



# Handbook for setting up and developing a centre for inquiry-based science education (IBSE) at elementary and middle schools

## Objectives, strategies and action plans



FONDATION  
**La main à la pâte**

POUR L'ÉDUCATION À LA SCIENCE

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<sup>1</sup> Agence nationale pour la cohésion sociale et l'égalité des chances : National  
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# Introduction

## The *La main à la pâte* Foundation

The aim of the *La main à la pâte* Foundation is to help improve the quality of science and technology teaching at elementary and middle schools, which provide the core knowledge and play a huge part in the access to equal opportunities.

The actions it carries out at the national and international levels focus on support and professional development of science teachers. It aims to help them introduce inquiry-based teaching methods that foster the development among pupils of scientific mindset, an understanding of the world and the capacity to express themselves.

The *La main à la pâte* Foundation for scientific cooperation, created by decree in 2011, was founded by the Académie des sciences, the École normale supérieure (Paris) and the École normale supérieure of Lyon. It is the continuation of the *La main à la pâte* operation launched by the Académie des sciences at the initiative of Georges Charpak, Nobel Prize in Physics, 1992.

### Key figures

- A team in France of approximately thirty people
- Almost 400 class activities available online
- 9 themed teaching projects produced over 10 years and circulated free of charge to 55,000 teachers
- Cooperation projects in 40 countries and 3 regional networks (European Union, South-East Asia and Latin America)
- A network of approximately 20 pilot centres in France
- Over 100 middle schools testing integrated science teaching in 5<sup>th</sup> and 6<sup>th</sup> grade (ages 11-12)
- 4 *Maisons pour la science* (professional development centres) for teachers set up regionally in 2012.

### Our work

- **A program to assist science and technology teaching** bringing together teachers, teachers' educators and the scientific community (pilot centres, scientist/teacher partnerships, integrated science teaching in middle school, etc.)
- **Producing and sharing teaching resources:** class activities, interdisciplinary themed projects, websites, etc.
- **European and international cooperation** through the creation of a network and skills and resources exchanges
- **Professional development options for teachers** through the *Maisons pour la science* and professional development activities throughout France.

## What is inquiry-based science education?

Understanding the process of scientific investigation is one of the key elements of this approach to science teaching. It calls upon a number of skills: asking questions, observing, predicting, creating experiments, analysing data and supporting conclusions with evidence.

It can be divided into three main stages:

- **explore:** pupils study the subject together, asking questions on the topic. The teacher's role at this point is crucial to encourage the pupils to reflect and formulate "productive" questions that require a detailed reply, rather than a short and obvious one.
- **research:** pupils plan and investigate, requiring them to have previously determined the key elements to be studied. They make proposals or suggestions (sometimes even hypothesis) and select the best method of investigation (experimenting, observing, documentary research, etc.). They can write down in their notebooks what they want to study and how they plan to do it. In an experiment, for example, by using the equipment provided, it is important to discuss with pupils how to vary the factors one by one while maintaining the remaining elements at a constant. If the investigation is mostly centred on observation, the pupils must agree on what is the best element to observe, how to observe it and gather the data. The teacher's role is to help the pupils think about what they are doing, encourage them to work and exchange with others and write down their observations and measures at every step.
- **drawing a final conclusion:** the pupils study the results of their investigations and compare them to what they gradually learned. The conclusions are then collectively drawn up and recorded in the experiment notebook. The teacher's role is to organize and guide the class discussion, provide the pupils with the resources that will help them compare their results to the knowledge acquired, allow them time to write up their results both individually and in groups and help give structure to what they have discovered.

The aim of science-teaching based on inquiry is to ensure pupils understand what they learn.

### Steps to take in order to successfully implement the inquiry-based approach

- Organize the classroom so that the pupils can work in groups, easily access equipment and tidy away their ongoing.
- Take into account the pupils' experiments and ideas and encourage them to reflect and reason in order to produce more coherent explanations.
- Organize discussions at each step so that the pupils may clarify their ideas by exchanging with other groups and agreeing on their conclusions.
- Guide the pupils in the preparation of their experiment notebook, an essential tool for them to see the progress they have made, the thought process they followed and the conclusions of their work.

## Contents of this handbook

The purpose of this handbook is to help the teams that wish to launch and coordinate a structured, long-term centre dedicated to promoting science and technology at elementary and middle school. It is based on the different experiments undertaken by *La main à la pâte* and in particular that of the pilot centres network.

Created in 2000, this network today includes around twenty centres, where over half of pupils attend school in sensitive urban areas. The programs set up by each pilot centre are based on different types of activities which, after being interlinked and streamlined over several school years, allow a significant number of teachers to partake in inquiry-based science and technology teaching. The pilot centres bring a number of partners together (higher education and research institutions, regional bodies, associations, businesses, etc.) to work on original projects that are later made available for teachers. They tend to serve as models in France and abroad and receive many visitors, individually and in delegations. Each centre sets out its 3-year objectives. An agreement is signed between the *La main à la pâte* Foundation and the centre's local partners, setting out the commitments of each to reach these objectives.

Using this experience, this handbook presents:

- recommendations to follow before setting up a pilot centre;
- model structure of the possible organization of the centre;
- 6 strategic elements to be considered when creating and structuring the centre.

These are:

- involving decision-makers,
- providing resources for teachers,
- professional development and support for teachers,
- coordinating a local support network,
- creating learning networks,
- assessment.

There is a chapter dedicated to each of these elements that describes the objectives to target, provides suggestions and real examples, refers to illustrative appendices and contains a chart with an example of a timeframe to plan a program. The conclusion summarizes all of the above-mentioned elements.

Setting up a centre for science teaching must be undertaken with a long-term vision. All strategic elements cannot be included right from the outset. The documents and examples that follow set out a possible scope and objectives that may need to be reviewed according to project needs and the directions it takes.

The team at *La main à la pâte* hopes that this handbook will help share the experience gained over the years both in France and in Europe, and they are available should you require information or assistance in preparing a local development project for science at school.







## Chapter 1

# Setting up a centre for inquiry- based science education

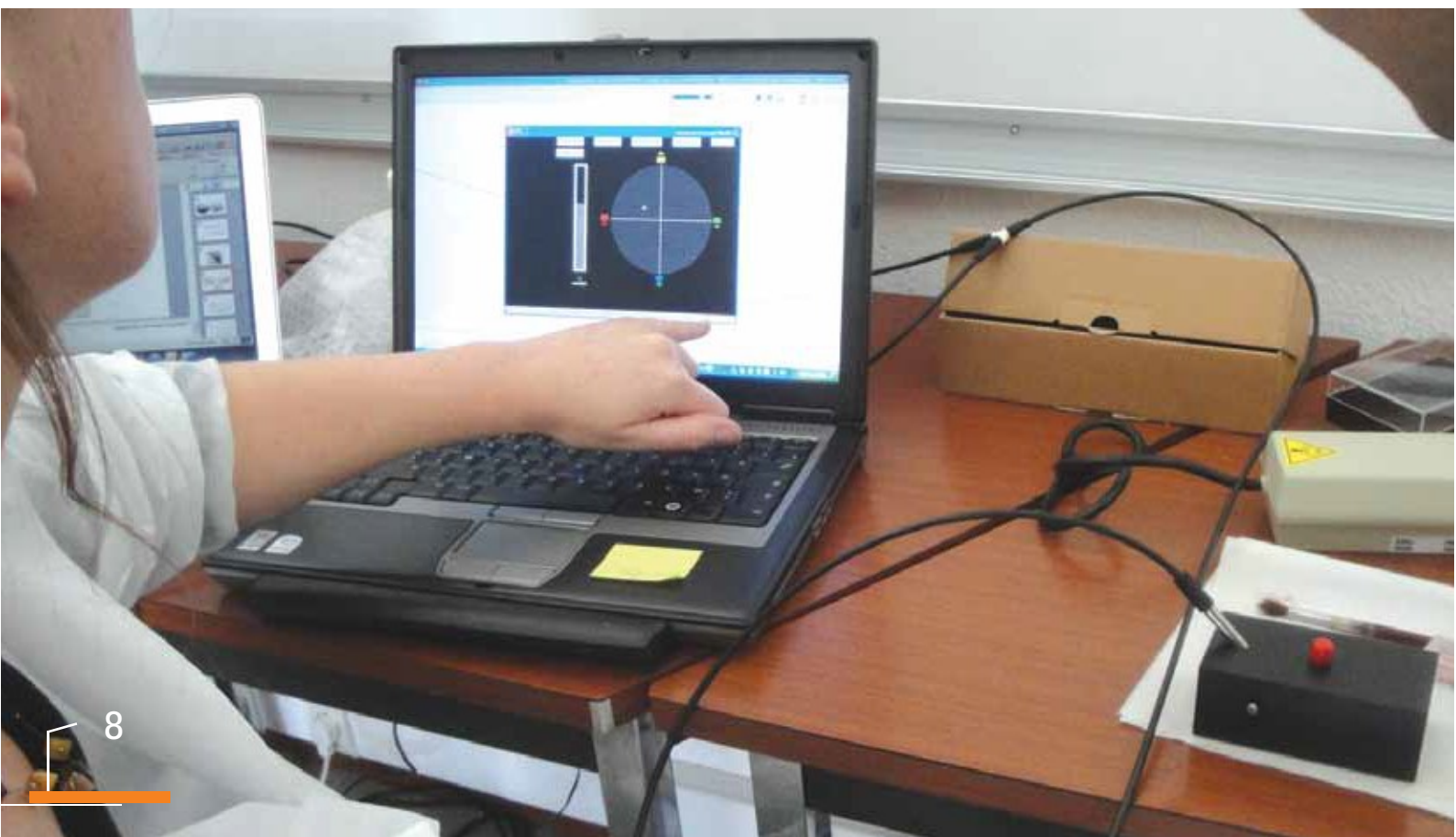
## Recommendations prior to setup

As a project for a centre dedicated to promoting science and technology at elementary and middle schools aims to ultimately involve a large percentage of the teachers in the area concerned, the local actors and partners must be involved and their participation sought right from the project's conception, before launching its development.

The project's continuity and success rely in particular on the following conditions:

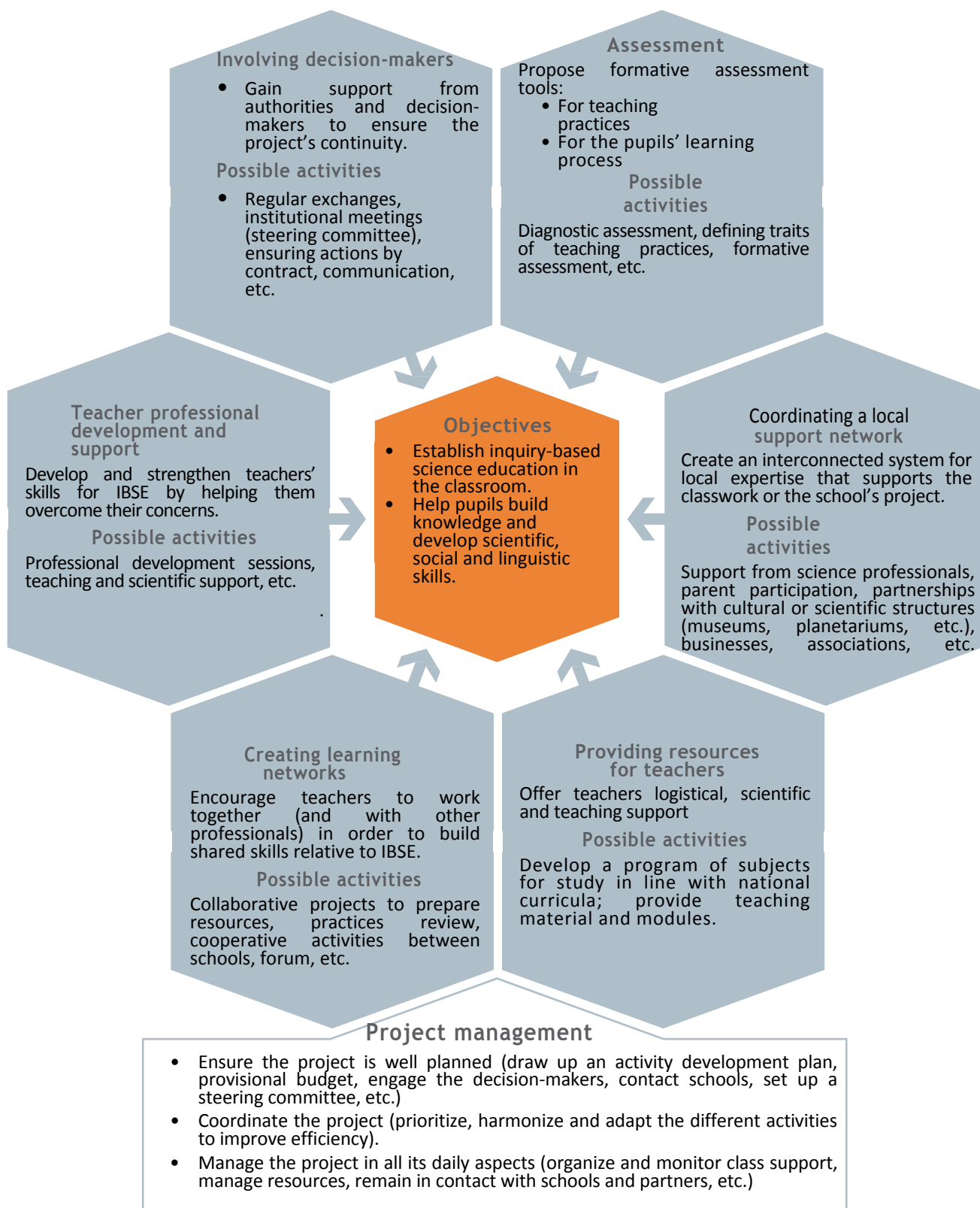
- a shared determination on the project's challenges and perspectives in the long-term,
- the political will at institutional level, including most importantly the country's Education Department
- the involvement and support of local actors (city or town authorities, scientists, parents, associations, etc.) together on the same partnership project, where a place for liberty and creativity is assured,
- an explicit agreement on the human and financial resources to be granted to the project throughout the duration (3 years minimum),
- institutional support for teachers: advice, teaching support, scientific support, confidence-building professional development activities,
- a development plan with a timeframe for activities, coherent with the strategic elements,
  - an agreement that formalizes by contract the commitments of the various partners for the duration of the project (3 years minimum)

By combining this partnership framework with different types of activities, the educational teams can aim for significant dissemination of inquiry-based science teaching both from the quantitative and the qualitative aspects.



