p.o.l.l.e.n.

Seed Cities for Science

A COMMUNITY APPROACH FOR A SUSTAINABLE GROWTH
OF SCIENCE EDUCATION IN EUROPE

OVERVIEW OF MAIN ACTIVITIES AND ACHIEVEMENTS

2006 - 2009

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2006-2009

Pollen is a European research and development project supported by the European Commission Directorate-General for Research (FP6). It has been selected as one of the reference projects to promote scientific education and culture in Europe.

EUROPEAN COMMISSION

SIXTH FRAMEWORK PROGRAMME

www.pollen-europa.net

...Carried by bees, Pollen made of few-micron grains,
will fertilize thousands of flowers. This evokes for me the work of all these
teachers who will spread knowledge among thousands of pupils...

Georges Charpak
Winner of the Nobel Prize in Physics 1992

Text
The Pollen partners

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All of these photographs are from schools participating in the Pollen project.
The figures related to pupils on pages 14, 15 and 21 are approximate.

Contents

Acknowledgments

Pollen is the result of a commitment to science education by 12 education and research institutions, members of the Pollen consortium.

- **École Normale Supérieure** – FRANCE (coordination)
- **Université Libre de Bruxelles** – BELGIUM
- **University of Tartu** – ESTONIA
- **Freie Universität Berlin** – GERMANY
- **Consorzio per l'Innovazione, la Formazione e la Ricerca Educativa** – ITALY
- **Universiteit van Amsterdam** – NETHERLANDS
- **Ciência Viva / Agencia Nacional para a Cultura Científica e Tecnológica** – PORTUGAL
- **P.A.U. Education** – SPAIN (coordination)
- **Royal Swedish Academy of Sciences** – SWEDEN
- **University of Leicester** – UNITED KINGDOM
- **Apor Vilmos Catholic College** – HUNGARY
- **University of Ljubljana / Faculty of Education** – SLOVENIA

They bring together a variety of backgrounds, talents and expertise (scientific research, teacher training, production of resources and material, project management, etc.), making mutual exchange an important dimension of **Pollen**.

Pollen has also involved an important community of primary teachers, science teachers, university professors and scientists committed to the objectives of the project.

We are extremely grateful to those pupils and their parents who participated in the project.



Presentation

Pollen is a European research and development project supported by the European Commission Directorate-General for Research (Sixth Framework Programme for Science and Society), proposed by a group of pedagogical and scientific organisations from 12 European countries and coordinated by *La main à la pâte* (École Normale Supérieure, France). The aims of **Pollen** are to stimulate and support inquiry-based science teaching and learning in primary schools, providing tools, training, coaching and assessment.

Pollen was launched on 1 January 2006 and took place over a three-and-a-half-year period. With inquiry-based science education as a primary objective, the project focused on the creation of 12 Seed Cities for science throughout the European Union. A Seed City is an educational territory that supports primary science education through the commitment of the whole community (families, education authorities, scientific and industrial partners, municipalities, museums and cultural centres, etc.).

The major goal of **Pollen** was to provide an empirical illustration of how science teaching can be reformed on a local level within schools whilst involving the whole community, in order to demonstrate the sustainability and efficiency of the Seed City approach to stakeholders and national education authorities, and to seek leverage effects.

At the same time as a local strategy was designed, tools and resources were provided by the project leaders to assist with the implementation. In each Seed City, **Pollen** provided material and methodological and pedagogical support compatible with the framework of the local curriculum.

All of the materials produced as part of **Pollen**, as well as further information about the project, its progress, achievements and outcomes, can be accessed free of charge through the Pollen website: **www.pollen-europa.net**. This booklet presents an overview of main activities and achievements of the Pollen project over 2006-2009.



The role of schools...

Schools and their teachers play a key role in introducing pupils to science and technology and guiding them through the learning process by implementing hands-on and inquiry-based methods, as well as working together with local community partners.

Schools can be seen as an individual setting, but are also part of a broader setting in which interaction with other local stakeholders is crucial in terms of enhancing pupils' skills. Pollen relies on the work carried out in the classroom and places emphasis on collaboration between the school and the local community.

Pollen starts at school, with the responsible authorities, and fosters community participation, including families, the scientific community, universities, public authorities, industries and other entities dealing with education, interacting on a local scale.

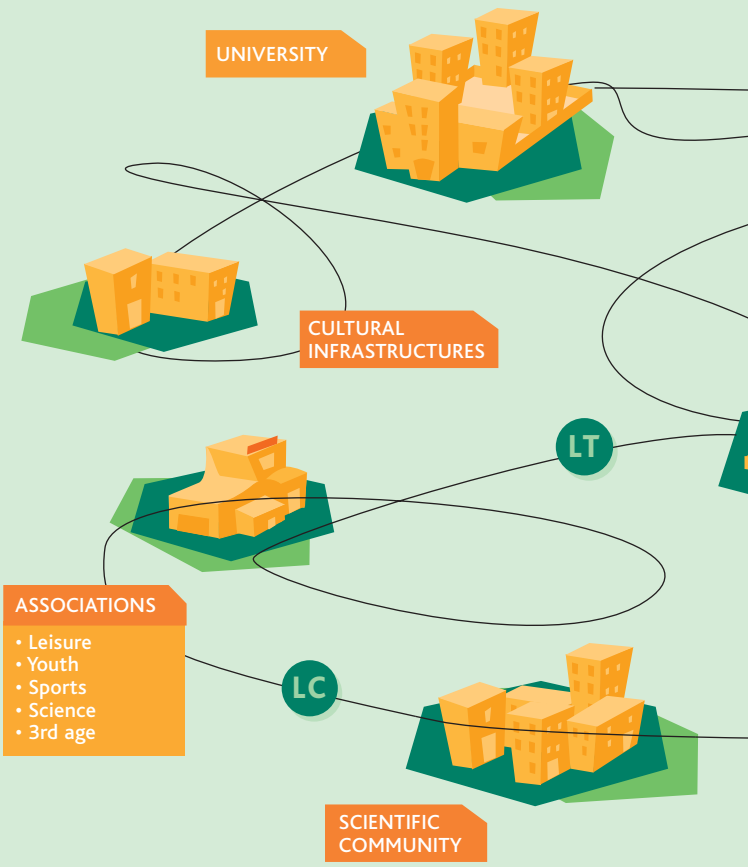
What does Pollen provide to schools?

