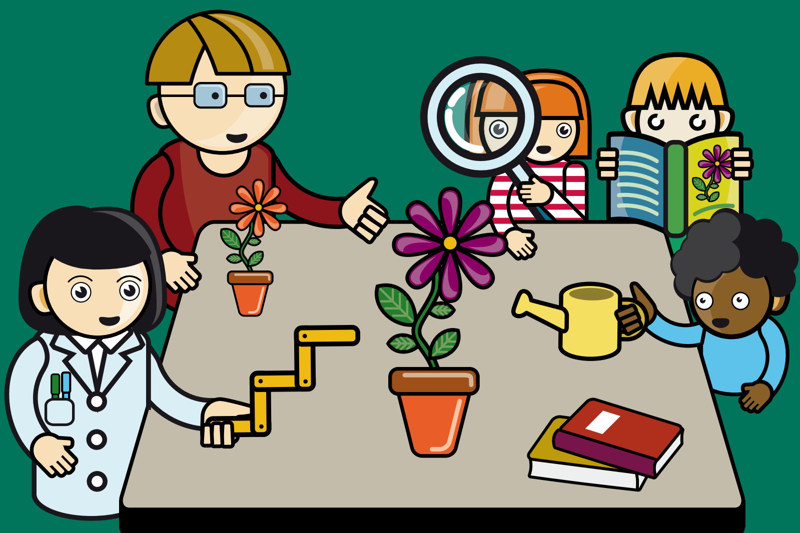
Introductory Guide

Supporting teachers through the involvement of scientists in primary education



Introductory Guide

Supporting teachers through the involvement of scientists in primary education (ASTEP)

INSTITUT DE FRANCE
Académie des sciences

ACADÉMIE DES TECHNOLOGIES

ministère éducation nationale

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MINISTÈRE DE L'ENSEIGNEMENT SUPÉRIEUR ET DE LA RECHERCHE

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This Guide received the support of:

Foreword

Condorcet, Arago, Langevin, Curie were all great scientists who were passionate about teaching and transmitting science to younger generations.

For the last 15 years, in the aftermath of *La main à la pâte* initiated by the Nobel Prize winner Georges Charpak, a new form of partnership between scientists and teachers in primary schools has taken shape called Supporting teachers through the involvement of scientists in primary education (ASTEP). It is particularly illustrated by the presence in the classroom, alongside the teacher, of scientists who are generally also still students. This support system is governed by the principles and characteristics outlined in this guide.

This cooperative work is beneficial for all the parties involved: pupils, teachers and scientists. They all discover a civic and formative project where all the fundamental aspects of the scientific approach are reinforced by the knowledge and experience of the scientist.

This guide is designed to provide practical information for all partners involved in the Teacher Support Structure. It contains principles, testimonies, resources and ideas that will help the reader understand and promote on a broader scale the ASTEP system and thus contribute to the renewal of science and technology teaching so that France is prepared for tomorrow's knowledge economy.

Joint presidents of the ASTEP
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Education

Supporting teachers to improve science and technology in primary classes

1 Supporting teachers to improve science and technology in primary classes

In order to develop inquiry-based learning in the classroom, ASTEP (Supporting teachers through the involvement of scientists in primary education) aims to promote a system where the research scientists, engineers, professional technicians and science students commit themselves to participate actively in supporting of primary school teachers and their pupils.

Professional scientists and science students can indeed make key contributions to teaching.

As active players and witnesses involved in everyday's professional and research fields of science, they provide by themselves stimulating and living examples. They can also facilitate teaching on the primary school level by providing support in ways that have considerably developed over the last few years.

Commitment of Engineering schools and universities

For several years now in France, the EMNantes School of Engineering, the École Polytechnique, the ESPCI (City of Paris Industrial Physics and Chemistry Higher Educational Institution), the ENSAM (École Nationale Supérieure des Arts et Metiers), the Universities of Bordeaux 2, Pau and Perpignan, the Doctoral School of the Natural History Museum, the CEA (French Atomic Energy Commission), are a few of the institutions that have joined the ASTEP in enabling students, researchers and engineers to regularly provide support for classes by creating specific resources for them, organising training courses or taking part directly in the classroom.

"Guiding teachers in setting up and implementing a scientific approach in compliance with primary school curricula" is the role of the scientific tutor. His mission is described in the 8th principle of *La main à la pâte*, a document which prescribes that "locally, scientific partners (universities, engineering schools) support work in the classroom by making their skills available".

The mission of the scientific tutor concerns, above all, the introduction and explanation of scientific knowledge and skills, that he highlights, comments and illustrates. He also is involved in *the implementation of an inquiry-based approach, in particular the experimental phase*.

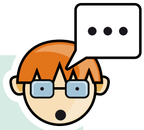
The scientific tutor's work completes the work of the teacher. His role is different from that of the pedagogical teams: **support in science and technology is complementary to teaching** and never a substitute. **His purpose is, above all, to make the teacher more autonomous** and therefore avoid any dependence on the scientific tutor.

His mission is to reinforce investigation in the classroom, as it is outlined in primary school curricula. This approach, which must be implemented under the responsibility of the teacher, essentially aims to enable pupils to appropriate scientific knowledge by partially building it up on their own. To achieve this, students must be encouraged to investigate the world around them, by allocating time to express and compare their ideas, explain their reasoning, test their hypotheses and express the outcomes of their experiments. The investigative approach takes advantage of the pupils curiosity to introduce the precision of scientific reasoning and investigation and, in this way, to enable sustainable acquisition of knowledge (see appendix 2).

This approach, which is briefly outlined here, has developed a great deal throughout the world over the last fifteen years under the name of *inquiry-based science education*. It has breathed new life into the teaching of science and technology by aiming to transmit, at an early age, a taste for science by enabling the acquisition of skills and knowledge that are used in science and by promoting the development and autonomy of children. However, it remains demanding in terms of methodology and preparation. Effectively guiding each student or group as well as organising experiments and transporting the necessary materials often requires considerable effort, especially for the initial sessions. In return, the activities put into practice create extremely rich pedagogical situations which contribute to teaching many fundamental skills where reading, writing and arithmetic are associated with reasoning for the construction of more vast and complementary knowledge.

Teacher Support: a special relationship between students, teachers and scientists ...

As the purpose of Teacher Support in science and technologies is to stimulate curiosity, critical thinking and independence as well as to awake passions and create vocations at a very early age, it does differ from other activities in that, it involves the pupils, teacher and scientist in a system of mutual enrichment and sharing of skills.



Testimony

ASTEP, a win-win partnership

At first, each person brings something different, but also something complementary, to the situation...

- the teacher brings his pedagogical skills, especially in the areas of class management and transversal learning, his listening skills...
- the children bring their curiosity, their spontaneous questions, their creativity...
- the scientist brings his scientific knowledge, his mastery of experimental and investigative methods, his familiarity with scientific vocabulary and arguments...

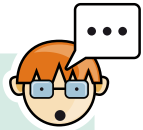
then the exchanges created by this collaborative project inevitably lead to a learning experience and enrichment for all...

Sophie Mathé,
manager of doctoral student-scientific tutors at the Paris Museum of Natural History, ASTEP Colloquium 2007

For the teacher, this support is an opportunity to try a new professional approach and therefore a chance to view the science programme with less apprehension, to gain confidence in the implementation of scientific or technological methods and to consolidate mastery of course content to achieve autonomy.

For the pupil, the presence of a scientific tutor is an opportunity to test his scientific ability and confront his approach with that of a specialist. This is a real source of shared motivation and pleasure. Moreover, the pupil develops his capacity for critical thinking and measures the precision of his reasoning... He discovers the virtues of patience and attention, he tries to construct arguments and finds in debate a means of experimenting with the rules of communication and democracy.