# Organizational model of a centre to promote inquiry-based science education

## Strategic elements to take into consideration



La couleur verte des feuilles





Chapter 2

# Involvement of decision- makers

## Objectives and recommendations

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An innovative project that aims for in-depth change of classroom practices must be supported by local institutions. It is essential that the project receives support from the country's department of education and other institutions that are involved in or interested in activities related to science teaching, so the programs that target long-term success may be initiated. With their support, these decision-makers give the project its security, ensuring its sustainability. They can also involve their institutions in the programs initiated by the centre, and even provide financing. Seeking and maintaining the decision-makers' support must be a constant priority for the centre. This requires strategies to be implemented that inform, encourage exchange and participation and are communicative.

Obtaining and maintaining the support of the authorities and institutions concerned by science teaching are important objectives to fix if the project is to survive. It also ensures there is effective change in classroom practices, following the principles of inquiry-based learning.

### A few recommendations

- *From the project's launch*, it is important to include the authorities that govern the schools in the project objectives and its development in order to gain their support. It is also important to inform the local institutions that are likely to contribute either directly or indirectly to the project (universities, graduate schools, regional teaching documentation centres, scientific institutions, regional authorities, businesses, science associations, parent associations, centres for scientific, technical and industrial culture (CCSTI), museums, etc.). This requires defining how the project can meet the expectations and interests of each group and the role they can play in its development.
- It is also important to identify as early as possible the institutions and people who, due to their activities or interests, may oppose the project; try to think of ways to reassure and convince them.
- Project stakes, the benefits for the school as well as the difficulties likely to arise must all be studied with all involved, including those working in the field.
- It is also essential to point out that such a project must be allowed time to develop before pupils' results can be measured.
- Before signing agreements, the different commitments made by participants are to be clarified (participation in the centre's initiatives, financing, allocation of staff, etc.) and ensure they agree on the entire contract. As such, it is often preferable to have a small number of active and committed partners rather than a large number of partners whose participation in the project is a mere formality.

*As the project progresses*, it is important to maintain close ties with the authorities and directors of local institutions by regularly informing them of the programs launched and the project's evolution.

## Examples of tasks to be carried out

### *During the project's beginnings*

- Prepare a report on current science teaching practices together with field actors in order to identify the levers and resources to draw on.
- Write up and circulate the project description and context map.
- Gradually form contracts for the commitments and responsibilities undertaken by the decision-makers and local structures in the form of signed agreements.
- Create a steering committee that brings together the decision-makers and representatives of local partner structures on the project's orientation and development.

### *As the project is developed*

- Regularly exchange with all partners.
- Invite partners to events organized by the centre.
- Organize class visits for the partners.
- Regular meetings with governing institutions.
- Communication and promotion of the project.

## Functions and roles of the steering committee

The steering committee brings together the different actors in the project. It has a determining role, as it defines the centre's orientation and priorities, the number of classes to be involved, the geographical area, budget, etc. It also oversees both the project's development and its follow-up and assessment. This committee mainly deals with the centre's initiatives and should not be confused with the other authorities set up at area level. It includes the centre's coordinator and representatives of the institutions party to the agreement that governs the implementation of the centre's objectives. It meets regularly (at least 3 times a year) at the centre coordinator's initiative, who ensures the members receive a report of the decisions made after each meeting. The meetings may be chaired alternately by different committee members.

It may be useful to invite representatives of the scientific, industrial and associative communities to a committee meeting (or organize a special meeting) along with field actors who, although are not party to the agreement, are involved or likely to be involved in the centre's programs. This larger steering committee would act mainly in an advisory role, reflecting on the project and its promotion

## Involvement of decision-makers in pilot centres

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### Mâcon pilot centre

From the beginning of the *La main à la pâte* operation in 1997, at the impetus of the board of education for the district of South Macon, the pilot centre was supported by expert partners. The first of these partners was the IUFM (teacher education college) of Burgundy (Mâcon centre), represented by two of its professors (biology and physics and technology). In 1999, the *École nationale des arts et métiers* (engineering grad school) in Cluny-Bourgogne joined the district centre project, which provides classes with the opportunity every year of conducting a project to create technological objects with first year student engineers. In 2004, other partners joined the project : the area centre for teaching documentation (CRDP), which provides schools with resources; the City of Mâcon, wanting to participate in the revitalization of science teaching, provides support for the installation and equipping of science rooms in schools in “priority education” zones; the “ALIZE” district teachers association, providing a space for reflection and decisions on the directions to take in terms of projects, initiatives and financing for the pilot centre.

### Nantes pilot centre

The Nantes pilot centre was formed in 2007, with seven partners signing a three-yearly agreement that governs its activity: the *Académie des sciences*, the board of education for the region of Loire-Atlantique, the City of Nantes, the University of Nantes, the *École des mines de Nantes* (engineering grad school), the regional centre for teaching documentation (CRDP) and the central bureau for cooperation in schools. Each party to the agreement commits to helping the pilot centre reach the objectives it has been assigned: to promote the development of inquiry-based science teaching in three “*Réseaux Ambition Réussite*”<sup>\*</sup> in the districts of West Nantes, Nantes Centre and Nantes Orvault. For example, the *Académie des sciences* provides the centre with an annual subsidy of 1,500 euros and provides science and teaching resources. The board of education finances a part-time position for the centre’s coordination and class support. The City of Nantes provides a location for the centre at Séquoia, the city’s science and environment hub, partly financing its running costs and supporting the schools’ projects. The university and the engineering school offer scientific support for classes and take part in teacher professional development. A steering committee, composed of the various partners, meets three times a year to define the centre’s policies and report on the initiatives undertaken.

<sup>\*</sup>Recovery plan for the French government’s policy to support schools in “priority education” areas.



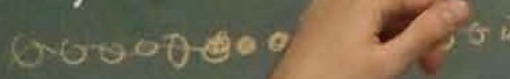
## Example of a program plan

Involvement of decision-makers	Description	Indicator 1	Indicator 2	Indicator 3
Stage 1  Estimated timeframe: 4 to 6 months	Informing representatives at the institutions whose involvement is essential : <ul style="list-style-type: none"> <li>• contact senior officials at the Department of Education (school boards)</li> <li>• find and contact senior representatives of the other institutions it would be useful to involve (universities, grad schools, teacher resource centres, local authorities, businesses, associations, etc.);</li> <li>• inform these representatives (decision-makers and financers) of the project to create (or develop) the centre ;</li> <li>• contact schools and field actors to introduce the project.</li> </ul>	General outline of the project is sent to decision-makers and financers. It is written and targeted specifically to each participant.	Individual contact is made with each decision-maker and financer to describe the project and seek their support and commitment.	A meeting is organized to bring together all institutions concerned and to specify the roles and commitments of each one.
Stage 2  Estimated timeframe: 3 to 4 months	Engaging the representatives of the institutions concerned: <ul style="list-style-type: none"> <li>• list of possible commitments each institution can make</li> <li>• representatives agree on the objectives and implementation of the project ;</li> <li>• the project and commitments of each institution are made official ;</li> <li>• setting up of structures for the active participation of representatives.</li> </ul>	A draft agreement is prepared specifying the centre's objectives, its development over three years and the commitments of each of the partner institutions.	A steering committee is formed from the representatives of the partner institutions. It meets 2/3 times a year at the centre coordinator's initiative.	The agreement is signed. (For pilot centres, the agreement is signed between the <i>La main à la pâte</i> Foundation and the centre's local partners.)
Stage 3	Promote the centre's initiatives in correspondence with partner institutions representatives : <ul style="list-style-type: none"> <li>• regular information on the centre's programs ;</li> <li>• send the partners the centre's productions ;</li> <li>• prepare an annual report for the partners.</li> </ul>	The projects and reports on initiatives led by the centre are regularly sent to the representatives of partner institutions and discussed during steering committee meetings.	The participation of senior representatives of partner institutions is sought for events organized by the centre.	The centre participates in events organized by partner institutions.

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 lipide 35%

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 phosphatidylcholine  
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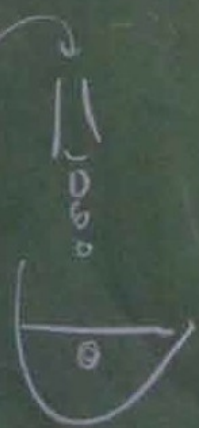
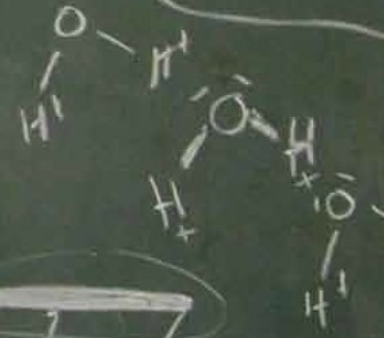
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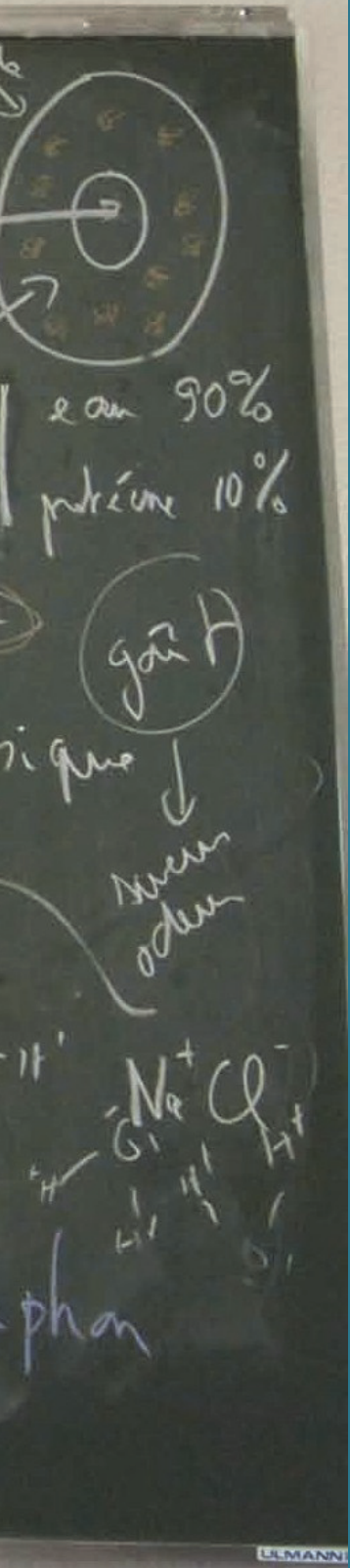
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### Chapter 3

# Providing resources for teachers

## Objectives and recommendations

Developing science education depends on structural resources that each centre must obtain and distribute. These resources include teaching modules incorporating learning sequences as well as experimental material. Resources allow students to tackle complex scientific subjects in different stages. Distributing to teachers enough teaching modules and material for an entire class is a major commitment to IBSE.

### A few recommendations

Teaching modules must be presented to teachers. This allows teachers who are starting out in IBSE or unsure of themes dealt with to better embrace scientific and educational content. These presentations can take place during events at the centre or specially identified professional development activities. It is important to:

- Involve teachers in developing the program of topics to be studied and choosing teaching modules,
- Use teacher feedback to improve material,
- Set aside enough time to put together materials kits ,
- Allocate a resources budget (covering the cost of putting together materials kits and purchasing documents and educational material).