- Dozens of hours of teacher training per year, educational materials, specially designed activities, experimental materials for the classroom, etc.
- A permanent advisory service for carrying out the different activities.
- A European network to intensify cooperation and twinning activities.
- A unique web platform in order to access tools, contact coordinators and receive information about the development of the project.

LT The local trainer

The local trainer is somebody who is familiar with school culture and in-service training, as well as with school development processes. He/she:

- Ensures and facilitates links between the Pollen community and the school in general.
- Carries out the in-service training and enhances cooperation within the local community.



...in the Seed City

A Seed City is a city in which synergies are created and forces are joined to foster science education. Municipal support is essential to develop a partnership between schools, scientists, industry representatives, health workers, cultural institutions and other entities, etc.

LC The local coordinator

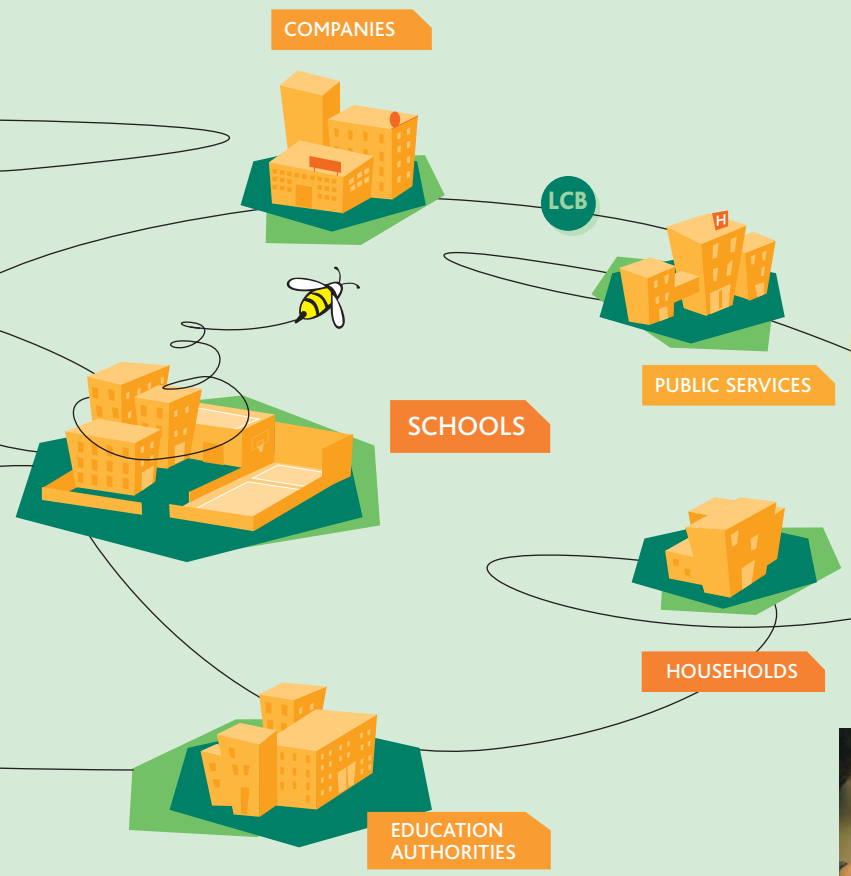
The local coordinator is familiar with the organisation and the dynamics of the local community and its processes. He/she:

- Coordinates Pollen local community board actions.
- Manages local budgetary and administrative issues related to the project.
- Ensures and facilitates daily contact between schools and the institutions within the local community, and coordinates joint events and activities.
- Ensures internal and external communications.

LCB The local community board

The local community board coordinates local Pollen activities.

- It is headed by the local coordinator: training, instructions and suggestions for Seed City community board management are provided through general coordination.
- It helps define and implement the action plan: this includes analysis of the community's scientific needs and suggestions for activities.
- It provides a participatory framework for all stakeholders, coordinating initiatives undertaken by schools and other actors, stimulating partnerships, sharing resources and assessing the whole project.
- It maintains high visibility of Pollen.



Step by step Work Plan

1. Initial evaluation of science education in each Seed City to define main objectives.
2. Creation of a sense of partnership in and ownership of the project.
3. Design and implementation of a strategic plan.
4. Development of all activities and actions in the school and community.

Amsterdam

SUCCESSFUL STORIES

In Amsterdam and in the district of North Holland, the aim of Pollen was to enable primary schools to implement effective ICT use in their science and technology programmes to promote science and technology education. This resulted in the development and implementation of ICT-enriched lessons, activities and material. Sensors to measure temperature, sound and light were also used and related activities were developed.

Coordination

- AMSTEL Institute, Faculty of Science, University of Amsterdam
- Main partner: Centre of Expertise on Science and Technology Education North Holland

What falls faster: the sheet of paper or the crumpled piece of paper?

A lesson on paper at De Scholekster nursery school, Karel du Jardinstraat. The teacher took out two bright yellow sheets of paper and crumpled one. She dropped the smooth sheet of paper and asked the children to describe its motion. Various descriptions were given. One child said: «It's like a leaf from a tree». Another used the word «whirling» and described the motion with her hand. The teacher then asked how the crumpled sheet of paper would fall. Some said «faster» or pointed straight down. Another described a complicated motion. They observed. Then the group measured. The paper was dropped while the children counted. The crumpled paper reached the floor on the count of one. The teacher asked the children which would fall faster: the smooth sheet of paper or the crumpled piece of paper. Many children said that the crumpled piece of paper would fall faster. The children were so eager to participate that there was some confusion over what they thought would happen, so the teacher asked the children to vote on whether the crumpled piece of paper would fall faster: 17 hands out of 25 went up. Isaac was asked to drop both sheets of paper at the same time. Of course, the crumpled one reached the ground first and the children were very excited. Throughout the lesson, the teacher succeeded in ensuring that reasons were given for answers. Next lesson? Paper planes!

«I am curious about what we are going to do. All the others who have done the activity say it is great fun».

After the activity, the child exclaimed: «It was great!»

A pupil

KEY TOPIC

Enhancing inquiry-based science and technology education in primary schools with ICT

ACHIEVEMENTS	2006	March 2009
Teachers	15	305
Pupils	300	4,300
Schools	7	114
Training hours (Total per teacher)	20	171

Berlin

SUCCESSFUL STORIES

Berlin has a high concentration of science in the academic, research and cultural fields. Since 2006, changes have been made to the primary school curriculum, with the addition of science topics. The fact that the teachers had not been given sufficient help to implement these changes made Berlin an excellent Seed City for starting Pollen.