Finally, **for the scientist**, it is an exceptional experience inside the world of teaching that allows all parties involved to share their skills. It is also a chance to show the real face of science to teachers who often only see a set of results, concepts and abstract notions, with no real relation to everyday life. Finally, it is an opportunity for the scientist to reconsider his own knowledge, to adapt his message to a special audience, children from 3 to 11 years old, which often leads to surprising situations, and to provide the pupils with a more realistic and accessible image of the scientific profession.



Testimony

"At primary school, the making of future scientists"

The European Space Agency (ESA) is engaged into an ambitious and long term project called ESERO (European Space Education Resource Office). ESERO has been conceived with the purpose of offering tailored support to the educational communities of the various ESA member States. The project is currently completing a pilot phase within 4 countries (B, UK, SP & NL). The project will be implemented in Norway, Portugal, Ireland and Italy as of 2009.

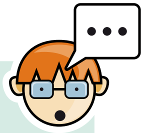
In Belgium, for example, schools in the regions of Mons and Courcelles, in Wallonia, have been involved in "space and teaching" pilot projects for nearly a year. With support from the ESERO project of the European Space Agency (ESA) and education authorities, they have made science the motor of their school projects.

Mrs. Servais-Delvaux, the inspector who promotes this project in the Courcelles area takes stock of the first year of experimentation: *"Now research has become a learning process. The children communicate more orally to explain their project to their fellow students, teachers and parents.*

The schools know more about the different professions in science in their environment. They have learned to use these resources and how to set up networks.

In the same way, almost every school has organised some scientific documentation, as well as a science corner, in the classroom or the school. The teachers exchange information, documentation, class files or experiments...In many schools the traditional school fair has been replaced by a science fair."

There is a real challenge which is highly stimulating and which can change the idea the scientist may have of the transmission of knowledge.



Testimony

Questions arise during class activities that are not always trivial or devoid of interest…

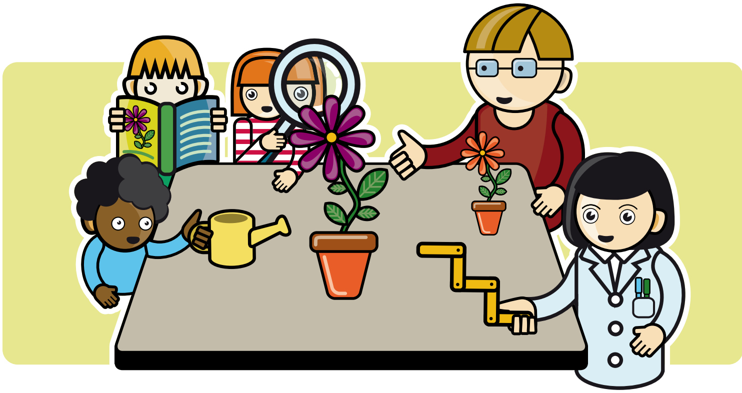
They encourage scientists to question their work and knowledge. This new approach to science is in fact not as simple as it seems. The transition from theory to the experimental phase is not always that easy. When you weigh a rubber balloon full of air, you have to take the buoyancy into account which is not the case for a football or basketball which doesn't change in volume. So, does it weigh more than an empty balloon? If two north poles repel each other, then why is the compass needle attracted to the Terrestrial North Pole? Why do bean plants, when placed in the dark, germinate while those in sunlight do not? These are all challenges that force the scientist to apply previously acquired knowledge, but also to take into account the parameters of the real world instead of an ideal situation or model.

A support science student

The following chapters offer guidelines for practice, advice and testimonies so that scientists, teachers and pupils can profit from of this privileged relationship.

Different ways of supporting teachers

2.1 Supporting teachers in the classroom



What does this consist in?

Professional scientists or scientists in training, support science students (from universities and engineering schools), research scientists, engineers, whether currently working or retired, take part in the classroom sessions devoted to science and technology.

The scientific tutor commits himself to regularly take part in classes, one half day a week, for a period of at least seven weeks between two school holidays in order to give his mission a certain continuity. His contribution is resolutely part of an investigative approach.

During preparation, the scientific tutor advises the teacher on the scientific notions targeted by the class activities. At the teacher's request, he explains them, underlining the relation with other notions dealt with in previous classes and linking them with certain everyday situations. He also helps set up the sessions by suggesting equipment, experiments and providing documentation.

Implementation in class is an opportunity for the scientific tutor to assist the teacher, to guide the pupils through the investigative approach, to stimulate expression and reasoning and to question them. To this end, the scientific tutor actively participates in exchanges. A posteriori, he analyses the organisation of the activities with the teacher. Each contributes his skills, scientific expertise on the one hand and pedagogical know-how on the other, in order to adjust appropriately the forms of Teacher Support. As he is concerned in making the teacher more autonumous, he also helps the teacher identify key moments in the investigation process which the latter can then use in the future to set up other learning situations... He takes great care not to take the place of the teacher who remains solely responsible for the learning process.

Testimony

The quality of the relationship between the teacher and scientist influences whether the project is successful or not and if it is to the benefit of all the parties involved. Thus I have observed the confidence and ease acquired by the teacher. This enables him, after the scientific tutor is gone, to continue teaching science and deal with scientific questions and remarks from pupils and sometimes to extend the approach to other areas of science. Making the teacher autonomous is really a key goal for the scientific tutor.

***Camille Charaudeau**, scientific tutor*

Moreover, the presence of a scientist in the classroom creates an original pedagogical situation: the diversity and richness of possible interactions between the teacher, the scientist and the students inspires new ways of learning as the past experience of engineering students from the ESPCI has shown.

Testimony

At the ESPCI (City of Paris Industrial Physics and Chemistry Higher Educational Institution) engineering students have provided Teacher Support in science and technologies in neighbouring schools since January 2000. A study was carried out on the new situation created in the classroom by the presence of a scientific student. It shows that Teacher Support in science is not a form of "aid" for teaching science. In this new pedagogical context multiple interactions immediately take place between the teacher, scientific tutor and students. The roles and skills, which are different yet complementary, seem to favour an interface that promotes knowledge rather than the execution of a task. It is not only the teacher and/or scientific tutor who make it possible for the pupils to learn, but the whole situation and space that makes other learning processes possible.

***M.O. Lafosse-Marin**, Espace des Sciences Pierre-Gilles de Gennes*

Some characteristics of Teacher Support in the classroom

A day in the life of a full-time scientific tutor provides a perfect illustration of all the different aspects involved:

Before the session

IIsabelle, a CP teacher (6 to 7-year olds) would like to work on the theme of Air. As I have already dealt with this subject with pupils in CE2 (8 to 9 year-olds) I can tell her about the difficulties I encountered: air is invisible and therefore does not exist in the pupils' minds. It is not easy to organise sessions on a subject that you don't know very well yourself...I help Isabelle recap the fundamental notions involved and we discuss the target we want to achieve: awareness of the physical existence of air.

We agree on the content of the first session: we will have the students handle bags containing different materials, including one "empty" one, or rather a bag full of air...Our aim is to start them thinking about air. Isabelle will take care of the bags and their contents while I will provide cardboard boxes to hide the bags.

During the session

The following Thursday we have a set of bags for 24 pupils. Isabelle is going to supervise the handling of the bags while I help the pupils with drawings and writing about their impressions.

Isabelle starts a discussion with the entire class: what were in the bags? How do we know? Isabelle glances at me from time to time. I jump in when she hesitates: No, wind and air are not the same; we'll talk about that later in one of the lessons.

We end the session with a summary dictated by the pupils that they will write down in their notebooks.