## Assembling kits

Assembling materials kits is a process in several stages:

- Researching teaching modules on *La main à la pâte's* website (national websites and pilot centre websites),
- Researching related documentary resources (books, films, videos, photos, audio recordings, etc.) ,
- Ordering material from different suppliers,
- Collecting material from stores and managing deliveries,
- Labelling kits ,
- Printing teaching modules,
- Putting together and restocking kits .

### Providing resources for teachers: the *Pollen* project

The European *Pollen* project ([www.pollen-europa.net](http://www.pollen-europa.net)) focused on different areas of action:

- Programming topics for all levels of study taking into account the French Ministry of Education's programs
- Identifying five main scientific themes per year for the duration of pupils' schooling
- Ensuring modules are selected by the coordination team and teachers in the schools concerned
- Addressing the five themes in classes as part of five seven-week programs separated by school breaks (this period being the estimated length of time required to implement inquiry-based learning on a topic)
- Supplying teachers with kits containing teaching modules and associated material

#### Budget:

- The cost of a set of kits for all levels of schooling (35 kits) was around €3000.
- The cost of restocking kits every year was around 10% of the total purchase price of material or €300 per year for a set of kits.
- Examples of production costs for different kits:
  - First-grade "Seed or Object" kit: approximately €25 (seeds, soil, pots, seedlings, cotton, plastic spoons, spray bottle, etc.).
  - Pre-school "Little Engineer" kit: approximately €140 (two boxes of CELDA building games).
  - Fifth-grade "Breathing and Circulation" kit: approximately €90 (model, stethoscopes, limewater, tube, straws, bottles, DVDs on the human body, etc.).
  - Third-grade "Level 3 Electricity" kit: approximately €45 (wires, light bulbs, motors, propellers and switches).

#### Time required:

For the *Pollen* project, it took around five or six weeks to complete research and select teaching modules, two weeks to order the material required for these modules and two weeks to put together materials kits. A further four to six weeks were required for delivery (this can be up to 12 weeks during school breaks).

## Loaning kits

A rotation schedule can be drawn up to optimize the loaning of kits to schools. This schedule is transmitted to teachers at the beginning of the school year, and contains information on when different subjects can be taught and the dates at which material can be picked up and returned.

To help with restocking between periods of use, each kit has a material monitoring sheet. At the end of each period, teachers record any missing material and provide feedback on material used. This feedback is taken into account when improving kit contents.

### Example of a material monitoring sheet

Combinations		Period 1		Period 2		Period 3		Period 4		Period 5	
S: supplied, R: returned		S	R	S	R	S	R	S	R	S	R
Material	Qty										
Sieve	7										
Hot plate	1										
Distilling flask	1										
Clamp	1										
Saucepan	1										
Food coloring	1										
Plates	14										
Sponges	2										
Coffee filters	Yes										
Gauze	Yes										
Cotton	Yes										
Funnels	Yes										
Wide mesh	Yes										
Fine mesh	Yes										
Coal	Yes										
Teaching unit	Yes										
<b>Not supplied</b>											
Plastic bottles											
Gravel, sand, salt											
Paper towels, gloves											

### Example of a kit return sheet

School: ..... Name:..... Personal email address (for information):.....  Teaching unit:..... Grade:..... Period of use:.....	
<b>Material used during classes</b>	<i>List material that has been used and which must be restocked so the kit can be used again</i>
<b>Your comments on material and documents in the kit</b>	Is the material suitable for the age of the students?  Did you notice any omissions?  Would you like any other material to be included? If so, what?  Were the class preparation sheets useful?  Did you use them as they were or did you modify them?  Are there any areas you would like to see developed further?  Thank you

## Examples of strategies implemented in pilot centres

### “Turnkey” kits Bergerac pilot centre

The centre provides schools in the town of Bergerac with 35 kits covering all topics studied as part of the programs. For each topic, the kit contained enough material for an entire class, a suggested learning sequence, as well as educational and scientific support documentation on the theme dealt with.

These kits are loaned to schools for six to eight weeks. Reservations are made on the pilot centre’s website. On average, each kit is borrowed six times over the school year. The centre designs, restocks and transports kits to schools.

Teachers can ask the team at the centre to provide classroom support; for example, when starting on a new topic.

## Providing documentation and support for teachers

### Nogent-sur-Oise pilot centre

The pilot centre gives teachers the opportunity to lead a sequence on a selected topic and receive classroom support from a member of the centre's team for several weeks. In 1998, when the Nogent-sur-Oise support program started, there was very little educational documentation in the science field. The centre therefore used "Insight" teaching modules from the US. For each topic, the "Insight" module contained a method, activities, a pedagogical progression and some scientific background. Over the years, the team adapted the theoretical structure of these modules to meet the needs of pupils, teachers and programs. In addition, the team added class reviews and documents on scientific concepts and ideas studied as part of each topic. Each teaching module contains enough material for an entire class.

These documents are now available to all teachers at the centre's schools, not just teachers receiving classroom support.

## Assembling kits with teachers

### Paris pilot centre

When the resource centre opened in 2010, the pilot centre's team decided not to offer "turnkey" kits containing learning sequences and material. This decision was based on the observations that many kits contained material that was useful in other learning contexts, and that the teachers' schools already owned some materials so not everything in the kits was necessary. The team therefore decided to supply teachers with learning sequences that included a list of useful material and a stock of material that could be borrowed upon request.

Lists of available material and learning sequences, organized by topic in a library, can be consulted at the resource centre and on the pilot centre's website.

After testing this initiative, the team came to the conclusion that sometimes pre-packed boxes were necessary for some sequences. For example, for a class on the solid/ liquid sorting where students work in pairs, around ten boxes containing different materials are needed. This preparation work takes time and it is therefore a good idea to pre-pack boxes.

While the centre has kept to its initial approach, it has amended its policy to be able to respond more quickly to requests for learning sequences that require complex and labor-intensive material preparation.



## Example of a program plan

Provision of resources	Description	Indicator 1	Indicator 2	Indicator 3
<p>Stage 1</p> <p>Estimated timeframe: 3 to 6 months</p>	<ul style="list-style-type: none"> <li>• Draw up an inventory of existing resources in schools and in the geographic area(s) concerned</li> <li>• Provide each centre's school with a list of existing material and material available for loan (via the website or by mailing to schools)</li> <li>• Identify resource requirements and requests (teaching modules, materials, topics to study, etc.)</li> <li>• Identify priority purchases (e.g. by first focusing on two or three topics and developing a network between schools and encourage joint preparation)</li> <li>• Organise the loan of the centre's material and start lending some resources</li> </ul>	<ul style="list-style-type: none"> <li>• Draw up an up-to-date list of resources available at the centre and schools</li> <li>• Draw up a list of resources available for loan</li> <li>• Inform schools of resources available for loan</li> </ul>	<ul style="list-style-type: none"> <li>• 25% of classes borrow and implement an IBSE unit per year</li> <li>• Schools provide logistical feedback</li> </ul>	<ul style="list-style-type: none"> <li>• An increasing number of requests to borrow material</li> </ul>
<p>Stage 2</p> <p>Estimated timeframe for steps 2 and 3: 6 to 18 months</p>	<ul style="list-style-type: none"> <li>• Loan out an increasingly wide range of resources</li> <li>• Monitor these resources (restocking, rotation, etc.)</li> <li>• Offer classroom support (educational and/or scientific) on topics teachers consider difficult and/or topics that the centre has identified as priorities</li> </ul>	<ul style="list-style-type: none"> <li>• 50% of classes borrow one unit per year</li> <li>• 35% of classes borrow two modules per year</li> </ul>	<ul style="list-style-type: none"> <li>• Support is provided to 25% of classes that request it</li> </ul>	<ul style="list-style-type: none"> <li>• Teaching modules are improved following feedback from users and support staff (ideas for use, additional content, etc.)</li> </ul>
<p>Stage 3</p>	<ul style="list-style-type: none"> <li>• Make more material available for loan and standardize resources for all 3 levels of primary schooling (there are around 15 modules per level, and therefore 40 different modules from pre-school to fifth grade).</li> <li>• Make copies of and restock material, in addition to giving the centre's schools access to complementary resources (rewritten material, additional resources, etc.)</li> <li>• Increase the centre's capacities to support the use of resources by taking into account educational and scientific perspectives (cf. professional development).</li> <li>• Create local resources building on existing resources (in-depth studies, guides, complementary material, educational and scientific guidelines) or new topics</li> </ul>	<ul style="list-style-type: none"> <li>• 80% of classes implement one unit per year</li> <li>• 50% of classes implement two modules per year</li> <li>• Resources' related content distributed to all the centre's schools</li> </ul>	<ul style="list-style-type: none"> <li>• Support is provided to 50% of classes that request it</li> <li>• Teachers participate in the reflection on the exploitation of resources</li> </ul>	<ul style="list-style-type: none"> <li>• Teachers contribute to producing new resources (1 to 2 per year).</li> </ul>





## Chapter 4

# Professional development and support for teachers

## Objectives and recommendations

Professional development and support for teachers are essential in the transition to IBSE. This requires time: courses and support initiatives must run for at least three years to be effective.

The objective is to draw up a three- or six-year professional development action plan that is based on: identifying real educational needs, allowing teachers to progress to different IBSE levels (from beginners to autonomous users), setting aside time for professional development activities (around 70 to 80 hours), taking into account the effect of networks that support professional development, and a realistic evaluation of the professional development program.

### A few recommendations

*La main à la pâte* has considerable national and international experience in this field. This allows the organization to make recommendations for planning professional development and support activities. The aim is to target the widest possible group of teachers given each centre's geographical location.

The organization recommends:

- Beginners professional development sessions of several days, and more specific sessions running over three years
- Alternating between sessions outside the classroom and opportunities to put in practice techniques learnt during courses in the classroom
- Providing easy access to resources: documents on scientific and educational contents, material, teaching modules, learning sequences, etc.
- Providing educational and/or scientific support on a local level (students, researchers or engineers). These support initiatives must form part of a well-defined professional development strategy that identifies any decisions to be made. For example, to increase efficiency and create momentum, it is recommended that school or schooling level teams are given the opportunity to take part in ASTEP (Supporting Science and Technology in Primary Schools). This educational and scientific support must be organized, prepared, coordinated and monitored. It does not replace courses, but can be a useful addition.
- Supporting teachers who master IBSE to encourage the professional development of teachers in schools, districts and regions.
- Coordinating different professional development activities for teachers.

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## Example of a three-day professional development program to introduce IBSE

### Objectives:

- learn about the main characteristics of inquiry-based science education
- discover and become familiar with the resources in order to use them in science sessions in class

Day 1	
<b>Morning</b>	<p><b>Experience and characterise inquiry in science through a hands-on session</b></p> <p>Participants experience a scientific inquiry for adults. They analyze this situation to characterize the methods used in inquiry-based science education.</p>
<b>Afternoon</b>	<p><b>Illustrate how to implement inquiry-based science education (IBSE) at primary school according to the different age levels (part 1)</b></p> <ul style="list-style-type: none"> <li>• Analysis of video extracts selected for different primary school levels (3/4 years ; 5/8 years ; 9/11 years): identify things in common, unique aspects and differences.</li> <li>• Prepare class visits planned for the following day by defining observation criteria focused on the teacher's role (based on observation tables previously drawn up, for example).</li> </ul>

Day 2	
<b>Morning</b>	<p><b>Illustrate how to implement inquiry-based scientific education (IBSE) at primary school according to the different age levels (part 2)</b></p> <ul style="list-style-type: none"> <li>• Observe a session in class.</li> </ul> <p>Exchange and analyze observations based on pre-defined criteria.</p>
<b>Afternoon</b>	<p><b>Teacher's resources</b></p> <ul style="list-style-type: none"> <li>• Present national and local resources</li> </ul> <p>Examples : class activities, themed <i>La main à la pâte</i> modules (module refers to a group of sequences), network of pedagogic and scientific consultants, <i>La main à la pâte</i> website, other websites, forum, ASTEP and other local support measures available to teachers.</p> <ul style="list-style-type: none"> <li>• Time spent on becoming familiar with the different resources : surf the different sites, browse printed modules, read network archives of the pedagogical and scientific consultants, discover kits on a given scientific topic (including class material and teaching sequences)...</li> </ul>

Day 3	
<b>Morning</b>	<p><b>Prepare a module (or sequence) to be used in class</b></p> <p>Choose a module to work on (for example : two different modules may be presented, the teachers attend the conferences and workshops for the chosen module)</p> <ul style="list-style-type: none"> <li>• Scientific conference on the module (or sequence) theme.</li> <li>• Present the main elements of the module (how the sequence will be organized, the progression of the concepts the pupils should grasp, choice of investigation methods depending on the sequences, suggestions for assessment, etc.)</li> <li>• Perform some of the experiments suggested in the module.</li> <li>• Presentation of the system for teaching support in the field (distance learning, in classrooms, feedback from participants on two different moments of the module implementation, etc.)</li> </ul>
<b>Afternoon</b>	<p><b>Science and language</b></p> <ul style="list-style-type: none"> <li>• Hands-on session for adults on the link between science and language</li> <li>• Reflection on class tools and teaching methods that encourage the structuring of science and language learning, such as :             <ul style="list-style-type: none"> <li>▪ How to give structure to writings in science class (posters, experiment copybook, glossary, etc.) ? For example: use the video "Wheat seeds and earthworms" from the DVD "Learning science and technology in school".</li> <li>• How to conduct a class discussion (pooling ideas, drawing provisional conclusions, the institutionalization of knowledge)? For example: use the video "Breathing and circulation" on the same DVD.</li> </ul> </li> </ul>

## Becoming autonomous in IBSE: a possible 80-hour programme of professional development

We estimate that a teacher needs 70 to 80 hours of professional development before fully mastering inquiry-based science education (IBSE). We use the expression “professional development” rather than ‘continuing training’ to emphasize the fact that the teacher can increase his/her professional skills in a number of formal or informal situations, alone or with others, within or outside the school environment.