Coordination

- Freie Universität Berlin

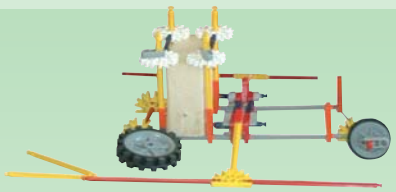
How Pollen successfully spread beyond the 11 original schools

Within Berlin, there has always been a waiting list of schools that wanted to be part of Pollen. Therefore, a new initiative was founded in 2007: TuWaS! - Technology and Science in Schools. This cooperation set up by the Freie Universität Berlin and the Berlin-Brandenburg Academy of Sciences and Humanities ensures that Pollen will continue after the end of the project.

With the support of the Senate Department for Education in Berlin, TuWaS! was able to start IBSE in 36 schools in Berlin, including 13 schools that were part of the German Sinus programme. The Senate Department provided the funds to buy teaching materials and appointed a former Pollen teacher to work part-time to support the TuWaS! schools.

Thanks to the support of the Chambers of Industry and Commerce in Cologne and Bonn, TuWaS! was extended to 16 schools in Nordrhein-Westfalen. The Chambers of Industry and Commerce raised money from companies in Nordrhein-Westfalen to finance teacher training, the purchase of teaching materials and a part-time employee to coordinate the programme.

With the help of the employers' associations in the metal and electrical industry, the number of TuWaS! schools in Brandenburg will be increased from one to six. In Baden-Württemberg, the first teacher training sessions have taken place in Ulm with the support of its Chamber of Industry and Commerce. This is how Pollen successfully spread beyond the 11 original schools.



«I had fun doing the experiments in the Pollen project, because you never knew what would happen.»

A pupil

KEY TOPIC
Gender issues and science education

Berlin studied the differences between boys and girls affecting their attitudes towards science.

ACHIEVEMENTS	2006	March 2009
Teachers	36	114
Pupils	1,000	2,300
Schools	7	11
Training hours (Total per teacher)	18	330

Brussels

SUCCESSFUL STORIES

The city of Brussels is the second school organisation of the French community (Brussels and Wallonia). The Pollen actions sought to improve children's skills and self-esteem. In addition, special after-school activities were organised for children in disadvantages areas of Brussels.

Coordination

- The *Laboratoire de Didactique des Sciences Physiques* at the University of Brussels (ULB).

*«At the beginning, it was difficult to introduce science experiments. However, the benefits are so clear that this first obstacle was quickly forgotten. The training is very good because I feel more confident when I have to deal with the crucial question **'why?'** from children looking at some scientific phenomena. I will try to continue and maintain links with the ULB to obtain ideas, material and lesson plans.»*

Teacher

KEY TOPIC

Science education in low-income areas

Disadvantaged children living in low-income areas suffer from a lack of language ability and insufficient curricular recognition of skills related to inquiry-based and manual activities, which condemns them to a high risk of school failure. The goal of Brussels was to promote and better understand the impact of the hands-on approach on socially disadvantaged children, specifically with regard to science performance and language skills.

Science on stage at Bockstael nursery school

«I would like a robot to perform my homework!» In response to this remark by her pupils, a teacher suggested that they learn how robots work. After a training session, the teacher was able to run a full sequence of programming experiments. She introduced the topic as a full-year project with the aim of participating in Expo-Science, a science fair, and in a theatre performance entitled «Science en scène» (science on stage).

The project was more successful than she could have imagined. All of the pupils participated. They learnt how to programme robots and were taught about related formal language. The children understood that elementary orders given to the robot had to be combined in order to be executed. The robots were splendid technical achievements. The results were so positive that the teacher continues to perform science experiments at school. From this point of view, Pollen was a success and led to sustainable activities.

ACHIEVEMENTS

	2006	March 2009
Teachers	65	227
Pupils	1,300	4,550
Schools	21	73
Training hours (Total per teacher)	126	441

These figures include schools, teachers and pupils from after-hour school.

Girona

SUCCESSFUL STORIES

Like most European cities, Girona faces challenges and opportunities as a result of immigration. The Pollen actions focused on learning science in multicultural environments through the contextualisation of the topic in this city.

Coordination

- P.A.U. Education, based in Barcelona, specialises in the design, implementation and evaluation of educational and participatory projects.

Science for all

Pollen organised in the 2008 and 2009 Science Fairs, held at the University of Girona with the support of the city council and the local education authority. The fairs were a huge success. More than 1,850 children, 70 teachers and 300 university students took part. The Pollen schools in Girona exhibited their work and experiments to the participating children, university students and staff. Science workshops were organised by teacher training students at the University of Girona for children from 4 to 11 years old.

«Everyone came out of the Science Fair excited and enthusiastic, saying that they had had a really good and interesting time.»

School head teacher

The children's participation and the students' involvement was a success. Organising the workshops was a lengthy process that lasted for several months, as the pupils designed the workshops themselves. The teachers and university staff welcomed the prospect of holding the fair at the university, as it was a way of exposing the children to a university environment and bringing the university closer to the children. Both fairs were full of excitement and, above all, science for all!

KEY TOPIC

Science education and immigrants - challenges and opportunities

Girona studied the criteria to be taken into account to produce a set of relevant science activities related to the key topic. The activities were implemented in the Pollen schools with the highest number of immigrant pupils to assess the effectiveness of these activities and analyse the impact of science education on pupils.

ACHIEVEMENTS	2006	March 2009
Teachers	65	221
Pupils	1,578	3,495
Schools	20	28
Training hours (Total per teacher)	25	140

Leicester

SUCCESSFUL STORIES

Leicester is the largest city in the East Midlands and the tenth largest in the country. The University of Leicester, the Pollen coordinator, is a leading UK university. Leicester developed creative activities to improve cross-curricular links. The environment and facilities within the city were used to enhance science. The following subjects were explored in relation to science: art, literacy, history, geography, sport, design and technology.

