, which affects both the way he or she understands his or her function and the degree of autonomy granted to him or her in decision-making.

The role assigned to the teacher is closely related to the methodological guidelines of a specific curricular proposal and the activities to be used to promote student learning. Therefore, on the one hand, we can conceive of the teacher as a technician who focuses exclusively on teaching what is in the curriculum. Also, on the other hand, we can conceive of the teacher as an autonomous professional who can guide his or her practice by analysing educational situations and using a full range of teaching strategies.

Role of the student

Not all students are the same, so their progress in learning will also be different. Therefore, during the design of a didactic unit, it is necessary to consider the psychological and sociological factors to cover as much as possible the spectrum that we can find in our classroom.

Role of the student

In the research on ideas of students and adults, it is essential to analyse how the use of everyday contexts is a determining factor to generate learning when dealing with scientific subjects, being found as factors that promote it:

- The emergence of controversy (nuclear power, embryo manipulation, …).
- Relevance. Issues that affect the population, the level of life, the welfare society, ...
- Commercial interests, when they wish to emphasise quality, novelty, … of a product
- Incidence regarding the attitudes towards science that generate, opinions and beliefs.

3. Defining goals / purposes / objectives.

Aims and purposes are close concepts. The teacher purpose, when he/she decides to do something, can be considered as equivalent as an aim. Both ideas are related to the result that it is intended to achieve.

In the same way, teachers usually interchange goals and objectives. The main difference comes in their level of concreteness. Objectives are concrete, whereas goals are less structured. Here is an easy way to remember how they differ:

Goal has the word "**go**" in it. Goals can be indicating going forward in a specific direction.

Objective has the word "**object**" in it. Objects are concrete.

Goals and objectives are tools for accomplishing what the teachers want to achieve.

However, goals are long term and objectives are usually accomplished in the short or medium term. Both describe what students will learn or be able to do after instruction.

In summary, goals and objectives specify what the teacher will teach and try to assess; so it is essential to write them in a manner that makes their meaning clear to the teacher and students.