The following table gives an example of a proposed distribution of 80 hours of professional development. This can be performed over several years.

Objectives of professional development activities	Possible approaches		Activity description	Possible methods	Hours
<b>Discover IBSE</b>	Introduction to inquiry-based science education		Illustration of the different IBSE practices according to the different levels of compulsory schooling.	<i>Conference</i>	3
	Inquiry-based hands-on sessions		Hands-on + inputs on the teacher’s and pupils’ roles, the type of pedagogy in accordance with IBSE specificity and the levels of compulsory education.	<i>Workshops</i>	6
<b>Design and implement IBSE with time allocated for sharing experiences and reflecting upon them</b>	Discovering and becoming familiar with class resources		<ul style="list-style-type: none"> <li>• Presentation and analysis of a resource (module or sequences to be used).</li> <li>• Scientific explanations of the concepts associated with this resource.</li> <li>• Appropriation of the module, preparation of how to apply it to class sessions and organization with close follow-up.</li> </ul>	<i>Workshops</i>  <i>Conferences</i>	6
	Sharing the experience of IBSE practice.	Alternate practice sessions and workshops for sharing those practices	<ul style="list-style-type: none"> <li>• Reflecting on experience with a group of colleagues engaged in the same approach.</li> <li>• Further study of certain issues linked to IBSE (active teaching practice, science and language, etc.)</li> </ul>	<i>Workshops</i>	9 (3x3)
		Working through networking with colleagues involved in the same professional development dynamic.	<ul style="list-style-type: none"> <li>• Group preparation period for module sessions.</li> <li>• Exchanges on success and problems encountered when conducting the sessions.</li> <li>• Exchanges (by network correspondence or in the local centres or resource centres) with a scientific or teaching consultant to deal with problems encountered.</li> </ul>	<i>School and distance working</i>	9

<b>Practise IBSE with support</b>	Scientific support to science and technology teachers.	<ul style="list-style-type: none"> <li>Information and education of scientific assistants and teachers for their joint class session.</li> <li>Joint preparation of the session.</li> <li>Analysis and adjustment time for the work done.</li> </ul>	<i>Workshops / Work in schools /distance working</i>	12
	Pedagogical support to teachers in class	<ul style="list-style-type: none"> <li>Visit by an educator to the teacher's class (outside look and assistance in analysing the session; participation in or teacher replacement on request, etc.)</li> </ul>	<i>Work in schools</i>	6
<b>Expanding IBSE practices</b>	Through personal work	<ul style="list-style-type: none"> <li>Renewing skills in the field of scientific knowledge and recommended teaching method.</li> <li>Research modules and adapt those chosen for teaching.</li> </ul>	<i>Distance learning / Conferences / Visits</i>	14
	Through meetings with scientists	<ul style="list-style-type: none"> <li>Professional development course such as Graines de Sciences.</li> <li>Lectures/conferences</li> <li>Visiting science labs or businesses</li> </ul>	<i>Longer activities Conferences Visits</i>	6 (to 18)
	By openings to new practices and the expansion of acquired practices	<ul style="list-style-type: none"> <li>Concepts and didactic inputs contributions (science and language, science and maths, science and history of science, science and technology).</li> </ul>	<i>Conferences Workshops</i>	9

## Teaching units for scientific support (ASTEP)

At a time when the education system is going through significant transformation, in particular with the creation of a master's degree in teacher education in more independent universities, the creation of an ASTEP (Science and Technology Support in Primary School) TU (Teaching Unit) at degree, masters or doctorate level provides an opportunity to both introduce science and engineering students to teaching science in a school environment and also provides support for teachers conducting scientific and technology activities in their classes.

### Aims of the TUs

- Offer practical internship at primary school
- Contribute to the academic aim to disseminate a culture of science.
- Include science students in a civic project dedicated to equal opportunities.
- Promote the development, renewal and dissemination of science and technology teaching in schools.
- Give students a taste for the teaching profession.

### Who are they for?

These TUs are intended for students in science and technology or grad students in engineering, from degree to doctorate level.

### How?

- TUs focus on three aspects :
  - Discovering the inquiry approach: hands-on exercises, observation in primary school classes or video analysis of lessons, discovery of the education system and its curricula, education in teacher support, etc.
  - Support: participating in lessons with primary school teachers.
  - Restitution and validation: prepare a report and its defence.
    - University credits for students: between 3 and 6 ECTS (*European Credits Transfer System*) depending on the number of hours spent.
    - Support assistants are supervised by tutors from the scientific institution.
    - Diversity of the TU: free, optional or compulsory depending on the course chosen.
    - Establishing a partnership with the board of education: wherever possible, it is preferable that a representative from both the department of education and the scientific institution coordinate and oversee the introduction and follow-up between the support assistant and primary school teacher.

### Benefits expected

#### *For the students*

- expand and develop scientific knowledge by using them differently,
- discover the career paths and professions in teaching,
- facilitates career orientation,



- adapt scientific discourse to a non-specialist audience: children and teachers,
- give an interesting and more accessible image of science,
- enjoy a rewarding civic experience, listening to others and trying to see from their point of view.

*For higher education and research bodies:*

- make a beneficial impact on teaching practices at primary school, encouraging future scientists,
- involve students in society-focused projects,
- develop communication and science teaching skills in scientists.

*For primary school classes*

- strengthen primary teacher skills and their capacity to practice science and technology activities by overcoming any possible concerns and consolidating their grasp of scientific approaches and content,
- practice scientific activities based on an inquiry approach by exchanging with the teacher and the support assistant,
- Help teachers and pupils discover science as a living, interesting, accessible and understandable subject.



## Three examples of teaching units (TU) for scientific support

ASTEP partner	Université de Nancy	École des Mines de Nantes	ESPCI : Espace des sciences Pierre-Gilles de Gennes, Paris
Name of Teaching Unit	<i>La main à la pâte.</i> Teaching science at primary school	Social Commitment Project	Scientific support
Methods	<p>This TU (valid for 3 ECTS <i>European Credits Transfer</i> and Accumulation System) is destined for</p> <ul style="list-style-type: none"> <li>Students in engineering schools or university science courses, who wish to help improve understanding of science and technology among a larger community (an assignment shared by teachers and researchers) ;</li> <li>Students aiming for a career in teaching at primary level</li> </ul>	<ul style="list-style-type: none"> <li>Each grad student in the EM de Nantes must participate in a Social commitment project, through an activity that is part of a personal development project.</li> <li>The student performs this activity for the first two years of his/her course.</li> <li>Some of these projects result in teacher support conducted by student engineers.</li> </ul>	<p>Since 2000, the science hub Pierre-Gilles de Gennes has contributed to ASTEP. Support to primary school classes in Paris is mainly provided by student engineers of all levels and a handful of teacher-researchers.</p> <p>All are volunteers and assist in classes during their free time, for 7 or 8 lessons beginning in November.</p>
Description and validation of the support program •	<ul style="list-style-type: none"> <li>The students first discover the methods of science teaching, the schools and the pupils with theory and practical learning and several class visits as observers. They then prepare, in collaboration with the school teacher, a teaching sequence (several sessions) that they draft in detail.</li> <li>They then conduct sessions in schools once a week for several weeks to contribute to science teaching</li> <li>The TU ends with a conclusive summary and presentation during which each student exchanges with fellow students on the various projects.</li> <li>An event is organised so that all the classes who participated be able to present their year's work to the others.</li> </ul>	<ul style="list-style-type: none"> <li>A general information meeting is available for students in September to inform them on class support and the challenges of science teaching in primary school.</li> <li>6 hours of course is provided before class sessions commence.</li> <li>Once the students have selected a support project, a meeting with the teachers is organised to discuss the necessary points to a successful activity.</li> <li>Next, the class support sessions commence.</li> <li>The project is supervised by the support coordinator and the head of the scientific field at the EM de Nantes.</li> <li>At the end of the project, the student gives an oral presentation before a panel, who assesses his/her work.</li> </ul>	<ul style="list-style-type: none"> <li>September: first information session on ASTEP when the new engineer students are welcomed by graduates and during the induction weekend.</li> <li>October: candidates meet the teachers from schools requesting support.</li> <li>November: meeting for support assistants on: <ul style="list-style-type: none"> <li>the education system and its actors, curricula, common knowledge core.</li> <li>resources (kits, websites, in particular <i>La main à la pâte</i>).</li> </ul> </li> <li>2-3 times per quarter, support assistants meet to exchange on experience, share tools, reflect on different themes (inquiry-based approach, directing sessions, introducing concepts, collective conclusion from sessions, etc.)</li> </ul>

For more information (<http://www.asteptu.fr>)

Several higher education institutions have already put in place an ASTEP TU for their science students. You will find summary sheets on the website ([www.asteptu.fr](http://www.asteptu.fr)) and a large selection of documents that present the organisation and content of these teaching units.

## The role of the resources teacher at Mâcon pilot centre

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The resources teacher is mainly in charge of providing pedagogical support to the teachers.

### Resources teachers entitled to one day of reduced work load per week

The work assigned to resources teachers is part of the pilot centre project “*La main à la pâte, sciences et technologie pour la réussite de tous*” (*La main à la pâte, science and technology for global success*) in the ZEPs (priority education zones) and REPs (priority education networks) in Mâcon and is part of an established support system.

As such, the resources teacher is committed to:

1. develop his/her skills to strengthen ISBE;
2. helping to prepare sequences (series of sessions) based on inquiry, for example within a mixed working group (teacher, scientist, educational advisor, etc.);
3. testing the sequences in his/her class, outlining the systems in place to engage and develop students' language skills and help structure the learning processes;
4. helping the school team to plan and formulate the different learning objectives for each level or school. Encourage and/or support school projects in the field of science and technology by assisting the teachers but without taking their role ;
5. meet with colleagues before assisting them, prior to a session and providing helpers in the classes for experimental situations;
6. report on and share the result of work done to initiate professional development programs directed at teachers (pedagogical activities, working groups, professional development courses);
7. contribute to the creation of an assessment protocol that assesses the pupils under three aspects : knowledge acquired in the subject matter, skills acquired in terms of language, skills acquired in terms of the pupil's attitude, take part in this assessment, allow teachers who are willing to, to assess the progress made in their teaching practice in the sciences;
8. liven up the science lab in the school, if it has one: discover the equipment and what can be done with it, develop the kits based on elements lacking or problems encountered.

The resources teacher must not take charge of the science session alone, act as a specialist or perform activities that are his/her colleagues' responsibility.

Role:

<b>Towards pupils:</b>	<b>in his/her own class</b>	<ul style="list-style-type: none"> <li>• Implement IBSE through pilot centre projects, with the pupils in his/her class</li> </ul>
	<b>in other classes</b>	<ul style="list-style-type: none"> <li>• Manage groups.</li> <li>• Act as a secondary teacher (the assisted teacher remains in charge of the class).</li> </ul>
<b>Towards teachers:</b>	<b>in his/her own school</b>	<ul style="list-style-type: none"> <li>• Share information.</li> <li>• Encourage discussion and exchange on the different teaching experiences within the school.</li> <li>• Offer to assist in other teachers' classes as a helper.</li> <li>• Help teachers establish the scientific approach.</li> <li>• Facilitate the organization of activities in the school : science lab, equipment, science notebook, projects, etc.</li> </ul>
<b>Within the project:</b>		<ul style="list-style-type: none"> <li>• Develop the kits.</li> <li>• Rework certain modules.</li> </ul> <p>Report on feedback from class practices.</p>

### Resources teacher with no entitlement to reduced work-load

Activities carried out are part of the “*La main à la pâte*” pilot centre project, science and technology for global success in the priority education zones (ZEP) and priority education networks (REP) in Mâcon.

As such, he/she takes responsibility for:

1. informing himself/herself and learning about inquiry-based science education;
2. try out sequences in class; help produce and/or adapt sequences with respect to the inquiry approach and outlining the methods and measures applied in class to engage language skills. Outline the different situations that help give structure to learning (including linguistic learning);
3. help the school team to plan and formulate the different learning objectives for each level or the whole school;
4. share the results of his/her work for professional development activities for teachers (teaching activities, working groups, professional development courses);
5. assess pupils under three aspects: knowledge acquired in the subject matter, skills acquired in terms of language, skills acquired in terms of the pupil's attitude.