After the session

I suggest that we adapt the module used with the CE2 class and help Isabelle select some experiments she has found in a pedagogical book. I advise against using some of them as they are too complicated to understand or explain.

Finally, we plan to progress over 6 or 7 sessions with a few supplements that Isabelle will do alone with the class over the week. We've been talking for over an hour already! We say goodbye and plan to meet next week for the second session...

***Estelle Comment**, Student at the Ecole Polytechnique, scientific tutor in a primary school during her internship in Personal Development*

Scientific guide
Teachers do not always master the subjects concerned. The scientific tutor can help overcome certain difficulties.

Contribution to logistics
Equipment and documents. Sometimes it is necessary to improvise.

A second adult in the classroom
With two adults it is easier to supervise all of the pupils during an activity.

New possibilities
By his presence alone, the scientific tutor encourages the teacher to experiment. The teacher can count on help from "the expert" when he is not sure of something.

Working in tandem
To be more productive, knowledge must be shared between peers: the scientific tutor knows "how things work" while the teacher knows "how to teach".

Contribution to the substainability the approach
The teacher sets up, with help from the scientific tutor, the steps of a learning process which is organised around a series of sessions.

A few guidelines for effective support

In order for everyone to fully benefit from in-class Teacher Support (pupils, teachers and scientists) there are a few necessary administrative, scientific, pedagogical or relations-related steps before, during and after the sessions that the scientist and teacher should devote some time to.

The relationship between the teacher and scientific tutor

The scientific tutor can benefit a great deal from an initial contact with the class during school hours in order to get a feel of the atmosphere, understand the habits of school life and work methods, get acquainted with the pupils, arouse their curiosity and have a preliminary contact with the teacher before the first Teacher Support session.

As for the teacher, he will make sure the curricula are followed by informing the scientific tutor of course content and objectives in science and technology for the class concerned. He will set up favourable conditions for the inquiry-based approach and teach the pupils.

He will also take care to facilitate the smooth integration of the scientist in the class, whether in terms of his relationship with the pupils or the school, by taking care of any behavioural or disciplinary problems in the classroom.

Creating classes and activities in tandem

Since preparation is essential, it is necessary to provide time before the sessions. This can sometimes be a problem: primary school teachers don't have many gaps in their schedules and can also help in the canteen at lunchtime or supervise study hall after classes.

Key points to cover

- the period in the school year and the duration of the Teacher Support project, drawing up a calendar if need be;
- the context of the work done: is it a school project, part of a cycle, a class project?
- an explanation of the notions of the programme to be covered and the target scientific concepts.

These should be limited in number as it will be a first approach for many pupils.

- the distribution of tasks required for the preparation of the project (equipment, research, documents...);
- the experiments to be carried out and tested before use in class.

Giving meaning to pupils' knowledge

The scientist will take care to:

- help pupils express in multiple ways the knowledge they have acquired in order to guarantee they have assimilated it;
- put their knowledge in perspective by showing them that it can be applied to many different situations in everyday life;
- demonstrate the cultural and social dimensions of science through the discovery of different professions and places where science is carried out (important national institutions, museums, associations, centres for scientific, technological and industrial culture, local governments, universities...) which can often arouse children's interest in science.

Analysing, *a posteriori*, class practices

During the course of the project adjustments often need to be made. Analysis and evaluation are easier if, at the outset, some means are set up to record the work done on both an individual level (experiment notebook, file...) and collectively (posters, tables, organisation charts, videos...). A grid is available in Appendix 3 that will enable the scientific tutor and teacher to evaluate their work in relation to the principles outlined in this chapter.

Pitfalls to avoid, hurdles to overcome

Nothing is as simple as it seems!
The role of the scientific tutor is a subtle one. He must act in the classroom without taking charge, answer questions without giving too many answers... All these difficulties can lead to problems, among the most frequent:

Taking the teacher's place

This goes against the principle of joint-intervention in class: the teacher must remain in charge of the class and implement the pedagogical programme so that he can organise the activities alone later on, after the scientific tutor has left.

Giving all the answers

The scientific tutor creates an unfortunate situation by positioning himself as "the one who knows" and the opposite of "the one who receives". It is much more interesting to develop the child's tendency to search for the answer himself, through experimentation, analysis and thought, according to the principle of co-production of knowledge.

Showing a form of science that is inaccessible, reserved for experts

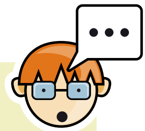
The level of conceptualisation must be carefully selected so that the subjects treated in the classroom are adapted to the children's ability to understand. Children should be made curious about science and their environment and not confronted with concepts that are too difficult, leading them to believe that science is not for them, even if their questions often spontaneously concern technological objects or complex phenomena.

Knowing everything and doubting nothing

Such an attitude gives children the wrong idea about science since it is through trial and error that science in fact makes progress. Contrary to what many children believe, scientists do not know everything and can make mistakes. Moreover, it is always useful to ask children to express their ideas before checking or refuting them as this is part of the knowledge building process.

Making oneself indispensable for the scientific activities in class

The ultimate goal of Teacher Support is to help the teacher achieve a sufficient level of autonomy. Therefore the scientific tutor should take great care not to make his presence indispensible for the success of scientific activities.



Testimony

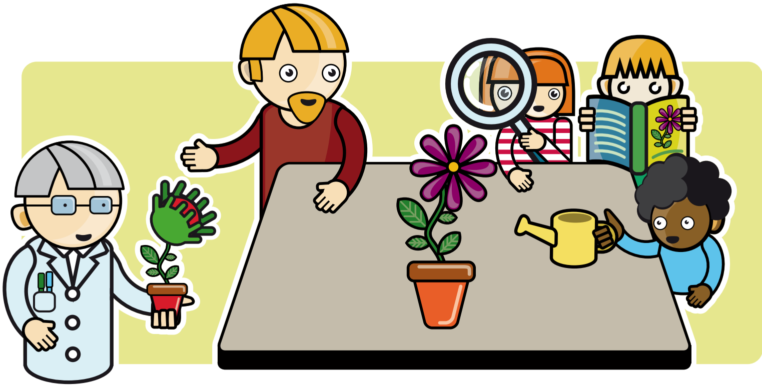
I have been able to take part in Teacher Support in CP-CE1 classes (6 to 8-year olds) for several years for 5 or 6 sessions per semester. The subject chosen is linked to the themes of the year (water, the atmosphere, the climate, etc...) and the content of each session is carefully planned with the teacher. The main difficulty has been to adapt to the rules of discipline and the inventive and exuberant behaviour of young children during experiments. It has never been difficult to show that an experiment that didn't work was just as demonstrative as one that had. A lot of time is always spent on the presentation and collective discussion of results and the writing up at home of reports has enabled us to involve all the pupils, especially those that tended to stay on the sidelines during the sessions.

***Jean Matricon**, Professor Emeritus at the University of Paris 7*

Scientific tutor student from Polytechnique in a 8 years old class in St-Etienne working on the body in movement.

Doctoral student in a class at Loire-Atlantique.

2.2 Supporting teachers through sponsorship



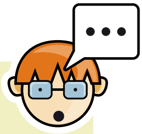
What does this consist in?

A sponsor is a confirmed scientist (research scientist, engineer, teacher...) either currently working or retired, who accepts to create sustainable links with the class and provide support for the teacher and pupils in learning about science. All year long, or throughout an entire project, he remains in contact with the class by written correspondence, telephone calls or email. He also meets the teacher at least once a semester to assess preparation and the results of the sessions.