Coordination

- University of Leicester

KEY TOPIC

Science education and the cross-disciplinary approach

ACHIEVEMENTS

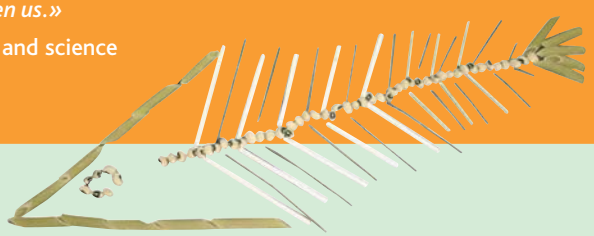
	2006	March 2009
Teachers	32	95
Pupils	800	2,500
Schools	14	27
Training hours (Total per teacher)	20	80

Reinforcing cross-curricular links

Pollen has increased the enthusiasm of several science teachers to such an extent that they are now getting involved in other science support activities. One such teacher started the Pollen course by helping her class of 10-year-old pupils to explore the science of bicycles. The class was visited by a triathlete. The pupils compared the triathlete's racing bicycle and her clothes with their own bikes in terms of properties of materials and other scientific concepts. They also visited a local bicycle shop to interview the manager. Both the teacher and the pupils learned about materials, stability and friction. Later, the teacher used the school grounds to study worms and linked the pupils' work to Charles Darwin's research. Since then, this teacher has become confident enough to give two training sessions for teachers within her own school.

« The project has had a massive difference on my teaching. I think, of all the professional development opportunities I've had, it's been about the best. I've done two years. I took a lot of ideas and used them again and again. The children went away really liking science rather than just learning for the SATs (tests). Our results have always been good, so it couldn't have that much impact on them, but what was missing was that buzz in the classrooms that I think the Pollen project has given us.»

Year 6 teacher and science coordinator



Ljubljana

SUCCESSFUL STORIES

The Pollen actions in Slovenia took place in the capital city, Ljubljana, which is actively involved in the scientific field. The University of Ljubljana played a leading role in researching and implementing science in primary schools in the nineties, developing new curricula in an experimental approach and providing new modules for in-service teachers training sessions.

Coordination

- Faculty of Education, University of Ljubljana

New experimental materials for schools

Pollen in Slovenia started in Ljubljana. Right from the start, several teachers from a nearby city, Kamnik, attended the workshops. They were very enthusiastic about the project and, with the help of the teacher trainer coordinator, they informed the local authorities about the aims and the popularity of the workshops and communicated their enthusiasm. In the second year of the project, Kamnik City Council financed the purchase of a complete set of experimental equipment for its city and one teacher to take care of its lending and refurbishment. In this way, Kamnik became fully involved in the project.

As selling Pollen equipment became commercially interesting, a small enterprise agreed to offer it on the market. Due to the positive feedback from the teachers involved, the Slovenian Board of Education issued a recommendation for schools to buy the Pollen experimental kits. Extra funding was also provided by the Ministry of Education to buy equipment. As a result, 150 Slovenian schools bought Pollen equipment. The project thus became national.

«Will we experiment tomorrow, too? I would like science to be like this every day.»

Pupils

«Pollen workshops are welcome because there are not enough science-oriented activities made available to teachers.»

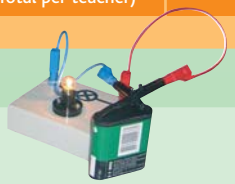
Member of the Board of Education

KEY TOPIC

Science education in new Member States

Ljubljana's main goals were to promote the hands-on approach and establish good local practices in primary schools. Special emphasis was placed on the training workshops for teachers and providing the schools with experimental materials.

ACHIEVEMENTS	2006	March 2009
Teachers	46	365
Pupils	1,000	5,000
Schools	11	45
Training hours (Total per teacher)	24	164



Loures

SUCCESSFUL STORIES

Loures is a city near Lisbon and is the Portuguese Pollen Seed City. It has a large community of children attending one of the local primary schools already involved in the Ciência Viva network. As part of the community participation aspect, the Pollen actions in Loures ensured that families in low-income communities got involved with their children in school activities and encouraged them to promote scientific culture in the community.

Coordination

- Ciência Viva Agency

«This school year, I felt more at ease when it came to planning activities based on the children's questions and ideas.»

Célia Fonseca, nursery school teacher

KEY TOPIC
Family involvement in science education

Parents participated in joint activities and class or school visits, thus taking part in their children's learning processes and changing their own perception of science. The activities related directly to daily family life to make scientific concepts more accessible. Experiments based on the kitchen as a laboratory were developed.

ACHIEVEMENTS

	2006	March 2009
Teachers	23	123
Pupils	46	2,046
Schools	11	43
Training hours (Total per teacher)	30	90

An open-air event story

During an open-air event organised by the local government in September 2008, the Pollen coordination team held a science workshop for children. This event was aimed at improving relationships among groups of immigrants in a problematic Loures community. The children kept coming and were enthusiastic about the activities, trying to find out the science behind the phenomena. They felt at ease carrying out the experiments and talking about their findings. It was difficult to stop them! By taking part in this event, the Pollen team and teachers from Pollen schools who also joined in were able to create links with people from the different local organisations and understand their needs and interests. The event was covered by one of the national television channels.

«My child keeps asking me to repeat the experiments she did at school.»

A mother from a Pollen primary school.

Perugia

SUCCESSFUL STORIES

In Perugia and the Umbria region, the way in which children's participation in science education can promote civic values was explored through Pollen, along with the kinds of participation activities that can help to promote child citizenship. This required the cooperation of different actors with the objective of raising awareness and generating solutions for sustainable development.

Coordination

- CIFRE, Consorzio per l'Innovazione, la Formazione e la Ricerca Educativa (*Consortium for innovation, training and research in education*), with the involvement of the various municipal, provincial and regional authorities.

Promoting active citizenship

Two classes worked to create a ballet, entitled «A never-ending journey», on the history of the water cycle. The background music is an Israeli song, *Mayim, mayim*, a hymn to water, the source of life. «This is our story, the story of the droplets (...). We discover that everything around us is magical and that, through our actions, we can change the environment. Atmosphere, air, clouds: everything is beautiful, but all of these phenomena have specific rules that must be obeyed. From the school courtyard to the district, the town, the region and then the world. I can see, touch, hear and listen: Pollen has shown us the path to knowledge and learning to respect the environment. We know how it works, we have experienced it and we have managed to communicate to others that you must live in harmony with the elements of the whole territory...» The children thus created posters on water saving, along with drawings, stories and poems on the responsible use of the natural resources, which were displayed for the public in the streets of the city. They also published booklets on consumer energy awareness and distributed them among the Pollen project's participants and the public.