The resources teacher must not direct sessions alone in a colleague's class or act as the only specialist qualified to practice science in his/her school.

His/her role:

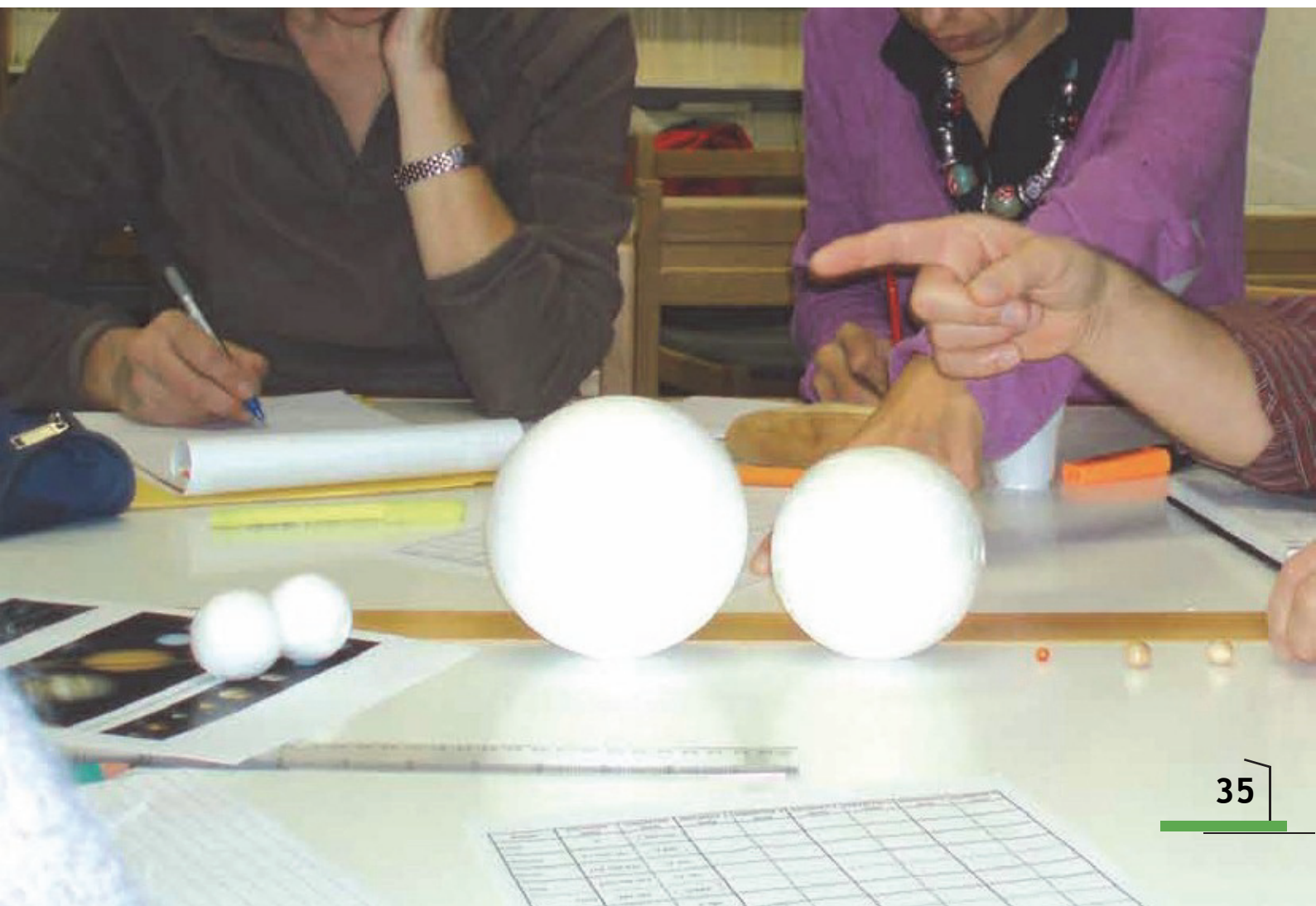
<b>Towards pupils:</b>	in his/her own class	<ul style="list-style-type: none"> <li>• Conduct pilot centre projects, with the pupils in his/her class.</li> </ul>
<b>Towards teachers:</b>	in his/her school	<ul style="list-style-type: none"> <li>• Share information.</li> <li>• Encourage exchanges on the different teaching experiences.</li> </ul>
<b>Within the project:</b>		<ul style="list-style-type: none"> <li>• Rework certain modules</li> <li>• Report on class practices.</li> </ul>

The resources teachers are an integral part of the pilot centre project. They are provided with the centre's resources, which they use in their class and help develop them and introduce them to their colleagues. They are assisted by the centre coordinator who organises the activities performed in the classes and provides everyday support with the help of partners of the pilot centre. The partners can provide assistance in specialist fields (scientific explanations and expertise) or even logistics or financial support.

### Different types of systems

Similar systems exist in other pilot centres with different names.

- in Perpignan, "*maîtres référents*" (referent teachers) give a quarter of their time per week to assist colleagues in their district in classes or to promote and share the pilot centre productions, providing a link between the schools and the centre;
- in Nogent-sur-Oise, "*maîtres surnuméraires*" (supernumerary teachers) give a third of their time assisting teachers in science sessions who wish to further their IBSE practices.
- In Troyes, "*maître-relais*" (relay teachers) take part in producing resources for the pilot centre and its website. They use these resources in class, helping them to evolve and introducing them to their colleagues. They also take part in professional development activities and the organisation of science-related events.



## Example of a program plan

Planning professional development programs depends on the choices the pilot centre coordinator makes with the project partners. The plan must take the local situation into account. Obviously, there is no one right program and each plan may have different priorities. As such, the stages suggested in the following table may need to be carried out in a different order or go in a completely different direction. However, priorities should be consistent with the recommendations given in the previous section.

The following table offers an example of a program plan. The choices are based on:

- Educating resources teachers who can then help further develop the centre's project in the schools.
- The presentation and supported implementation of the modules. Having teachers implement the same module facilitates dialogue and information sharing among network members.

Teacher professional development and support	Description	Indicator 1	Indicator 2	Indicator 3
<b>Stage 1</b>  <b>Estimated timeframe: one year</b>	<ul style="list-style-type: none"> <li>• Identify teachers' professional development needs at the centre's participating schools and establish a realistic professional development plan according to educators' potential.</li> <li>• Sensibilize the teachers on the different principles of IBSE.</li> <li>• Create a network of science resource teachers.</li> </ul>	<ul style="list-style-type: none"> <li>• Survey teachers to identify their educational needs and practices.</li> <li>• Hold a 3-hour conference on IBSE principles.</li> <li>• Hold a 2-day course to present and analyse a module.</li> <li>• Identify teachers who want to become science resource teachers.</li> </ul>	<ul style="list-style-type: none"> <li>• Establish a 3- to 6-year professional development plan that includes 80 hours of course / support.</li> <li>• Provide learning activities (6 hours minimum) for teachers participating in the 2-day course.</li> <li>• 1-day course for science resource teachers.</li> </ul>	<ul style="list-style-type: none"> <li>• Create an initial list of teachers and schools who will participate in the first courses.</li> <li>• Set up classroom visits by an educator for:               <ul style="list-style-type: none"> <li>• A co-presentation</li> <li>• Support in analysing the lesson.</li> </ul> </li> <li>• Set up individualized support and/or ASTEP for science resource teachers.</li> </ul>

<p><b>Stage 2</b></p> <p><b>Estimated timeframe: one year</b></p>	<ul style="list-style-type: none"> <li>Strengthen the network of science resource teachers.</li> <li>Offer professional development for teachers who have never had any, especially regarding using the learning modules.</li> <li>Offer additional professional development or individualized support to teachers who have been educated but who are not part of the network managed by science resource teachers.</li> <li>Assist schools in their teaching planning.</li> </ul>	<ul style="list-style-type: none"> <li>Work with the science resource teachers to establish an action plan for their colleagues.</li> <li>Hold a 3-hour conference on ISBE principles.</li> <li>Hold a 2-day course to present and analyze a learning module and have teachers who attended the prior year's session discuss their experience.</li> <li>One or two 3-hour conferences on specific challenges in ISBE (scientific concepts, themes such as science and language or science and math).</li> <li>Offer courses on new themes.</li> <li>Suggest school events on these themes.</li> </ul>	<ul style="list-style-type: none"> <li>Implement a working group for science resource teachers to learn about using the available resources.</li> <li>Offer learning activities (6 hours minimum) for teachers participating in the 2-day course.</li> <li>Offer ASTEP and organize a day for teachers and scientific support assistants to meet and discuss the program.</li> <li>Participate in school meetings.</li> </ul>	<ul style="list-style-type: none"> <li>Organize 3 meetings per year with science resource teachers to review their actions.</li> <li>Have an educator or science resource teacher visit classes to help teachers implement a learning module.</li> <li>Hold a 3-hour conference on the scientific theme chosen for the year.</li> <li>Offer individualized classroom assistance to begin a learning module with which the teacher is not entirely comfortable.</li> <li>Rely on science resource teachers to contribute to teaching planning in schools</li> </ul>
<p><b>Stage 3</b></p> <p><b>Estimated timeframe: one year</b></p>	<ul style="list-style-type: none"> <li>Extend ASTEP support depending on the situation (first ISBE experience, additional professional development, resource teacher).</li> <li>Expand the scope of action for resource teachers in their school, district or region.</li> <li>Offer professional development on new themes.</li> </ul> <p>Continue the professional development plan for teachers who have not benefited from it yet</p>	<ul style="list-style-type: none"> <li>Plan two days of course for ASTEP, bringing together scientific professionals and teachers.</li> <li>Ask scientific resource teachers to focus their support on teachers who are not yet participants in the centre's support program.</li> <li>Hold conferences on scientific or educational themes.</li> <li>Hold a 2-day course to present and analyse a learning module.</li> </ul>	<ul style="list-style-type: none"> <li>Offer occasions for teachers to learn about new scientific advances and educational techniques.</li> <li>Organize meetings between teachers and scientists.</li> <li>Ask resource teachers to speak during professional development sessions in the district or region.</li> <li>Create a working group or workshop on "specialized" subjects: scientific writing, assessment, etc.</li> <li>Learning activities (6 hours minimum)</li> </ul>	<ul style="list-style-type: none"> <li>Hold a 3-hour conference on the scientific theme of a learning module.</li> <li>Develop resource teachers' skills on new resources so they can present them to their colleagues.</li> <li>Have resource teachers participate in the creation of new resources.</li> <li>Encourage teachers to work with scientific institutions and industrial companies.</li> </ul>



5

Procedure for the assay:  
1. Prepare the reaction mixture in a microcentrifuge tube.  
2. Add the substrate (100 µg/ml).  
3. Incubate at 37°C for 10 minutes.  
4. Stop the reaction by adding 1M NaOH.  
5. Measure the absorbance at 405 nm.

Reaction mixture:  
- substrate  
- cofactor  
- cofactor

Substrate: 100 µg/ml







Chapter 5

# Coordinating a local support network

## Objectives and recommendations

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An educational project such as developing a pilot centre for sciences must be aimed at a particular territory, like a city, region, district, RAR (a French educational network program) or ÉCLAIR (a French elementary and middle school program). It is important to study potential local resources to identify the players who will actively participate in the project. The scientific and industrial communities, as well as local associations, are all possible partners. Cooperation can be gradually built around the centre's projects.

The goal is to:

- Make use of the local community's diversity and complementary contributions
- Link these contributions to create synergy for the benefit of the centre's actions as part of a shared, well-developed project.

### A few recommendations

From the start of the project, it is crucial to review the existing local scientific and cultural organizations that can potentially be involved in the project.

To increase potential partners' willingness to participate, the project needs to have clearly outlined objectives. If not, partners may not have a precise idea of what their participation entails.

The ASTEP program, which offers scientific and technical support to elementary school teachers, is a good way to establish partnerships with scientific organizations. For more information, go to <http://www.astept.fr>

Implementing a steering committee, on which interested players can serve, is an excellent way to give them information and get them involved in school-oriented actions.

## Examples of established programs

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### Projects developed in cooperation with different partners Pilot centre in Nantes

*"Et la Loire dans tout ça?"* (What about the Loire?) was a joint project by the pilot centre and Séquoia, the City of Nantes' centre for science and the environment. It focuses on a key aspect of local heritage – the Loire River – on which a number of topics are based, including the environment, ecosystems, human activities, history and more. The various topics, divided into lesson sequences, are given to teachers during professional development days held to mark the start of the project. Teachers may receive classroom teaching support, such as by the pilot centre's resource teacher, or scientific support from students at the École des Mines in Nantes or the local university. Classes can also visit Séquoia for one or two special lessons. The project coordinators work to connect teachers with institutional partners (e.g., the local Conseil Général, museum, planetarium) and associations (e.g., Bretagne vivante, LPO, Quai vert, Cale 2 l'île) that are able to offer scientific and technical expertise applicable to the project. This gives students an opportunity to study a topic through local resources, such

## Scientific and cultural pathways related to activities from a module implemented in the class Pilot centre in Nancy

The pilot centre in Nancy has instituted a scientific program entitled ‘scientific pathways’ to provide an eight-week series of teaching sequences to elementary school teachers. The program topics reflect the elementary school curriculum and include astronomy, sustainable development, energy, steam engines and the functions of living things. Each program includes school lessons, a trip to the pilot centre and a visit to a local organization (e.g., museums, laboratories, associations) related to the topic studied. For example, the “*Objets techniques*” (Technical Objects) program, which deals with mechanisms and motion transmissions, includes visits to Jarville’s iron museum to discover steam engines. The “*L’eau : une ressource*” (Water: a resource) program involves trips to the Maxeville water treatment plant and the Museum-Aquarium in Nancy. “*L’eau et les transports*” (Water and Transport), a program initiated in cooperation with *Voies navigables de France* (the public institution that manages France’s waterways), gives students the opportunity to visit a canal lock and meet with the lock keeper or sail through locks on the *La Bergamote* barge.