A few characteristics of Teacher Support through sponsorship

The sponsor is a scientific reference for the teacher. He provides theoretical and practical assistance that can take on various forms:

- **intellectual support,** to help specify a concept, interpret a phenomenon, refine an investigative approach, define the limits of a model or generalisation.
- **a scientific guarantee,** when it is necessary to define a project of scientific activities and the related target notions.
- **assistance with experiments,** by contributing ideas for experimental activities or lending equipment for carrying them out.
- **organisational support,** from the design to planning of projects or arranging visits on site.



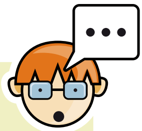
Testimony

When scientists from the University of Paris 13 sponsor classes in the Seine-Saint-Denis...

This type of Teacher Support first involves setting up a dialogue between teachers and research scientists so that each protagonist can familiarise himself with the other's work and have a more tangible representation of what it consists in. Therefore it is important to meet at least once in the workplace, school and university. Science Week was an opportunity to organise a preliminary encounter in the researchers' laboratories where they presented their work.

This is how cooperative projects were imagined. Exchanges took place mostly by email thus enabling communication back and forth between the scientist and the class.

Maxime Fauqueur, *pedagogical advisor*



Testimony

During a discussion with a CM1 class (9 to 10-year olds), we wanted to introduce the study of matter by showing that chemistry is a discipline present in the children's everyday lives without them necessarily being aware of it (from cooking to cosmetics, through dyes, medicines...). But very quickly it became clear that for them chemistry represented pollution from factories. We therefore had to confront them with experiences from their own lives so that, little by little, they could identify other, more positive, forms of chemistry. When, at the end, in response to the question "Is chemistry good or bad?" the answer was "both", you therefore felt as if you had really contributed to making the children more objectively aware of these aspects of chimistry..

Christophe Joussot-Dubien,
research engineer at the CEA (Atomic Energy Commission) in Marcoule.

A few guidelines for effective Teacher Support

At the start of the Teacher Support experience, the sponsor can observe from a session of scientific activities in the classroom the following:

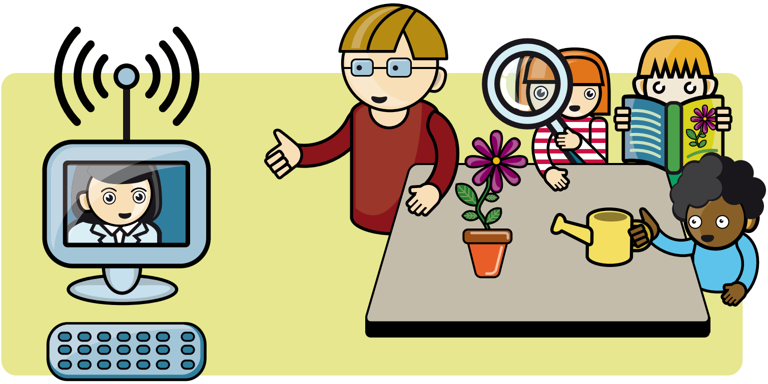
- the scientific level of primary school pupils,
- the type of questions they ask,
- the type of reasoning they develop.

Pitfalls to avoid, hurdles to overcome

Excessive enthusiasm and insufficient attention to primary school curricula:

- these curricula are a valuable guide as they take into account the pupils' abilities according to age and class.
- Irregular contacts: sponsorship is a long-term commitment. It is important that the scientific tutor agrees to maintain a certain level of accessibility and regular contact.
- Contributions that the teacher has difficulty exploiting alone: the information supplied by the sponsor should be precise, accessible for the teacher and easy for him to use on his own.

2.3 Supporting teachers from a distance



What does this consist in?

Teacher support from a distance consists in contacts between a scientist and a teacher via Internet (email, mailing list, forum…). The scientist answers questions from teachers.

This exchange can take place directly, but also can be facilitated by a portal dedicated to this type of exchange and the presence of a moderator who helps with the drafting of questions and answers.

A few characteristics of Teacher support from a distance

- It concerns **the teacher** and not the children.
- It is essentially based on occasional needs, which enables the scientific tutor to manage his time more easily. However, he must be able to react quickly in order to maintain a two-way exchange with the teacher.
- It also includes participation in forums and mailing lists for the science teacher.

A sample question

In experiments with water, we have produced steam by boiling it. This is a simple experiment, but it is always fascinating for 6-year olds.

When writing up their reports, the pupils express what they have seen in words and illustrate the steps of the experiment. At one point, they wanted to write "the steam escapes and disappears in the air". This remark bothers me because after holding a glass over the steam the children observed the condensation...

What could they say instead of "the steam disappears in the air"?

- **Answer by Jean-Louis Basdevant:**
  The children are still right. The steam indeed "disappears" in that it is no longer visible; it no longer "appears". Water vapour is water in a gaseous state that mixes with the air and cannot be seen (just like we cannot see the perfume we smell in the air, but we can see its colour in the perfume bottle). When water is mixed with air it can reappear as droplets, like the clouds, or be condensed on a glass, if the conditions are right, for example if it is cold enough. [...]
- **Answer by Martin Shanahan:**
  I think you can suggest the concept of "concentration" or "dilution"- the steam is "dispersed" in the air and therefore "rare". [...]
- **Answer by Jean-Louis Basdevant:**
  I agree with M.E.R Shanahan. "Appearance" is also an important concept in physics. "Disappear" does not mean "cease to exist".
- **Réponse by Jean Matricon:**
  I suggest: the steam escapes in the air, where it is invisible, like a sugar lump in a glass of water that dissolves until we cannot see it. The use of the verb "disappear" is however "correct": disappear = no longer seen, visible (Dictionary)

A few guidelines for effective Teacher support

All scientific tutors must have the following characteristics:

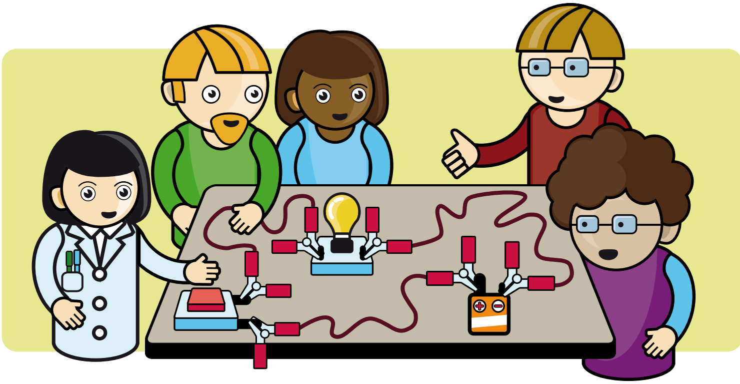
- proven competence in a specific field;
- motivation and desire to help teachers with difficulties on a volunteer basis;
- availability to answer the teacher promptly so that he can use the answer in class without delaying scheduled activities.

In order to obtain maximum efficiency, it is necessary to create file archives of these exchanges on a website so that an electronic library is built up which is accessible for all. This is the case of the website *La main à la pâte*, among others.

Pitfalls to avoid, hurdles to overcome

- Answers must be very clear in order to preserve a good level of mutual comprehension during exchanges. Particular attention should be paid to the formulation of questions, the vocabulary used (paraphrasing instead of using jargon), the description of the experiment (avoiding omissions or approximations) and the interpretation of the question's meaning. In any event, the scientist must ask, if need be, for more details before providing a hasty answer.
- The same goes for representations made by the person asking the questions that can prevent comprehension of the answer. The scientific tutor should not hesitate to provide more ample explanations and provide sufficient details about anything in his own answer that seems to him obvious.
- Authoritative arguments and mathematical equations are prohibited. The same goes for any value judgements concerning the relevance of a question.
- To satisfy the teacher's curiosity, answers to questions that do not concern class activities can be provided, while avoiding systematically the development of any subjects that would not be meaningful for the pupils.

2.4 Supporting teacher training



What does this consist in?