«I have always been convinced that universities and schools should cooperate closely. The experience of teaching on courses for teachers and tutors involved in the project reinforced this belief and created further opportunities for knowledge, contact and joint work.»

Raimondo Germani, Professor of Organic Chemistry, Department of Chemistry, University of Perugia

«We chose from the beginning to focus the project on the regional dimension instead of just creating one Seed City. The project size made coordination very complex. The response of schools and territories was very enthusiastic.»

Anna Allerhand, national coordinator

ACHIEVEMENTS

	2006	March 2009
Teachers	89	420
Pupils	800	3,200
Schools	15	57
Training hours (Total per teacher)	102	180

KEY TOPIC

Children's participation in science education and active citizenship

Saint-Etienne

SUCCESSFUL STORIES

Saint-Etienne was selected as the French Seed City due to its rich scientific network of more than 800 researchers and extensive experience in the development of science teaching at school. The city approach stressed the provision of scientific and pedagogical support to teachers.

Coordination

- École Nationale Supérieure des Mines de Saint-Etienne, CCSTI La Rotonde
- Education authority of the Loire
- IUFM (teacher training institute), Saint-Etienne

«The quality of the relationship between the teacher and the scientist has an influence on the success of the project and the benefits gained by all the parties involved. I have observed how the teacher acquires confidence.»

«This enables the teacher, once the science tutor has left, to continue to teach science and deal with scientific questions and remarks from pupils and sometimes extend the approach to other areas of science. Making the teacher independent is really one of the key goals for the science tutor.»

Camille Charaudeau, science tutor

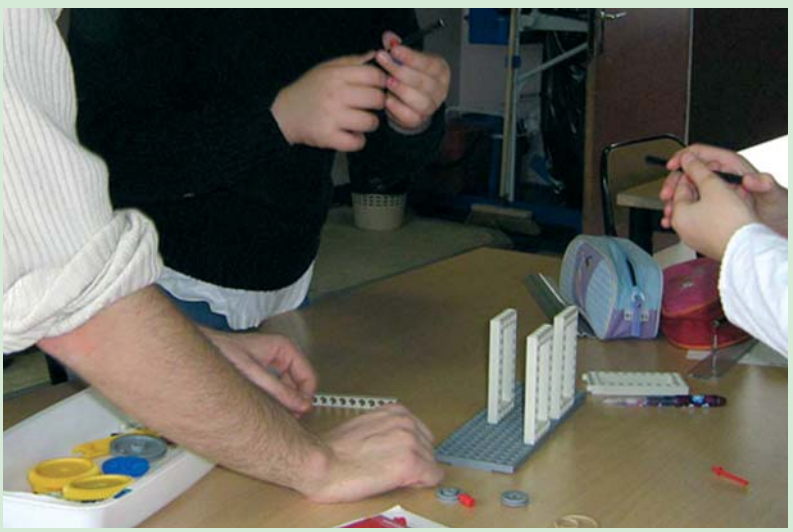
KEY TOPIC

The involvement of the scientific community in primary school education

The scientific support of teachers by engineering students and researchers formed a significant part of the Seed City activities.

Teacher training: peer-to-peer

Among the different methods of teacher support, one of the best and newest initiatives involved «resource teachers». A number of volunteer teachers were trained in IBSE. The objective was to support other teachers wishing to implement the IBSE approach in their classes. Each resource teacher was in charge of a specific group of schools. The teachers who implemented the inquiry-based approach often preferred this support option, since they felt that they were receiving coaching from colleagues who had the same position and not the position of experts. They felt more confident with their colleagues. This support method made it possible to reach more teachers in the project. While supporting other teachers, the resource teachers were replaced one or two days a week in their classes by trainee teachers.



ACHIEVEMENTS

	2006	March 2009
Teachers	52	185
Pupils	1,200	4,500
Schools	11	49
Training hours (Total per teacher)	25	25

Stockholm

SUCCESSFUL STORIES

The work of Pollen was based in Stockholm, the capital of Sweden, where a number of pupils up to 7th grade benefited from a hands-on approach before moving on to secondary school. In secondary school, the hands-on approach is far less developed than in primary school, whereas science as a learning field is much more important and teachers have better scientific knowledge.

Coordination

- The Royal Swedish Academy of Science (KVA) through the NTA programme (Natural Science and Technology for All)

Looking into the future

A new lesson was developed for 12- to 15- year-old-pupils: the «future mission». The aim was to build boats of the future. The students greatly enjoyed this mission and were inspired to carry out the tasks. They felt that it was a real mission. As IBSE through the Pollen/NTA programme has been operating for many years in this class, with seven units successfully completed during primary school, the students have developed a high level of scientific knowledge, which they demonstrated when building their boats. This mission was presented at the Pollen seminar in Slovenia in May 2008 and was very much appreciated by the participants.

«The pupils do not want to miss the science class when they work with hands-on science. They jump for joy when they are introduced to science through the IBSE method.»

A science teacher

«Parents ask whether the school has inquiry-based science teaching through the Pollen/NTA programme before applying to a school.»

«The children learn facts about science which we have not heard of. Many parents have been heard to say this.»

«I know that the concept works; the pupils love hands-on science.» Reported by 99% of the teachers

KEY TOPIC

Science education and the transition from primary to secondary school

This Seed City explored how hands-on inquiry methods could be designed to support the continued development of teaching and learning in science and technology in secondary school (7th to 9th grades, 13- to 16-year-old pupils). Specific resources such as a unit on properties of matter, and material about energy and sustainable development were developed.

ACHIEVEMENTS

	2006	March 2009
Teachers	32	90
Pupils	797	2,568
Schools	6	8
Training hours (Total per teacher)	339	788

Tartu

SUCCESSFUL STORIES

The second largest city in the country and the capital of Southern Estonia, Tartu is the scientific centre of Estonia. It introduced guided inquiry-based learning in special needs education with the aim of helping children to develop greater cognitive skills. The field of special needs education in Estonia is well established and a great deal of attention is paid to children with different disabilities.

Coordination

- University of Tartu, with the support of the city council.

«A nursery teacher who has been using the inquiry-based method in her class for three years (with 5- to 7-year-olds) reported that, when the time came for the children to leave her class and move on, the children asked her to give them at least one (material) kit to take with them, saying that, otherwise they would be bored!»

KEY TOPIC
Science education and children with special needs

In Tartu, the project focused on children with special learning needs. The objective was to better understand the impact of the hands-on approach, especially on language and thinking skills, and to implement new specific activities for the children. Adapted science activities in particular enabled them to move from learning by heart to learning by understanding.