## Partnership with a local company Pilot centre in Châteauneuf-les-Bains

The pilot centre in Châteauneuf-les-Bains in the Académie de Clermont-Ferrand established original partnerships between its local schools and companies. For example, every year since 2009 the project “*Eurêkart: ça roule*” (Eurekart: It rolls!) in partnership with the manufacturer Michelin, was created to let students build a car that rolls straight as long as possible without pulling or pushing it and which is able to carry a small load. Each year, the entire research community gets behind this project, promoting cooperation between students, their teachers, educators and the company’s scientific engineers. This broad scientific and technological adventure ends with a special event at the Ladoux site. Classes are accompanied by their scientific mentors to discuss their research process before doing a real demonstration on how their finished prototypes work. This project, initially designed for elementary school students, has been expanded for middle school students. Another project developed in cooperation with the Aubert and Duval des Ancizes steel mills, “*Air et polluants*” (Air and pollution), has been underway with elementary schools since 2012. For this project, the classes receive an instructional scientific guide and materials kit, in addition to support for their inquiries into questions such as: *What is the air we breathe made of? What pollutes air? How can we test air quality? Can you prevent pollution? What can you do?* It’s a program chock full of collaborative activities!

## The knowledge market

The knowledge market is based on the idea that nobody knows everything, but everybody knows something. This is a place where knowledge can be exchanged: those with special expertise can offer it to those who need it while being able to interact with others. In terms of students, the market consists in designing and hosting a sort of

trade show with stands where students can be both “sellers” and “buyers” of knowledge. Students share what they know with their peers, creating a strong link between fun and learning by expressing and recognizing their own talents. The knowledge market is a place where students can change their perceptions of knowledge.

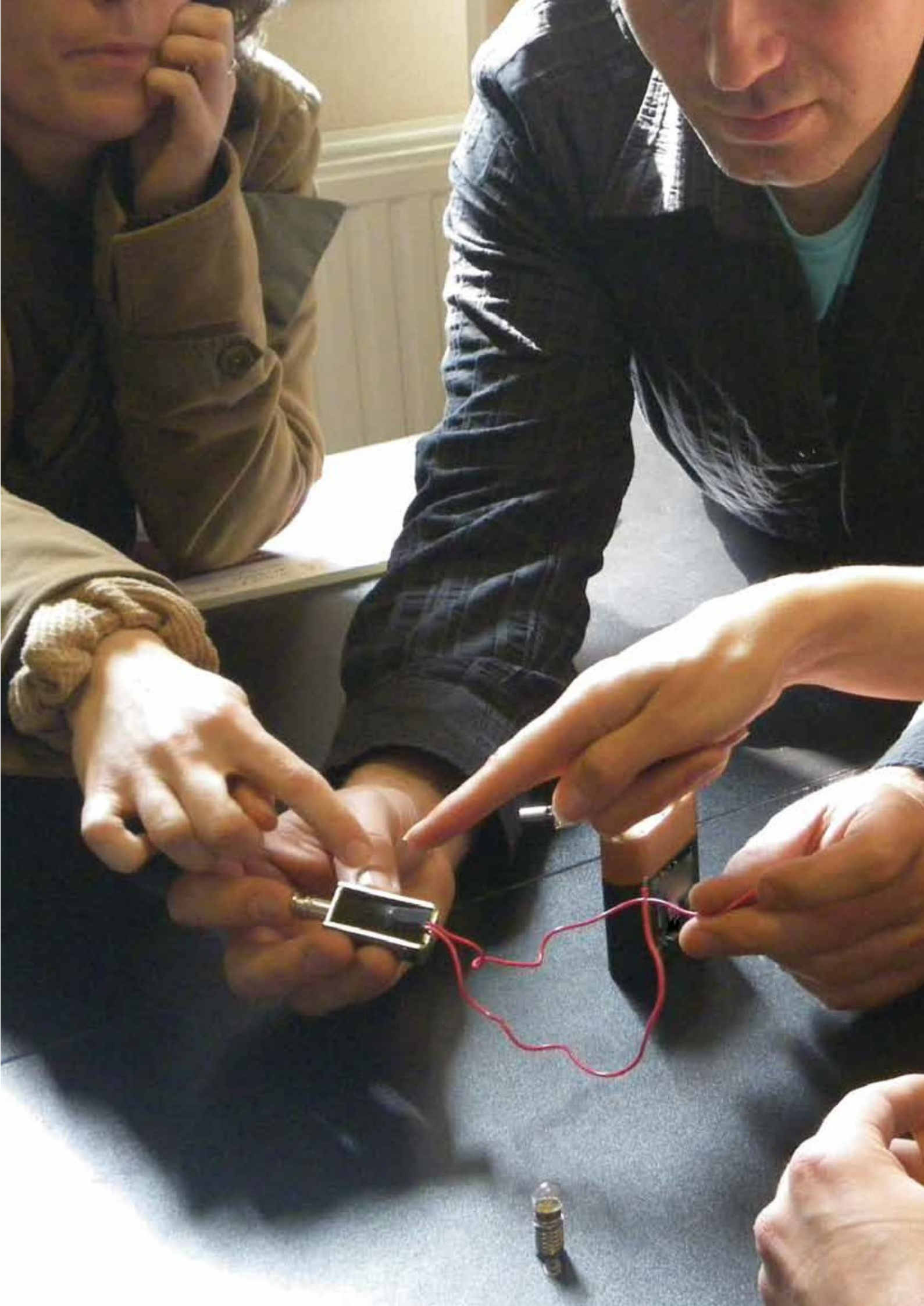
In a similar vein, a knowledge market can be organized for teachers and/or educators. The idea is to present a practice, teaching lesson or original experience that someone wants to share with others, whether because it offers interesting teaching resources or promotes teachers’ professional development. One option is to set up 30-minute sessions that take place at the same time in two or three adjoining rooms. A different topic can be presented in each room for 15 minutes, followed by a discussion. Each room therefore hosts three successive sessions that run over a total of 90 minutes. The participants go to their “market” by attending three out of the nine possible sessions. This allows everyone to make the most of the resources and experiences according to their own interests and needs.

A knowledge market is held during the annual meetings between *La main à la pâte* pilot centres to facilitate resource pooling between network members.

## Encouraging parents to participate in scientific initiatives and share their knowledge Pilot centre in Paris

The pilot centre in Paris has made strengthening ties between schools and parents a priority. The Cavé elementary school, located in the Goutte d’Or neighborhood, puts on *La cave aux sciences* (the science cave) every year to exhibit students’ science work. Parents are invited to see the student-managed stands placed throughout the school hallways. This event is a success every year and caps off a year-long information campaign aimed at parents. At the start of the year and during meetings with parents and school boards, information is distributed about the various scientific activities. Letters are also sent out to families and attached to students’ science notebooks at the start of certain sequences, especially for classes receiving classroom support from an educator or student from the École polytechnique. Generally speaking, parents are encouraged to monitor their children’s work by completing their science notebooks with research, activities or experiments at home. This connection is always there but should certainly be developed in order to make parental involvement a habit.

Coordinating a local support network	Description	Indicator 1	Indicator 2	Indicator 3
<p><b>Stage 1</b></p> <p><i>The estimated timeframe for each stage is between 6 months and one year.</i></p>	<ul style="list-style-type: none"> <li>Identify partners (other than those who have signed the convention) who may want to be involved in the centre's projects and actions: institutions, associations, private individuals (e.g., retired scientists, engineers, etc.).</li> <li>Meet with these potential partners to discuss the centre's project, missions and objectives.</li> </ul>	<ul style="list-style-type: none"> <li>Informal contact with potential partners.</li> </ul>	<ul style="list-style-type: none"> <li>Organize a knowledge market with potential partners during a conference or professional development session.</li> </ul>	<ul style="list-style-type: none"> <li>Hold meetings to review actions between the centre and potential partners.</li> </ul>
<p><b>Stage 2</b></p>	<ul style="list-style-type: none"> <li>Tell schools about the resources (human and material) available at local institutions (scientific institutions, associations, private individuals) which may be able to help them with their scientific projects.</li> <li>Launch projects that bring schools together with potential partners.</li> </ul>	<ul style="list-style-type: none"> <li>Distribution of an informational document (brochure or flyer) to potential partners that presents the centre's project and actions.</li> </ul>	<ul style="list-style-type: none"> <li>Organize targeted meetings between schools and partners according to the projects and resources.</li> </ul>	<ul style="list-style-type: none"> <li>Hold regular meetings to develop and monitor projects.</li> </ul>
<p><b>Stage 3</b></p>	<ul style="list-style-type: none"> <li>Develop original partnerships that contribute to the centre's educational vocation of <i>teaching science and through science</i> (e.g., implement cultural programs that team up several partners).</li> <li>Showcase the centre's work through regular presentations of the results and benefits of the actions carried out with multiple partners (e.g., to those involved in the school community such as teachers and parents, partners, companies, cities, etc.)</li> <li>Monitor possibilities for new local partnerships: companies, scientific institutions and associations who are open or interested in participating in this type of educational project.</li> </ul>	<ul style="list-style-type: none"> <li>Hold regular meetings (such as an extended steering committee) to generate and debate new ideas.</li> <li>Facilitate and assist document production: cultural programs, presentations on cooperative actions or reviews, assessment documents.</li> </ul>	<ul style="list-style-type: none"> <li>Co-host and co-manage major public events with partners, such as forums, science fairs, scientific challenges.</li> </ul>	<ul style="list-style-type: none"> <li>Produce communication documents targeted to the audience (e.g., brochures, flyers, films, web forums, articles).</li> </ul>





Chapter 6

# Creating learning networks

## Objectives and recommendations

Quality change in teaching practices requires time and collective efforts. Measures need to be implemented to foster support, receptiveness and dialogue to give teachers an opportunity to share and compare their practices, analyses and individual skills. Initiating this dynamic, as well as developing a learning network of several schools, helps set the stage for long-lasting changes in teachers' practices, while teachers remain the main players of their own professional development.

The aim is to motivate teachers and get them involved in a shared goal with other professionals with a view to improving the skills of all players:

- By encouraging and developing their autonomy, sense of initiative and receptiveness,
- By promoting reflection and cooperation,
- By ensuring results are recognized and communicated.

### A few recommendations

- The development processes depend on the level of teachers' willingness, ability and availability in committing to a mid- and long-term process of change. Experience has shown that simply offering a few professional development sessions, occasional assistance and resources is not enough to effect meaningful and long-lasting change in teaching practices. Teachers also need to feel trusted and have a certain level of autonomy, time for collective debate and opportunities for professional cooperation.
- It is possible and desirable –in the frame of a centre-, to create an environment that encourages the development of learning networks that can contribute to progress in science education based on collective expertise built by teachers.

### References

- GATHER, M., THURLER, M., BRONCKART, J.P., *Transformer l'école*, De Boeck, 2004. In this book, the authors discuss "learning organisation."

## Examples of activities to prepare

- Organize debates at elementary and middle school
- Develop tools and classroom resources or update existing materials (learning modules, lessons, etc.)
- Participate in collaborative or thematic projects, such as *Sur les pas d'Eratosthène* (In the footsteps of Eratosthenes), *Le climat, ma planète et moi* (The climate, my planet and me)
- Joint preparation of science lessons, pair up teachers to give lessons followed by a group analysis of the lessons.
- Encourage teachers to describe and analyze classroom practices as part of a formative evaluation; suggest writing reviews of classroom experiences.