This form of support involves the participation of a scientist in initial or continuous teacher training (internships, events, autumn universities...).

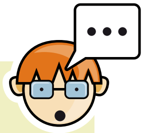
The goals are:

- to develop a taste for science among participants by offering a vision of science in the field as it is carried out in the world of research;
- to answer questions concerning scientific notions;
- to present experiments in order to better understand certain concepts;
- to create a relationship between science in the laboratory and science as it is taught in schools.

A few characteristics of support during teacher training

Support during teacher training aims to:

- establish a relationship based on confidence with the teacher so that he can express his difficulties, questions, points of view, without fear of being judged.
- raise awareness among teachers that scientific knowledge and reasoning are accessible and that they can be taught without fear.



Testimony

The pleasures of this collaboration

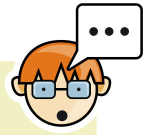
... for example, the elaboration of a conclusion with, against all hope, an adult or child who has said nothing the whole time, and who suddenly can't help but take part. Or perhaps, when someone blurts out "but, it's the same when we..." Or maybe an experiment that has been adapted, completed, often in a surprising and relevant way, which reverses the roles. Finally, the satisfaction of seeing the people trained unexpectedly enjoy themselves, to feel them "hooked", to hear them say they want to share this discovery with the children, to observe their newfound autonomy.

All this intelligence, both individual and collective, where you can see the cognitive wheels turning because there is no interest in hiding ones ignorance, pretending to know, is fascinating. It enables us, using practically nothing, to reach subtle notions and all their shades of meaning, to distinguish the links woven between them.

Marima Hvass*, trainer for the association 1,2,3,sciences.*

In this context the activities are designed

- to promote types of training where the teacher is active and not just a listener, so that he can appropriate the inquiry-based approach through practice. It is through these "learning situations" that teachers, faced with a basic scientific problem, can understand the use of experimental methods and the framework (upstream: observation, questions, formulation of a hypothesis, translation into an experiment; downstream: interpretation and formulation of results, validation or not of the hypothesis, search for other factors);
- to establish a link between classroom activities and scientific research and demonstrate that the "science which is happening" is also related to apparently simpler scientific questions;
- to enable the distinction between an inquiry-based pedagogical approach and scientific research;
- to show that science is universal and developed collectively.



Testimony

The EMNantes regularly takes part in continuous training programmes for elementary school teachers organised by Academic Inspectors, the IUFM (teacher's college) and the Diocese for the catholic schools. The teachers are not only interested in acquiring scientific knowledge, but also in discovering, in an active way, the researcher's approach in the lab. The emphasis is placed on scientific investigation and the experimental approach.

The main goal of the sessions is to provide teachers with a different vision of experimental practices and to dissipate any fears linked with scientific activities. It's also an opportunity for the teachers to visit a scientific establishment that they can use later on as a resource centre.

***Ludovic Klein**, EMNantes engineering school*

A few guidelines for effective support

It is essential that the scientist takes into account the profession, training and technical and scientific culture of the teacher.
Moreover, he should make sure that:

- training promotes contact between teachers and the subject itself: investigation followed by experiments, observations, questioning… carried out by the teachers themselves;
- theoretical interpretation dovetails with the experimental activity of which it is a part;
- teachers are confronted at the same time with
  - manipulations that are conceptually simple but tricky to carry out;
  - experimental protocols that seem simple, but whose interpretation can be difficult or lead to erroneous explanations.

  The idea is to raise awareness of the difficulties created by experimental practices and the importance of orienting and applying them in a relevant way. Therefore they should be more capable of choosing the best activities for their pupils and adapting them to the class.
- the training sessions include periods of collective discussion, debate and comparison of different points of view…
- scientific writing assignments (such as an experimental protocol) structure the experimental approach and promote exchanges.

- the teachers are encouraged to think about how they can take advantage of what they learn during the training situations and how to use this directly in their classes.

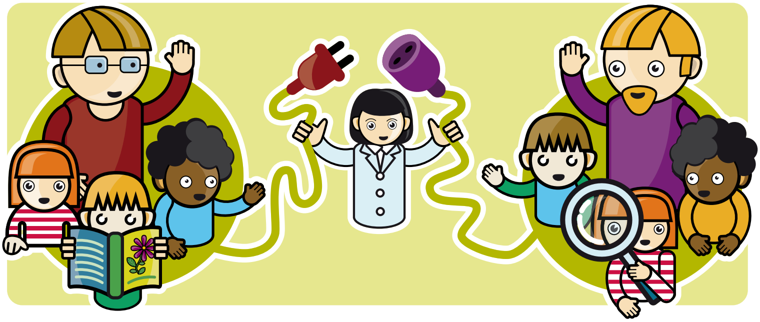
Pitfalls to avoid, hurdles to overcome

- Turning the course into a series of lectures: hands-on experiments and construction of the approach guarantee effectiveness.
- Not taking into account the specific characteristics of an audience of teachers: skills, role in the classroom and expectations linked to classroom practices.

Training session in the inquiry-based approach carried out by trainers from IUFM and research-teachers from the Ecole des Mines de Nantes.

Experiment carried out on the flow of sand. one sees a sand castle representing the famous sagrada Familia designed by the architect Antoni Gaudi.

2.5 Supporting collaborative projects



What does this consist in?

The aim of collaborative projects is to create links between several classes in different districts, even different regions or countries, and work simultaneously on a common scientific project.

In this context, the scientist can take part in the design of the project alongside teachers or take part as an expert inside the actual classrooms of participating classes. His role is that of a reference. These projects take place over several weeks or even the entire school year.

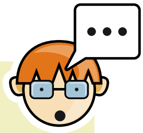
For projects that involve international exchanges, members of the scientific community can be called upon to relay the project to other schools in their region or country and periodically bring the appropriate scientific support.

A few characteristics of supporting a collaborative project.

- The contact between classes is continuous throughout the entire project: exchange of ideas, skills, tips and results, etc...Internet access in each school is essential.
- Design of the project is conceived by a teachers/scientist team:
  - The scientist can help with the explanation of certain scientific concepts.
  - He provides scientific background for the teachers.
  - He provides coherency between the notions treated and the sessions planned.
- During the actual project:

- The scientific tutor serves as a scientific reference who, whenever possible, regularly visits the classes involved.

- The advantage of this type of collaborative project resides in the fact that one scientific tutor centralises and coordinates the progress of work in numerous different classes.



Testimony

"Twenty worlds below ground" is the name of a collaborative project devoted to the study of soil fauna which takes into account the diversity of land within the French department of the Pyrénées Orientales. The project was part of the programme Environmental Education for Sustainable Development (EEDD). It was carried out by 18 classes spread out over the entire department. Soil fauna was studied by all the classes, according to an experimental protocol. The necessary equipment (especially non-consumables) was used on a rotating basis by each class according to a pre-defined calendar managed by the teachers. For example, we had around 20 binocular magnifiers (very useful for the observation and description of soil fauna) for 15 classes. Each class could use 6 binoculars for 2 to 3 weeks and then sent the equipment on to another class. All the participating classes had computer equipment enabling them to exchange written information and images. The text exchanges concerned mainly the experimental protocol and tips for overcoming technical difficulties.

Concerning the results, we could observe a difference in the biodiversity of the soils studied. For example, soil heavily impacted by human activity had a low level of diversity with respect to soil fauna. The pupils were able to observe some remarkable results.