ACHIEVEMENTS	2006	March 2009
Teachers	4	180
Pupils	80	640
Schools	4	32
Training hours (Total per teacher)	40	760

Hands-on inquiry for social inclusion

Several nursery schools provided children with special needs with the same teaching environment as children in regular classes. During a special summer camp, a teacher showed how she was able to combine activities from the inquiry unit on senses with different outdoor activities for her children with special needs. Teachers from other nursery schools came over and asked for teacher training sessions for their groups in order to implement the same approach in their own everyday work.

A lot of discussions with special needs teachers took place and they did not initially believe that the hands-on inquiry-based approach was suitable for their purposes. Having seen the activities in the camp, however, they understood the real power of this method.

Vác

SUCCESSFUL STORIES

Hungary has a long tradition of science education at the secondary and university levels, but primary schools had not been involved in the inquiry-based approach. The Pollen Seed City in Hungary is Vác, one of the oldest towns in the country.

Coordination

- Apor Vilmos Catholic College

Empowering local communities

Pollen has become very popular in terms of in-service training for teachers in Vác and the surrounding region. The changes observed in the teachers' practices during in-service training and after-class activities were the most successful achievements. These related to the ways in which they were able to use their in-depth knowledge of inquiry-based activities, cooperate with other teachers and their own pupils, and transmit their positive attitudes towards science to the children, their parents and their colleagues at school.

The disadvantaged children, who received particular attention throughout the project, liked the experiments in class very much. Their teachers were glad to take part in the Pollen project. Fruitful relations with foundations and scientists have been developed.

«Anyone at any time can open up the gates of the fairytale world of sciences and see unimaginable colourful wonders. How can we open up these gates? Simply by performing experiments that anyone can do.»

József Öveges (Colourful physical experiments out of nothing)

KEY TOPIC
Science education in new Member States

Vác has implemented the basic IBSE framework in the Pollen community approach. Its main objective was to spark interest in natural sciences through hands-on activities. Along with the inductive method, which has been maintained, it has helped schools to carry out more practical investigative work. As the Seed City is located in a disadvantaged region encompassing a lot of small villages, helping disadvantaged children, in particular the Roma minority, in science education was a specific objective. Special emphasis was placed on training facilities to empower local communities.

ACHIEVEMENTS

	2006	March 2009
Teachers	20	52
Pupils	400	900
Schools	9	19
Training hours (Total per teacher)	12	12-15

Resources

Pollen has offered a large number of free resources for teachers, trainers and educationalists in order to assist with the implementation of local IBSE projects. All of them are available free of charge on the Pollen website.

The Pollen E-centre: www.pollen-europa.net

An interactive web portal (E-centre) was developed in order to foster the mutual exchange of experiences and to support and disseminate processes throughout the duration of the project at local, national and European levels. The E-centre has provided a space for each Pollen Seed City, cooperative workspaces for all Pollen participants to develop joint projects, a set of resources, tools and documents related to good practices and activities, and an agenda of events taking place in all of the participating cities.

Learning units

22 tried-and-tested scientific activities that cover various primary school levels are available in English at the E-centre. They can be downloaded free of charge and used by any teacher or trainer. Each activity provides a concrete illustration of how to employ the IBSE approach in the classroom.

Resource database

A downloadable list of complementary material and pedagogical resources collected worldwide is also available to all E-centre visitors.

Pollen tools

Three main Pollen guides have been published:

- *Guide for coordinators:* a tool for the Seed City coordinator to initiate and implement a school science development programme, including guidelines for designing a strategic plan.
- *Guide for trainers:* a complete guide on how to organise training sessions and how to coach and support teachers implementing school activities.
- *Guide for teachers:* a practical guide featuring the main inquiry-based approach principles, many examples of activities for all primary school levels, and other resources.

Key issue guides

The work of Pollen partners related to different key issues resulted in several guides that are available on the website:

- The introductory guide entitled *Supporting teachers through the involvement of scientists in primary education* is designed to provide practical information for all partners involved in a scientific structure supporting teachers.
- *The fun-flavoured way to learn science* guide suggests many experiments for the family to do together, using the kitchen as a science laboratory.
- Booklets on cross-disciplinary sciences in the UK: *Cross-curricular hands-on primary science, Science and Art, Geography and Science, Sport and Science*.
- Booklets and videos on best practices in Belgium, France, Germany, Slovenia and Sweden.

The Pollen effect: impact evaluation

A team of evaluators defined the frameworks for the entire project assessment, focusing on the following three topics: teachers' attitudes towards science, students' attitudes towards science, and community participation in the project. In addition, continuous evaluation was carried out by the local staff, with the participation of the community board and occasionally representatives of the different stakeholders. The evaluation of the three main topics resulted in the following conclusions:

Evaluation of teachers' attitudes towards science

Primary teachers' confidence and attitudes in 10 European countries taking part in the Pollen programme (with the exception of Spain and the Netherlands) were investigated by Prof. Tina Jarvis, Dr. Tony Pell and Phil Hingley from the Science Learning Centre East Midlands.

Changing confidence and attitudes to different teaching approaches were assessed using 69 Likert items[1]. In Autumn 2006, before the intervention, 420 teachers completed questionnaires.

In June 2008, 143 teachers who had been in the programme for two years and 224 teachers who had taken part for one year redid the questionnaire.

After two years, the confidence of teachers teaching science had improved significantly. While overall attitudes have remained stable, attitudes to specific Pollen objectives have shown significant improvements (see table).

Differences in teachers' responses in different countries appear to relate to teachers' levels of qualification, the amount of governmental control and inspections, the provision of structured support such as kits, political and/or management credit given to participation in training, and compatibility between the Pollen aims and existing national strategies.

Significant changes in individual attitude questionnaire for teachers involved in the Pollen programme for two years

	PRE-TEST	POST-TEST
Importance for teachers to:	**Mean/score item**	**Mean/score item**
Encourage pupils to try out their own ideas in experiments	4.52*	4.68*
Participate in local and city science education initiatives	3.93*	4.08*
Teach pupils to understand science ideas	4.09**	4.32**
Use field trips to support science learning	4.22*	4.41*
Choose activities so that the class is easy to control	4.04**	3.81**
Use information technnology	3.84*	3.99*
Expect pupils to use scientific words correctly	3.83**	4.10**

* p<5%, p**<1%, Wilcoxon matched pairs (five-point Likert scale gives a maximum mean score of 5).