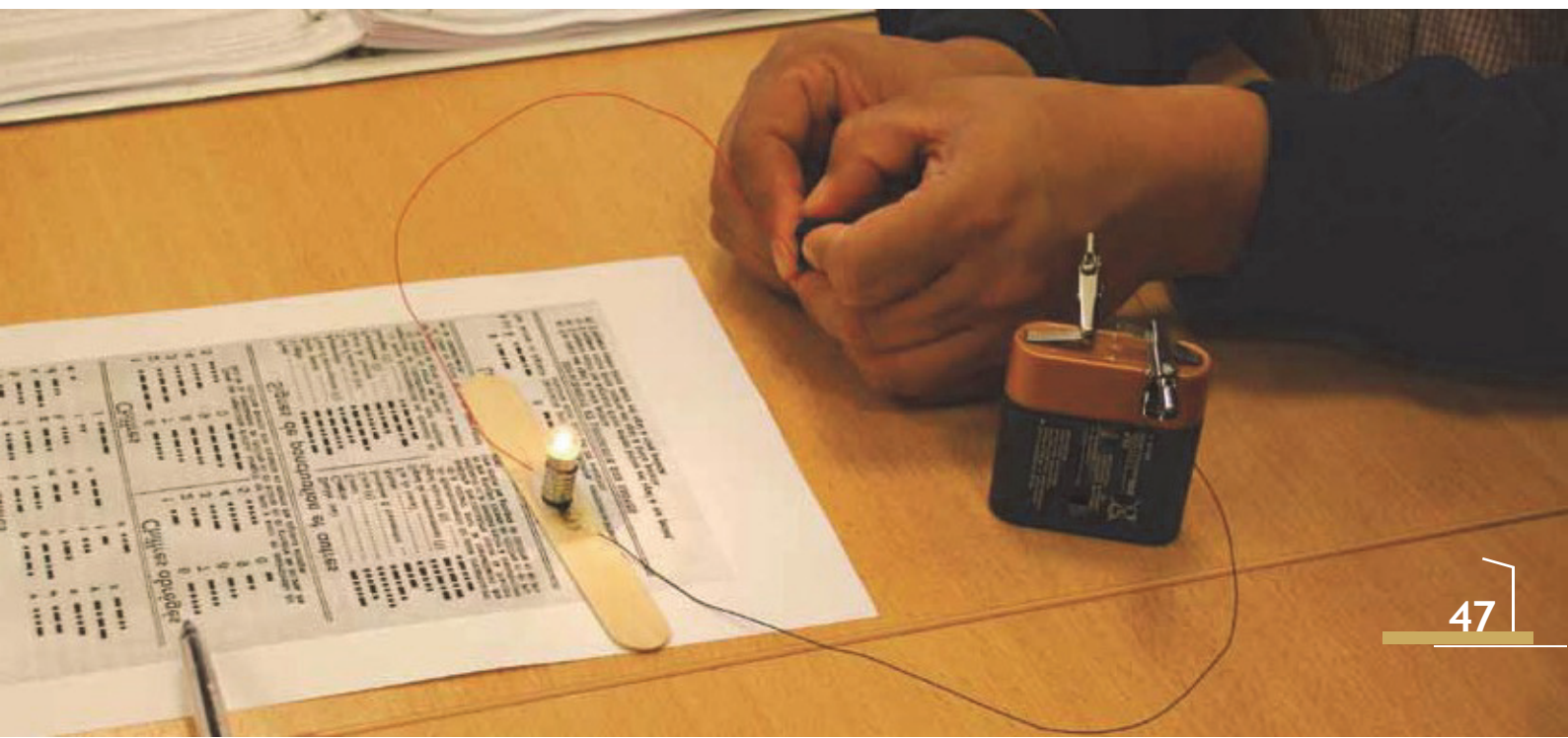


- Analyse classroom measures in place and their impact on student learning (e.g., record debates between students to analyse their level of understanding of the topics covered).
- Give teachers access to a system of educational and practical material resources.
- Offer situation analysis grids to help teachers overcome difficulties and support the project at the elementary or middle school.
- Promote actions conducted at the elementary and middle schools by teachers and students through public events (e.g., exhibitions, forums, school newsletters, articles, blogs).

**EXPERTS SCIENCES forum held by the *La main à la pâte* associated centre in the city of Gardanne and the Bouches-du-Rhône département in schools in the towns of Tarascon and Marignane.**

To recognize the science and technology work students and teachers do in their classes, the associated centre in Gardanne organizes a yearly forum called EXPERTS SCIENCES (Science experts). This forum showcases the work carried out throughout the school year through a project. The participating classes choose a theme and begin their study to become “experts” on the topic. As part of a challenge, they come up with questions that they send to forum organizers (science and technology resource teacher). Once all the questions have been collected, they are sent to the different classes who must rank them in order of preference and send the list back to the organizers. The organizers then select two questions for each class, and between December and March, the students have to answer them by adopting an inquiry-based approach. During this period, the science resource teacher is available to teachers and students to answer their questions and provide any necessary support. In April, all classes meet at the forum to offer their suggested answers to the questions they worked on in class. The students must also present the theme for which they became experts to the other classes in any way they choose (game, multi-media presentation, posters, etc.).

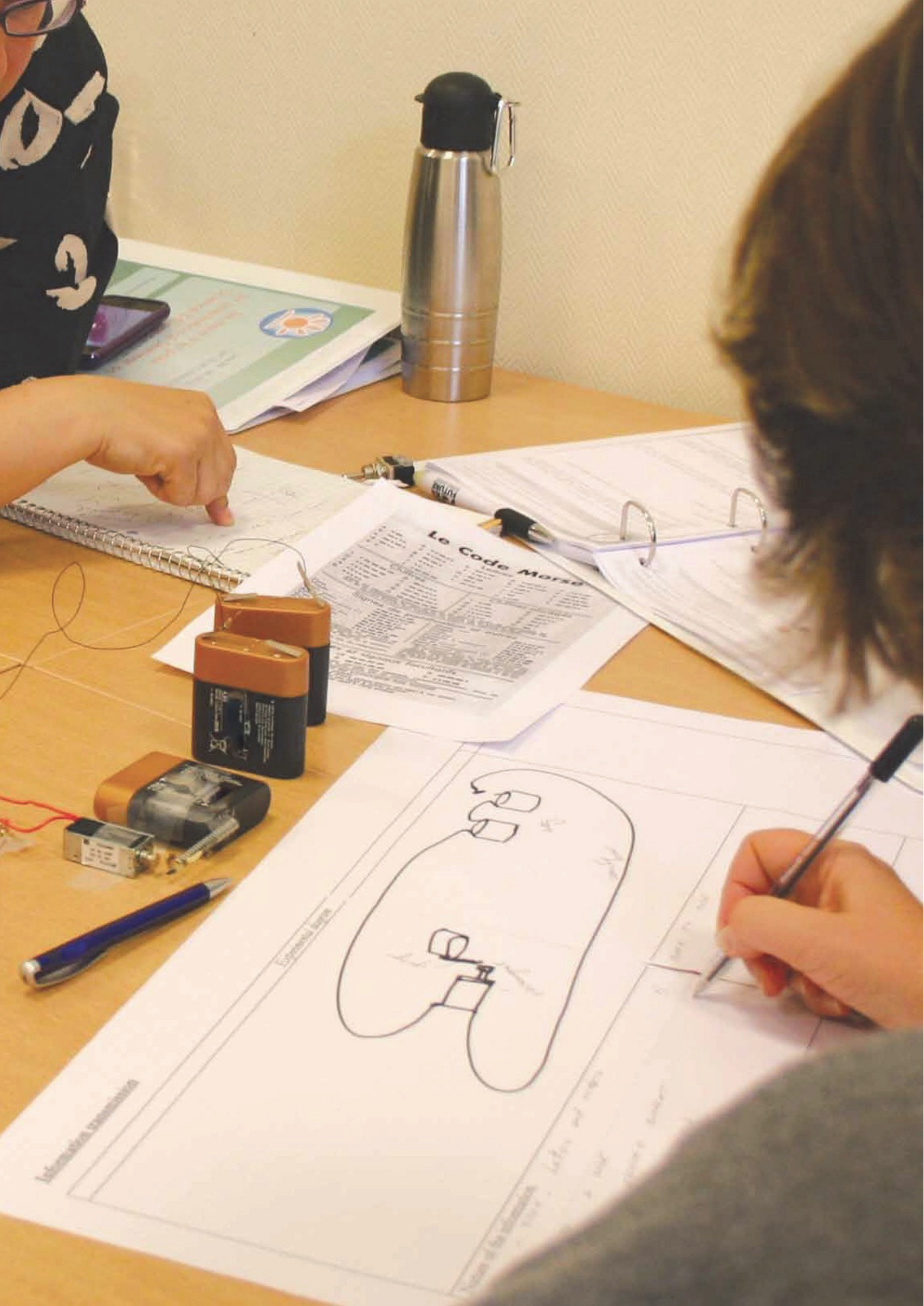
This project helps create a connection between classes, their teachers and the science resource teacher during the classroom work. It also gives all the classes a chance to discuss the results of their work together.



## Example of a program plan

The following table offers an example of a program plan. The plan is centred on promoting and increasing meetings between teachers, including in their own classrooms, to foster dialogue within the school. It also aims to open the network to other professionals to support, strengthen and enhance their work.

Creating learning networks	Description	Indicator 1	Indicator 2	Indicator 3
<b>Stage 1</b>  <i>The estimated timeframe for each stage is between 6 and 18 months</i>	<ul style="list-style-type: none"> <li>• Create an environment where learning networks can emerge by giving teachers opportunities to created or participate in group discussions to strengthen their science teaching practices.</li> <li>• Recognize this working time as an integral part of their professional development.</li> </ul>	<ul style="list-style-type: none"> <li>• Start discussion groups within and between elementary and middle schools.</li> <li>• Set aside time to prepare and analyse lessons with several teachers from multiple schools or other professionals (psychologists, specialized teachers, etc.)</li> </ul>	<ul style="list-style-type: none"> <li>• Create groups to develop resources for an inquiry-based science education (use, adaptation and enhancement of modules, sequences, etc.).</li> </ul>	<ul style="list-style-type: none"> <li>• Implement a program at elementary and middle schools where teachers can teach science classes in pairs or with several adults.</li> </ul>
<b>Stage 2</b>	<ul style="list-style-type: none"> <li>• Encourage and support the development of groups to enhance and strengthen a large science-based network (e.g., seek involvement by other professionals).</li> <li>• Encourage an in-depth study of specific scientific and educational topics (biodiversity, education for sustainable development, managing group work, interdisciplinary approaches, language and sciences, interactive whiteboards, interactive touch screens, etc.).</li> </ul>	<ul style="list-style-type: none"> <li>• Hold regular meetings between teachers, scientists and science professionals (e.g., companies, artisans, associations, scientific and cultural centres, laboratories.).</li> </ul>	<ul style="list-style-type: none"> <li>• Neighbourhood debates about scientific topics organized by the scientific and local communities.</li> </ul>	<ul style="list-style-type: none"> <li>• Start a group to analyse IBSE practices between schools.</li> </ul>
<b>Stage 3</b>	<ul style="list-style-type: none"> <li>• Share and recognize the work by groups and networks.</li> <li>• Ensure these networks take into account local cultural and scientific initiatives.</li> </ul>	<ul style="list-style-type: none"> <li>• Initiate groups to develop and share assessment tools for teachers and students.</li> </ul>	<ul style="list-style-type: none"> <li>• Create local resources for teachers, students and families.</li> </ul>	<ul style="list-style-type: none"> <li>• Hold neighbourhood events, such as knowledge markets, forums, etc.</li> </ul>





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Chapter 7

# Assessment

## Objectives and recommendations

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Assessment here does not mean simply measuring results but creating a system that allows information to be collected at specific intervals. This information is then analysed so that decisions can be made to develop, improve and structure support, professional development and teaching measures.

For a centre that aims to support ISBE in classrooms, assessment focuses on two separate but related areas:

- Evaluating the teacher support measure(s) (i.e., strategies, actions and services) put in place by the centre
- Promoting and distributing formative evaluation practices for students and teachers.

With regards to evaluating the measures, the goal is to design a centre-specific assessment system that takes into account the scope of the actions (e.g., strategies to increase partner and teacher involvement, professional development, resources, creating learning networks, organisation, etc.).

For formative assessment practices in the classroom, the aim is to make teachers aware of:

- Their own ISBE classroom practices by making self-assessment tools available
- Students' formative evaluation, by educating teachers and distributing modules that take into consideration the suggestions from the formative and summative assessment.

### A few recommendations

- Before assessing the impact of the support measures on classroom practices and student learning, it is important to know if the measures were implemented as planned. In this case, the assessment should be based on information collected mainly by observing teachers and students, through interviews held with teachers and students, teachers' lesson plans and students' notebooks. "It is only when ISBE methods have been applied to student activities for a sufficient amount of time that you can begin to assess the impact on learning. Otherwise, we may come to the wrong empirical conclusions, leading to inadequate decisions."<sup>1</sup>
- The formative student evaluation requires clear, targeted learning objectives, both in terms of knowledge and skills. Consequently, it is extremely important to help teachers identify and take ownership of these objectives.
- The formative and summative assessments differ both in their purpose as well as in when they are made and the tools required to carry them out. Mixing them will undermine their usefulness.
  - A formative assessment aims to help students recognize and understand their successes and errors. It is carried out throughout the teaching sequence.
  - A summative assessment aims to review the knowledge and skills learned. It is generally carried out at the end of the module, but can also be useful at the start as an initial diagnostic tool.