Gabriel Mouahid,
Montpellier 2 University (IUFM at Perpignan)

A few guidelines for effective supporting

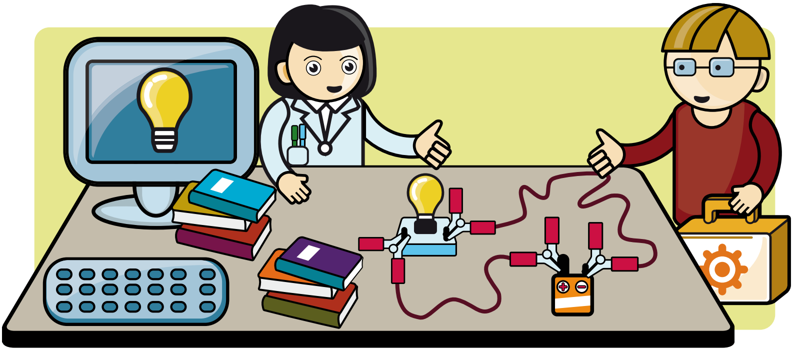
- Regular interventions via the Internet are decisive in order for the scientific tutor to maintain contact with the classes and promote exchanges between them.
- Exchanges between staff members as well as pooling of equipment and joint activities breathe life into the project.
- Teachers can, within the training sessions or during encounters and exchanges, get acquainted, identify together the project goals, different phases, the role of the inquiry-based approach, media for exchanges between classes, possible difficulties…
- Regular monitoring is necessary as well as an intermediate and final assessment of the project.
- Promotion of the results is achieved by disseminating them through an exhibition (ExpoSciences) a website or book.

Pitfalls to avoid, hurdles to overcome

In general, project logistics (Internet, online help, pooling equipment…) is the main source of difficulties

- Timing between classes: to actually carry out the activities can vary from one class to another and it is sometimes difficult to synchronise exchanges between classes. Do not hesitate to propose a calendar with the main phases and related exchanges.
- Impersonal exchanges: to breathe life into virtual exchanges it is a good idea to promote inter-class correspondence (similar to twinning) even if this remains a marginal activity within the project (description of the school, class organisation, student names…).

2.6 Supporting the production of resources



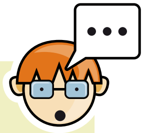
What does this consist in?

Supporting teachers in classes and in teacher training are all opportunities which produce at the end of the day different resources for teachers. This often requires a team effort combining different skills (scientists, specific course tool designer, trainers, experienced practitioners...). It also requires careful proofreading and validation by the different players involved in science training in schools.

There are two types of production:

- **books that offer scientific activities for the classroom:**
  Often organised around a central theme and arranged according to an interdisciplinary approach, this type of book requires a solid scientific background and therefore the support of a scientist, laboratory or research institute can be highly valuable.
- **equipment kits:**
  The opinion of a scientist concerning equipment kits generally available in science resource centres can be very valuable. While the scientific tutor can provide an opinion on the experiments offered, it is equally essential that he verifies the precision of the associated protocols and eventually adapts these if necessary with additional scientific information for the teacher.
- **books on scientific culture more specifically designed for teachers:**
  The scientific tutor can also take part in the writing of science books or scientific files for primary school teachers.

- **websites or ICT media (CD, DVD):**
  More and more research institutions are providing teachers with resources via their websites. These initiatives should however comply with school curricula and make sure that the documents provided can be used inside the classroom.



Testimony

To design a pedagogical guide on climate change, we set up three "concentric circles" made up of authors, teacher-testers and a group of experts in the field. Each circle was also pluridisplinary and included scientists, specific course designer, teachers and trainers.

The first six months of the project enabled the authors to produce an initial pedagogical framework and submit it to, on the one hand, the teacher-testers and, on the other, the scientific and pedagogical experts. Once this structure was validated and finalised in the form of a workable "turnkey" pedagogical module, it was tested in about 20 classes.

The tests and their analyses took five months and enabled us to take into account the difficulties linked to the organisation of classes (timing, equipment, prerequisites...) and the experience of the teachers (certain being highly experienced while others were beginners). The final pedagogical module is the product of very rich exchanges between teachers, trainers, specific course designers and scientists.

David Wilgenbus,
Co-author of the project *"Le climat, ma planète...et moi!"*

A few characteristics and guidelines for effective practices

- The production of resources is the result of a collective work by people with a wide variety of skills in science, pedagogy, educational tools / design of courses...
- Resources are tested in advance in order to take into account observations based on practical experience.
- Class documents are completed by scientific and pedagogical backgrounds so that the teacher can appropriate the scientific notions involved and use the resources without difficulty.

EMNantes equipment kits

Equipment kits developed with the help of teachers are disseminated by scientific tutors.

These kits contain all the equipment required to set up a science session on a given theme. A guide book is also provided (it describes all the experiments and proposes how to progress in general).

The kit and guide book therefore provide **a base for setting up scientific activities** which enables the teacher to rapidly become operational by making sure he is freed of material constraints so that he can concentrate on the content and actual teaching of the session.

The teacher is free to choose the pedagogical approach.

Ludovic Klein, EMNantes Engineering School

Pitfalls to avoid, hurdles to overcome

- Producing a resource alone, especially when one is a scientist. There is a great risk of introducing too many understatements or not targeting the audience concerned – pupil or teacher.
- Introducing too many notions that would not be understood by the pupils using an inquiry-based approach.
- Providing a document or equipment… whose use is too restrictive. It is important to systematically provide the teacher with the possibility of adapting the resource in question to the level of the class or the project.
- Not providing the teacher with enough time to familiarise himself with the tool before using it.

The way to set up a Supporting teacher project

3 The way to set up a Supporting teacher project

Who to contact and how to get started

Before you start, get a copy of this guide and the ASTEP charter and familiarise yourself with the principles and forms of scientific Teacher Support. You can also have access to a lot of information regarding this Support by visiting the ASTEP site (www.astep.fr).

You must program your teacher support project well in advance

The school year at the primary level usually starts for most classes in September and ends in June or the beginning of July of the following year. The year is divided into 5 periods separated by school holidays. Teachers usually organise their pedagogical projects around these periods which generally last from 6 to 8 weeks. Teacher support projects should take into account the school schedule and cover at least one full period, or more if need be. With one session a week it is possible to treat several notions around a theme. In this respect, the annual hours for the 2008 curricula offer new possibilities.

As scientific activities are often planned at the beginning of the year, it is advisable to organise an initial contact with teachers in September/ October to define the support project.

Appendices

A.1 The ASTEP Charter

Introduction

Science and technology support is designed to provide Teacher Support in the organisation and implementation of a scientific approach in compliance with primary school curricula. The goals of science and technology support are the following:

- to create links between the school and the scientific world through exchanges of scientific knowledge and experimental practices;
- to contribute to making science and technology accessible for all;
- to highlight scientific and technological careers, stimulate curiosity, arouse interest, create vocations at an early age;
- to facilitate the connection of science with everyday life, solicit questions, encourage argumentation and experimentation so that students can acquire new knowledge while consolidating skills in oral and written expression.

Types of support

The different types of science and technology support target the conception and direct application of projects initiated by the teacher: modules, sequences, sessions... They represent a cooperation, over a certain length of time, between "scientists and teachers" and can take on the following, non-exclusive, forms:

- taking part in classroom teaching of science and technology during one or more sessions;
- sponsoring teachers;
- using IT tools and communication via Internet, consulting specialised websites, collaborative projects...)
- design and implementation of cooperative projects;
- providing resources;
- creating materials and publishing documents;
- taking part in cultural events and pedagogical encounters with teachers;
- taking part, at the request of trainers, in initial and continuous teacher training;
- contacting players in civil society to set up exchanges.

Profile of the science and technology scientific tutor

The scientific tutor is an adult volunteer who, in his field, has achieved a level of competence and knowledge in science and/or technology that is at least the equivalent of a 2-year university degree. The scientific tutor takes part in the project in person or in a partnership with a recognised organisation: large organisations, institutions, institutions of higher education and research, associations, companies. The scientific tutor has at least a basic understanding of the educational system. Teacher Support is a volunteer activity.