In statistical hypothesis testing, the p-value is the probability of obtaining by chance a result at least as extreme as the one that was actually observed. It thus measures the accuracy of the statistical results.

[1] A Likert scale is used in questionnaires and usually indicates levels of approval, agreement of importance. In this case, a five-points Likert scale was used. The teachers were asked to rate statements from 1 (not important at all) to 5 (very important).

Evaluation of pupils' attitudes towards science

This topic was studied by Britt Lindahl from the Swedish NTA programme, and conducted through a four-part pupil questionnaire (44 questions in total):

- What do you think of being at school?
- What do you think of science at school?
- What about you and science?
- What do you think of science in society?

The first round of data collection took place just before the teachers started to use the teaching material, from September to December 2006, and the second round took place two years later. It was possible to match some pupils from one data collection round to the other. The final database includes seven countries with about 2,900 pupils in total, distributed as follows:

	DATA COLLECTION 2006				DATA COLLECTION 2008			
	Number of		Age		Number of		Age	
	Classes	Pupils	Mean	Range	Classes	Pupils	Mean	Range
FRA	41	670	8.4	5,12	17	291	8.7	6-13
GER	41	940	9.9	8-13	32	686	11.6	9-14
HUN	15	284	9.2	7-15	14	288	10.0	7-17
POR	12	209	7.8	5-13	13	238	8.2	6-12
SLO	26	414	7.8	5-11	9	213	8.8	5-11
SWE	34	621	11.5	10-14	18	312	13.2	12-15
UK	17	432	8.3	5-11	34	881	8.5	5-11
TOTAL	186	3,570	9.3	5-15	137	2,909	9.9	5-17

FRA: France, GER: Germany, HUN: Hungary, POR: Portugal, SLO: Slovenia, SWE: Sweden, UK: United Kingdom.

A preliminary analysis carried out for Germany (Berlin) shows that the impact of Pollen on pupils' attitudes is generally positive. The following initial conclusions refer to the Berlin Seed City:

- Pupils most like working with their friends, doing experiments and using the computer.
- The girls' favourite subject is reading, followed by science, writing and maths, and the boys' favourite subject is science, followed by reading, maths and writing. These views did not change during the two years.
- Pupils do not consider science in school to be a difficult topic, nor do they think that there is too much science in school. All of them, especially the boys, prefer doing experiments to writing during science lessons. The boys understand that science is also for girls.
- Pupils also think that science is important, although they do not want to be scientists. The view that one needs to be clever to do science becomes less widely held over the duration of the project. The result of the questionnaire is that science is good for everybody in society, but that perhaps it could deal with social issues to a greater extent.

The complete results and questionnaires are published on the Pollen website (June 2009).

Overall quantitative impact

ACHIEVEMENTS	2006	March 2009
Teachers	479	2,377
Pupils	9,301	35,999
Schools	136	506
Training hours (Total per teacher)	781	3,181

Evaluation of community participation

The involvement of community actors determines the level of overall participation and dynamics of the project. It also establishes the further ownership of the project on a local level and ensures its sustainability. In order to evaluate the former, a questionnaire was filled in by all of the Seed Cities in 2007 and 2009, and three field visits were made in 2008 to Lisbon, Berlin and Saint-Etienne. P.A.U. Education was in charge of the assessment.

The assessment resulted in a series of key questions and findings:

- **What is the desired participatory scheme: a single or a flexible framework?** There are extremely diverse community participation schemes. Most Seed Cities structured their own particular community configuration (Community Board - CB) involving local actors, creating links among these and establishing organisational features according to specific needs.

- **What is the desired intervention level?** The nature of the CB gradually changed: it started out as an informative/consultative structure, and developed into a meaningful partnership in which members were able to propose ideas, get involved in future steps, and support implementation through concrete actions (technically and financially). This positive evolution was generally related to additional time and resources dedicated to building the Pollen community and the definition, through specific formal agreements, of CB member roles and responsibilities.

- **What is the desired involvement of private entities?** The participation of private companies, which were not initially given specific consideration by the Seed Cities, was progressively generally accepted. Successful examples of meaningful support (technical, financial) exist within Pollen, built on clearly regulated cooperation.

- **How to reach community actors?** Pollen activities evolved from being confined initially to schools and classes to taking place **in other spaces** involving a multitude of actors. With some difficulty, Seed Cities came up with imaginative ideas for reaching parents and other community members. A series of **good practices** on how to reach other community actors, involve them in the local implementation of Pollen and related strategic decisions and communicate about the project were identified.

- **What are the benefits of school-community participation?** The benefits are clear to all actors (teachers, parents, institutions, etc.): such participation makes it possible to respond to specific local needs, complement existing skills, strengthen the school dimension and, in particular, **ensure the sustainability of Pollen**. As such, the importance of strong political and financial support as a key element for the future of the project was recognised by all of the local coordinators.

- At different levels in each Seed City, a local collaborative framework involving community actors to support science education was established. Efforts were made locally in order to ensure that this collaborative framework enabled the project to continue beyond the current experimental phase.

European dissemination and sustainability

National dissemination

Many Seed Cities started to disseminate their expertise among other cities in their own countries. From the numerous activities related to this task, a number of aspects common to all of the strategies can be observed:

- Training sessions (pre- and in-service) for newcomers to the project.
- Dissemination of information (booklets and resources) on a national and local scale.
- Newspapers and media interviews.
- Integration in an ongoing national IBSE network.
- Production and dissemination of material kits.
- Participation in or organisation of science fairs conferences on IBSE.
- Participation in the reform of national primary science curricula.
- Production and publication of videos and tools on a national scale.
- Publication of research papers.
- Visit from international delegations.
- Creation of new structures to increase the activities of the Seed Cities.
- Involvement of national or regional institutions (city councils, education ministries, science academies, chambers of commerce, private companies, etc.).