- Any assessment must strictly specify the four following aspects<sup>2</sup>:
  - A conceptual framework: for example, defining what is meant by “knowledge”, “skill” or “ISBE”
  - The objectives to evaluate: for example, spelling out and verifying exactly what should be learned, or outlining what an inquiry-based teaching approach entails.
  - Choosing a source of data (an activity, questions, a notebook, observation, etc.) and the tools to organize the information (e.g., a table, worksheets)
  - How the results of the assessment will be interpreted to make conclusions: the level reached, areas to improve upon, etc.

## Examples of activities to prepare

To assess the measures:

- Before implementing a support or professional development measure, analyse teachers’ needs (through a questionnaire or interview).
- Keep a logbook of all initiatives for all of the areas the centre works in and periodically review them to see whether objectives have been met.
- After the initiative has been in place for a few years, measure its impact on the classroom practices of participating teachers (using a questionnaire or observation form for science classes, such as the *La main à la pâte* and Fibonacci charts).

To increase awareness about the assessment questions:

- Hold professional development sessions on assessment.
- Work with teachers to develop tools for them to do self-assessments.
- Offer teachers learning modules with explicit learning goals that are consistent with their curriculum and which include an evaluation part.
- Provide tools to refine the assessment of pupils’ knowledge and skills in terms of the common core.
- Suggest an assessment of students’ knowledge of a theme at the beginning and end of the module.

### References

- IAP, (2006) *Report of working group on international collaboration in the evaluation of Inquiry Based Science Education (IBSE) programs*, (French version available at <[www.fondation-lamap.org/fr/page/14211/evaluation-internationale](http://www.fondation-lamap.org/fr/page/14211/evaluation-internationale)>)
  - SHAVELSON, R., RUIZ-PRIMO, M.A., LI, M., CUAUHEMOC, C., (2003), *Evaluating new approaches to assessing learning*, National Centre for research on evaluation, standard and student testing, California university, Los Angeles Cse-r-604. NRC (2001), *Knowing what students know: the science and design of educational assessment*, Washington D.C., NAP.
  - Since 2007, nine pilot centres have carried out science class observations. You can find an example of the evaluation chart used at <[www.fondation-lamap.org/fr/page/14203/evaluation-de-dispositifs](http://www.fondation-lamap.org/fr/page/14203/evaluation-de-dispositifs)>. You can also review the results analysis in DELCLAUX, M., SALTIEL, E., (2011), *Résultats des observations de séances de sciences pour 274 classes de 9 centres pilotes*.
- <sup>1</sup> See the *Fibonacci* project at <<http://fibonacci.uni-bayreuth.de/resources/>>
- <sup>2</sup> See the table ‘Skills, Knowledge and Evaluation Methods’ (*tableau Compétences, connaissances et modalités d’évaluation*) at <[www.fondation-lamap.org/fr/page/14205/evaluation-des-l-ves](http://www.fondation-lamap.org/fr/page/14205/evaluation-des-l-ves)>

## Example of a program plan

Assessment	Description	Indicator 1	Indicator 2	Indicator 3
<b>Stage 1</b>  <i>The estimated timeframe for each stage is between 6 months and 1 year</i>	<p>Analysis by the centre of the professional development and support needs.</p> <p>To implement a support measure that is suited to teachers' needs, the centre must review:</p> <ul style="list-style-type: none"> <li>Teachers' practices (do they teach science regularly, use an inquiry-based approach, use student notebooks in their classes; challenges they face in the classroom; expressed needs).</li> <li>Tools used by teachers to prepare and teach lessons</li> </ul>	<ul style="list-style-type: none"> <li>The centre should create tools to carry out a review (questionnaires, interview protocols) and arrange for the distribution of tools to the schools.</li> </ul>	<ul style="list-style-type: none"> <li>The centre should analyse the results and evaluate practices and professional development needs.</li> </ul>	<ul style="list-style-type: none"> <li>The centre should design and adapt its support measure according to the results.</li> </ul>
<b>Stage 2</b>	<p>Familiarize teachers with the assessment questions and the creation of tools to:</p> <ul style="list-style-type: none"> <li>Allow teachers to assess changes in their classroom practices.</li> <li>Allow teachers and students to assess their acquired science skills and progress made.</li> </ul>	<ul style="list-style-type: none"> <li>The centre should make self-assessment tools available to teachers which can be used individually and before and after a professional development session.</li> </ul>	<ul style="list-style-type: none"> <li>The centre should make documents and tools available to teachers for student evaluations, such as a module that includes formative and summative evaluations.</li> </ul>	<ul style="list-style-type: none"> <li>The centre should hold professional development sessions about the evaluation questions.</li> </ul>
<b>Stage 3</b>	<p>Assessment of the impact of the centre's support measure:</p> <ul style="list-style-type: none"> <li>On classroom practices</li> <li>On student progress.</li> </ul>	<ul style="list-style-type: none"> <li>The centre should create a list of indicators to measure the impact of initiatives, such as the number of modules taught in the year, number of classes involved in a scientific project, etc.</li> </ul>	<ul style="list-style-type: none"> <li>The centre should offer participating teachers the chance to be observed during one of their lessons, followed by a discussion.</li> </ul>	<ul style="list-style-type: none"> <li>The centre should analyse student results on national evaluations with teachers.</li> </ul>









Chapter 8

# Project management

A project for a centre for sciences, which involves a variety of activities and resources and in which a great number of participants are involved, requires operations and activities to be carried out jointly or successively in the fields of planning, coordination and management.

## Project planning

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During this stage, the different tasks and resources required to implement the project are anticipated and given a timeframe. It is essential that it is carried out at the project's launch, and requires detailed and often lengthy preparation, which implies both reflection and contact-building. A solid document on the operational aspects of the project can then be written in detail, and then used as a basis for a future partnership agreement.

The main stages are:

- Stage 1: Define the project's context and general objectives; draft a three-year strategy and development plan in accordance with objectives; prepare a provisional budget. This is the responsibility of the project initiator(s). It is a priority, and must conclude with the production of a general overview of the project that can be sent to potential partners and schools.
- Stage 2: Present the project to decision-makers to ensure their support. Make contact with and present the project to the institutions likely to become involved and possibly provide financing. Present the project to schools and record their reactions. The different contact points and discussions should gradually lead to the official participation of all actors likely to become involved.
- Stage 3: Sign a partnership agreement planning the programs over three years. Set up a steering committee for the centre.

## Project coordination

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Coordination is a continuous effort, from the beginning to the completion of the project. Its purpose is to ensure the coherence of the activities carried out within the project. It involves determining, prioritizing, harmonizing and regulating the various activities to ensure efficiency.

It is applied to several fields of action, notably:

- the analysis of resources needed for professional development and support for schools,
- inventory and observation concerning the potential of professional development and support in the area around the centre,
- inventory and observation concerning the institutions likely to participate in the centre's program (local scientific and cultural structures),
- communication (contact and exchanges with the different partner institutions and field actors),
- prioritizing activities and organizing them in time and place,
- defining criteria to select the classes to include in the centre's support system in relation to the support strategy adopted,
- regular supervision and assessment of initiatives undertaken in order to adjust and improve the system,
- seeking new professional development and support activities that could more effectively meet the needs of teachers.

Project coordination is the centre coordinator's responsibility. To do so, he/she relies on the recommendations, opinions and orientation decided on by the steering committee. The coordinator regularly convenes steering committee meetings and reports on the project's progress by sending summary reports, progress reports, financial and other reports. These are discussed during steering committee meetings.

## Daily tasks

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Project management requires much daily attention and consists of many tasks. We recommend that the coordinator form a small team of experienced teachers, district academic advisors, educators, etc. to assist him/her in daily coordination and management tasks. The following list is not exhaustive; it gives an insight into some of the fundamental aspects (support/ professional development, resources, finance management, PR, etc.) of the tasks to be carried out in the centre.

### Coordinating support teams and class supervision

- Organize and set up scientific and teaching support sessions in the classes involved in the project.
- Manage the teams that operate in the schools (partners, course participants, support assistants, students, etc.) and keep in contact with them regularly.
- Organize the monitoring of classes involved in the project.

### Resource management

- Ensure resources are monitored (school equipment needs, preparation of modules, etc.).
- Manage teaching material (organize loans, handle orders and replenishment).
- Produce and/or adapt teaching resources with teachers, teachers' educators and the scientific community.
- Manage and develop the website, linking partners and field actors.

### Professional development

- Monitor teachers' professional development needs.
- Organize and/or participate in professional development activities (design, preparation, execution)

### Finance management

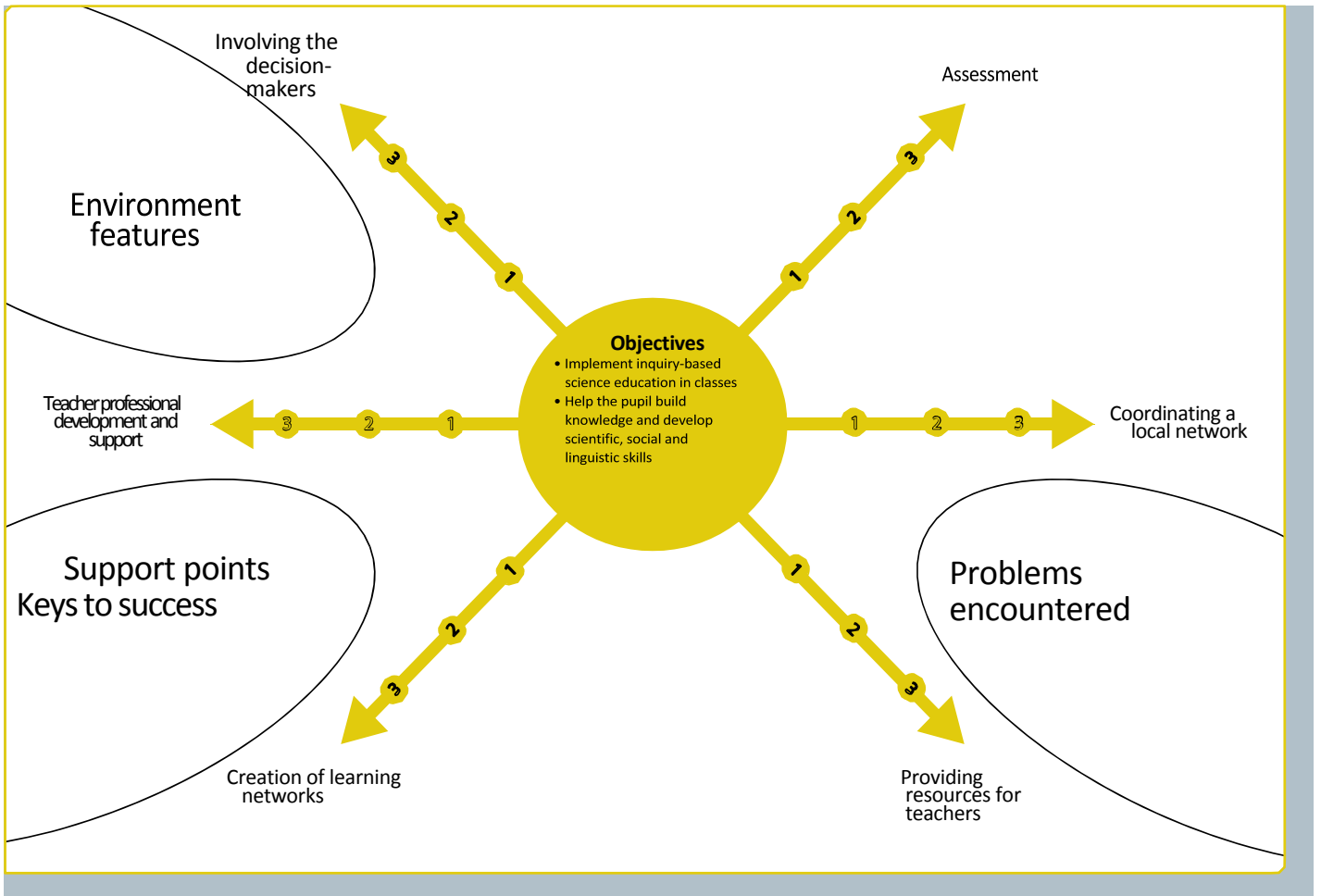
- Seek financing.
- Handle the centre's budget.

### Communication and promotion

- Organize meetings (coordination, information, committee meetings, etc.).
- Prepare the documents needed by participants (progress report, minutes of meetings, summary reports, emails to schools, etc.).
- Conduct communication and promotion activities (newspapers, science exhibition, brochure, welcoming delegations, etc.).

**“Strategic development star”**

For the different strategic elements to take into consideration when setting up a centre or structure aiming to promote IBSE, this “strategic development star” helps provide an overview of the execution of the different elements according to the stages defined for each at any given time.





Since the year 2000, *La main à la pâte* has led a network of pilot centres that aims to locally promote inquiry-based science education (ISBE). These centres put support systems in place over a number of years that allow a significant number of schools and teachers in a given geographic region to take part in ISBE practices.

This handbook is the result of this field work, and is intended to help teams wishing to launch and coordinate similar projects in the schools of a town or city, academic district, network or region.

## Contact

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