General rules for science and technology support

The support provided contributes to the teaching of science and technology which remains at all moments in the class under the sole responsibility of the teacher.

About content: the content shall always be adapted to the cognitive abilities of the pupils. It will comply with the topics defined in the curricula. Support can lead to certain aspects being studied over a longer period of time or in more depth.

Concerning the production of resources: a partnership between national education and organisations or individuals can be set up in order to produce scientific and technological resources for classroom use (documents of all kinds, written or audiovisual, equipment). A group of partners who wishes to join the charter to create resources must accept and make sure that its production complies with the following principles:

- the resources offered are designed to enable the implementation of the inquiry-based approach prescribed in primary school curricula;
- any mention of the partner organisation or its sector must not go beyond a discrete form of recognition which should in no way be construed as advertising or propaganda;
- the level of the pupils is clearly specified and the contents are adapted to their cognitive abilities;
- equipment is designed in compliance with safety standards in force in primary schools.

Concerning intellectual property rights: if the publication of these resources entails the payment of royalties, these should be distributed among the partners in compliance with the laws in effect at the time of the publication agreement. The position of each party must be clearly defined in a signed document dealing with this issue.

Special rules concerning support in schools

Concerning the issue of presence in the classroom: the teacher who is effectively and permanently present cannot hand his class over to the scientific tutor. No substitution of roles is allowed.

Concerning durations: the durationof any support project: all support activities in schools must comply with the class timetable.

Concerning the way the support project is carried out:

1. **In the preparation phase:** outside school hours, the scientific tutor helps the teacher prepare and organise the project. Together they agree on the activities that the pupils will carry out, the notions, approaches and knowledge involved, as well as the level of formulation. They use, together, the different facets of the subject while complying with the current school curricula. They prepare, together, and for each session, an appropriate timetable with respect to the progress aimed at and which will be adapted to the pedagogical and scientific aspects involved.
2. **In the classroom:** the teacher defines the pace of the session and the pedagogy. He maintains authority over the class for which he is responsible.

Conclusion

This charter was written in order to provide potential partners with greater knowledge concerning the framework and orientation of support in science and technology. It presents the goals, identifies the forms of support, defines the profile of the scientific tutor and specifies a set of general rules.

A.2 Investigation

2.1 A repeated process

A step by step approach

It is very important that the pupils understand what they learn and avoid superficial learning motivated by the satisfaction of a reward instead of the pleasure of learning and understanding something new and therefore acquiring knowledge.

The global approach is represented in the following table, which is not meant to be a set of instructions that must be followed step by step, but rather a guide whose main aim is to help the teacher situate what he is trying to do.

It goes without saying that depending on the topics dealt with and the demands of the experiments planned (for example all germination of seeds takes a certain amount of time), the teacher will find himself at one of the stages within this framework without necessarily having gone through each step one at a time from beginning to end. Also, an extremely important point is not included in this table which is: the possibility to frequently return to phase 2 after the results obtained in phase 4, i.e. to ask new questions and organise new experiments.

<table>
<tr><th colspan="5">AN INQUIRY-BASED APPROACH TO THE TEACHING OF SCIENCE</th></tr>
<tr><td>1 – Start with a functional situation or a fortuitous or triggered starting point</td><td colspan="4">Astonishment, curiosity, questions
Formulation of a problem to solve</td></tr>
<tr><td>2 – Use reason and knowledge</td><td colspan="4">Possible explanations, possible answers, representations of the solution
Formulation of hypotheses to be tested and eventually to be checked against documentation</td></tr>
<tr><td colspan="5">3 – Depending on the type of problem and the hypotheses, establish one or more protocols with either:</td></tr>
<tr><td>Experimentation</td><td>Trial and error</td><td>Use of a pattern or model</td><td>Observation</td><td>Documentary research</td></tr>
<tr><td>Set up the system; vary only one factor at a time; collect results through observation or measurement</td><td>Plan different tests; compare the results</td><td>Reason by analogy; check by constructing a model</td><td>Use documents (images, data, results from experiments)</td><td>Read paper or electronic documents or use interviews of competent persons</td></tr>
<tr><td colspan="5">Carry out protocols</td></tr>
<tr><td>4 – Observe the results and compare them against the hypotheses tested</td><td colspan="4">Validation or not of the hypothesis
or certain hypotheses</td></tr>
<tr><td>5 – Summarise all the hypotheses confirmed or refuted</td><td colspan="4">Structure the knowledge built up in response
to the problem</td></tr>
<tr><td colspan="5">6 – Confront with existing knowledge</td></tr>
<tr><td colspan="5">7 – Transfer to a new situation in the classroom or everyday life</td></tr>
</table>

Edith Saltiel, from “La démarche d’investigation: comment faire?”

2.2 Two examples of a learning process carried out in a different way

Concerning ice

Strategy 1: The teacher prescribes the activity of the pupils	Strategy 2: The pupils take part in research
When we talk about global warming and its consequences on glaciers, many students in the primary level admit that they do not know how to answer the question **"At what temperature does ice melt?"** This question can serve as the starting point for a scientific activity and be extended	
The two approaches described below lead to two different learning experiences	
The teacher of class (A) gives the students, in pairs, a cup of water, ice cubes and a thermometer.	**The teacher of class (B) organises a group project:** the children try to work out an experimental protocol that they illustrate in their experiment notebooks. Then each group conducts the experiment it has designed.
The students are instructed to read the temperature indicated on the thermometer two or three times and to write down the results without showing the others.	**The pupils exchange their results** which are sometimes contradictory, discuss them, criticise their protocol, realise they haven't read the thermometer correctly, that it should be read when it is plunged into the mix...and do the experiment again, differently.
The results of each group are written on the board as well as the average for each one. The teacher points out the coherency of the results, apart from some errors in readings and small differences in averages...	**Collectively, they draw up a summary:** the experimental conditions are represented, the teacher helps with the interpretation of deviations between results, the readings are written down in the experiment notebook...
The teacher has prepared a transparency: it shows a graph with the temperature for an ideal water/ice mix over time. He leads them so that they can read the graph while, at the same time expressing what it represents and guides them in the conclusions they can draw from it.	**Each student notes in his notebook,** at regular intervals, the level of liquid in the thermometer, thus drawing up a graph with the temperature in relation to time. Each student contributes to the interpretation of the graph.
Knowledge is established by the teacher: The experiment shows that when the ice melts the temperature of the water/ice mix is 0°C.	**Knowledge is established by the class:** Our experiment shows that first the temperature of the mix water/ice goes down and then remains stable at 0°C as long as there is some ice and then, finally, it increases.

Strategy 1: The teacher prescribes the activity of the pupils	Strategy 2: The pupils take part in research
The difference between these two pedagogical approaches used by these teachers has significant consequences: • The children of class A did what the teacher told them to do and they were active. Of course, they measured temperatures, but we cannot be sure that they really gained knowledge. Moreover, some of them may have had questions like: does the temperature at which the ice melts depend on the size of the cubes? Does it depend on the size of the recipient? etc. They could not express these ideas. • In class B, the students learned how to use a thermometer. They were able to ask questions and try to answer them. They were active. Moreover, they all saw and noted that the temperature of the mix remained constant as long as there was a small piece of ice.	

About flowers

Strategy 1: The teacher prescribes the activity of the pupils	Strategy 2: The pupils take part in research
When we ask primary school pupils what a flower is, many admit that they cannot really answer the question (often confusing plant with flower). While its colour is often pointed out, its different parts and biological function remain a mystery. The main challenge of a pupil's activity on this topic is to establish a link between the anatomy and the reproductive function of a flower. This can be set up in two different ways: one is similar to the birds and the bees and starts with the dissection of a flower and then discusses its function, the second is an investigative approach starting with the reproductive function and winding up with its anatomy.	
These two approaches to the same concept use different objects that lead to different questions	
The teacher of class (A) has picked plants of the same species (e.g. daffodils) and hands one to each student who must try and answer the question: "What is inside a flower?"	**The teacher of class (B)** has picked plants. He selects a species of plant that has flowers, fruit and all the intermediate phases in between on the same stem (e.g. colza or broom). The pupil must answer a question on the origin of the fruit*.
Each pupil is instructed to dissect his "flower" and to place and glue, in an organised manner, all of its different components on a piece of paper (floral diagram)	**The pupils observe,** discuss, try to establish links, understand the chronological order. Their discussions lead them to dissect the flower to observe the pistil and compare it to the fruit located on the lower part of the stem…
The teacher asks the pupils to display their work and then invites them and helps them compare what they have done. He gives them the vocabulary they need to communicate (stamens, pistil etc.).	**Collectively, each group comes up with a synthesis:** the group produces an explanatory drawing, based on their observations and links they have established.

Strategy 1: The teacher prescribes the activity of the pupils	Strategy 2: The pupils take part in research
The teacher has prepared a transparency: it shows a diagram of a flower with the necessary detailed key that recaps all the expected results and enables the students to define the flower through its components.	A comparison of the results obtained by each group enables them to confirm or specify them. The vocabulary required for their explanations is provided by the teacher.
Knowledge is established by the teacher: *Our observations have shown that a flower is made up of petals, stamens and a pistil.*	**Knowledge is established by the pupils:** *Our observations have shown that the pistil of a flower is transformed and changes into a fruit. A flower also has stamens, sepals and petals.*
After the activity, students from class A will have to memorise terms and definitions while the students of class B have tried to understand the relationship between the flower and the fruit. They now understand the biological function of the flower (to produce fruit).	

* the term fruit (and therefore the concept) is not used in the question whose form would be something like: "Where do you think the round objects along the stem come from?"

2.3 A few suggestions for successfully teaching science

- Make science and technology a source of pleasure to be shared with everyone, even when it is performed with a pedagogical aim. Constructing a valid conclusion with others, no matter how simple, contributes to this pleasure.
- Elaborating a conclusion in response to the questions we all have is the true motor behind scientific activity.
- Using the conclusion to forecast the outcome of a different situation and checking this experimental forecast provides a satisfaction that the students must not be deprived of.
- The educational value of a hesitant but structured explanation by a pupil is greater than a pat answer by an adult.
- The pupil's "ignorance" fuels his activity and is not an obstacle, on the contrary.
- Information provided by the senses is not a priori false if we take care to distinguish between "what we perceive" and "how we interpret it". Taking in consideration the information given by our senses, it enables us to situate ourselves in the world around us.
- Notions studied by the pupil should be meaningful for him and useful in familiar situations and with everyday objects.
- The words used to describe different things should be those of everyday life and paraphrasing can be used in order to introduce the need for scientific vocabulary at the right time.
- Instead of becoming a traditional lecturer, the scientist should promote the exchange of skills, listening and dialogue. To do this, he has to accept the idea that not everyone reaches the same point at the same time and listen to the reactions and needs of the learner. He can help develop self-confidence by pointing out that lack of knowledge is neither total nor a handicap, and that one is capable of reasoning. There are no pre-requisites or presuppositions.
- The practice of science is an essential activity for personal development. It can be performed in the classroom and is not reserved exclusively for the laboratory.

Suggestions based on the experience of the Association 1,2,3, sciences

A.3 Self-evaluation questionnaire for science and technology scientific tutors in primary schools

	Yes	No
1. Conceptual phase		
Did I have a clear idea of my role as a scientific tutor?		
Was I familiar with and comfortable using *inquiry-based learning*?		
2. Preparation phase		
Did I specifically discuss the content of the planned activity with the teacher?		
Did we check together that the content was part of the school programme?		
Did we carefully organise how the sessions would be carried out and specify the goals and knowledge to be acquired?		
Did we define and share the tasks together?		
Did we identify the necessary equipment for the session and its compliance with safety regulations in force in schools?		
3. The way the activities are carried out		
Did we take care, while the activity was going on, to apply an investigative approach?		
Did I take care, once the topic was announced, not to reveal my knowledge, but encourage pupils to ask questions and look for answers?		
Did I respect the role of the teacher in charge of the class?		
Did I take care to make sure all the pupils took part in the activity?		
Did I listen to the pupils, their questions, suggestions and discussions?		
Did I make sure to let the pupils take over the execution, organisation and interpretation of the results of the experiments, whether or not they achieved the desired results?		
Did the teacher and I make sure that the work done and the results obtained were recorded in the experiments notebook?		
4. After the session		
Did the teacher and I make a final assessment of the work done in class, listing the investigative approach, the difficulties encountered, possible improvements and how to exploit these during a future session?		

Bibliography and description of websites

B Bibliography and description of websites

Smart guides

Common foundation of knowledge and skills (French Ministry of National Education)

http://media.education.gouv.fr/file/46/8/5468.pdf

- The knowledge, abilities and attitudes that should be acquired by children at the end of secondary school are grouped under 7 headings. Pillar 3 concerns the main elements of mathematics and scientific and technological culture.

ASTEP Charter (cf. Appendix 1)

- Published by the French Ministry of National Education, this charter outlines the main principles of scientific support

La démarche d'investigation: Comment faire en classe?

http://www.pollen-europa.net/ (cf. tools section – guide for teachers)

- A methodological guide for inquiry-based learning in the classroom.

DVD: Apprendre la science et la technologie à l'école primaire, published by the CNDP, 2008.

- Distributed in 2008 in all French schools, this DVD contains eight filmed class sessions, interviews with specialists and thematic inputs. (available with English subtitles).

- **Teaching science at school**
- **Discover the world at kindergarten level: the living world, matter, objects.**

http://www.pollen-europa.net/ (cf. tools section – learning units)

- Examples of series of activities organised around different topics of the school programme for pupils 3 to 11 years old.

La main à la pâte

http://www.inrp.fr/lamap/

- The website of *La main à la pâte* is designed to help teachers and trainers, scientists and institutional staff set up quality science teaching in primary schools. You can find classroom activities, scientific or pedagogical documents, tools for exchanges and collaborative projects and many other resources…

Consultants network:

http://www.inrp.fr/lamap/index.php?Page_Id=30

- The network of *La main à la pâte* volunteer consultants is made up of around 100 scientists (researchers and engineers) and an equivalent number of pedagogues (trainers and designers of specific courses) who answer primary school teachers' questions concerning the preparation or organisation of their science and technology sessions in the classroom.

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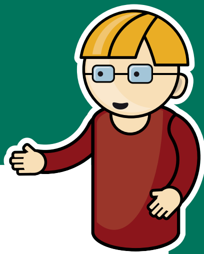

Stimulate observation of tangible objects and phenomena, encourage relevant questions about the world, promote argumentation and experimentation, implement a scientific approach so that pupils can acquire new knowledge while developing oral and written expression: these are the goals of teaching based on investigation. Provide Teacher Support by scientists (currently working or retired) or science students can considerably help primary school teachers reach these goals.

This guide presents the different types of collaboration between scientists and primary school teachers which have been actively used over the last few years in France within the framework of ASTEP (Supporting teachers through the involvement of scientists in primary education). Teachers, scientists and trainers will find guidelines, testimonies and advice for making the most of this relationship based on sharing and complementary skills.

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