Examples

- Children's and teachers' activities benefited from local, national and even international media coverage. Numerous newspaper articles and reviews were published (in *Der Spiegel* in Germany, *Le soir* in Belgium, *Le Progrès de Lyon* in France, and *El Punt* in Spain among others).
- In 2006 and 2007, European and national Pollen coordinators were requested to contribute, through interviews and data, to the *Science Education Now* report (European Commission) supervised by former French prime minister Michel Rocard.
- In 2007 and 2008, in two occacions Pollen partners and experts were invited by members of the Cultural Commission of the Estonian Parliament to explain the project.
- On 18 June 2008, during the Primary Science Conference at the National Science Learning Centre in York, Tina Jarvis gave a keynote presentation on the work of the Leicester City Pollen teachers to 180 science coordinators from all over England.
- Since early 2008, the Hogeschool Amsterdam and the AMSTEL Institute from the Netherlands have been running the regional Centre of Expertise for Science and Technology Education in North Holland. Through a government programme, they will be running in-service courses for about 120 teachers over the next school year.
- Courses will be provided at the East Midlands Science Learning Centre in 2009, including an MA course entitled «Teaching Primary Science», which will cover forces, materials, electricity, earth, space, environmental issues, how children learn science, evaluating teaching strategies such as practical investigative work, cross-curricular approaches and the use of ICT.

Observer members

The following four new Seed Cities joined Pollen as observer members in 2007, after the involvement of a leading institution in science education reform: the National Institute for Lasers, Plasma and Radiation Physics, Bucharest (Romania), the University of Luxembourg (Luxembourg), Trnava University (Slovakia), and the University of Belgrade (Serbia). Science education programmes from Ireland (Discover Primary Science) and Denmark (Centre for Educational Resources) also showed an interest and joined the network.

New towns & areas involved

France
Saint-Etienne Métropole

Estonia
Tartumaa county
Järvamaa county
Pärnumaa county

Germany
Berlin (38 additional schools)
Nordrhein-Westfalen (Cologne and Bonn)
Brandenburg (Schwedt)
Baden-Württemberg (Ulm)

Italy
Region of Umbria (starting expansion in Lazio)

United Kingdom
County of Leicestershire

Hungary
Surroundings of Vác

Slovenia
Kamnik, Domžale, Kranj, Slovenska Bistrica

Original Seed Cities

Dissemination at European seminars and conferences

- Three European seminars, each bringing together about 50 participants, were organised over the course of Pollen (Paris, 2006; Gerona, 2007; Ljubljana, 2008).
- Pollen was also discussed extensively at several European conferences:
  - Science is Primary II - Engaging the new generation, Stockholm, Sweden, 15 to 17 October 2006.
  - Science Learning in the Europe of Knowledge, Grenoble, France, 8 and 9 October 2008.
  - Research Connection 2009, Prague, Czech Republic, 7 and 8 May 2009.
  - Changing research landscapes to make the most of human potential - 10 years of EU activities in Women and Science and beyond, Prague, Czech Republic, 14 and 15 May 2009.

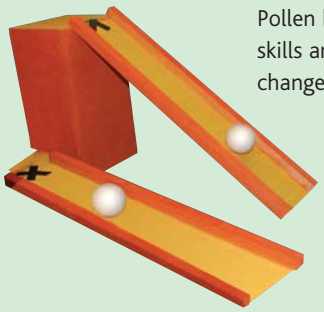
Dissemination through reports and media

- Pollen was broadly referred to as a reference project in the *Science Education Now: a renewed pedagogy for the future of Europe* (June 2007) report".
- Science Education in Europe: critical reflections, January 2008, the Nuffield foundation.
- Research EU: Special issue on science education, June 2007.
- Growing Interest in the Development of Teaching Science network: www.grid-network.eu

Seed Cities for Science Education Charter

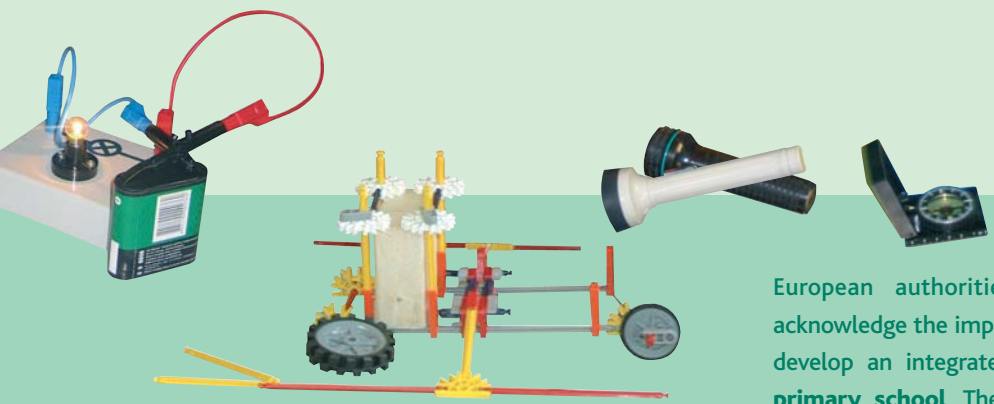
2 Teacher training

Research has clearly established that teacher training and tutoring are the main components required for a **profound change in practices**, especially to combat the reluctance related to science teaching that is common among primary teachers. By providing in-service training sessions and tutoring in the classroom, Pollen has contributed to enhancing IBSE teaching skills and has thus succeeded in achieving lasting changes in practices.



1 Inquiry-based science education (IBSE)

IBSE is at the core of the pedagogical approach supported by Pollen. By combining global research, scientific learning, experimentation and evidence-based reasoning, language and debating skills, IBSE enables pupils to further their understanding of the objects and phenomena around them, as well as enhance their **curiosity**, **creativity** and **critical skills**.



European authorities and the international scientific community acknowledge the importance of **inquiry-based science education** (IBSE) to develop an integrated strategy for scientific literacy and awareness at **primary school**. The Pollen approach, implemented in more than 400 schools (36,000 pupils) across Europe, is made up of **5 pillars**.

3 Community involvement

Schools are part of a broader setting, in which interaction with other local stakeholders is also important in order to strengthen educational innovation. Pollen **has fostered community participation**, through a board involving families, the scientific community, universities, public services, industries, and other entities on a local level to better incorporate science education policy within the city agenda, as well as to provide teachers and pupils with field experience and visits.

4 Resources and material

Equipment is a key factor, although it does **not necessarily have to be expensive or based on advanced technology**. Pollen has made available for teachers sets of basic scientific material for the classroom, as well as ready-to-use protocols based on this material. Usually provided in the form of kits or boxes containing all the necessary elements for teachers and pupils to start with, it has helped to reduce the practical difficulties teachers are usually afraid of, as well as to structure practices around common frameworks underpinned in the teaching protocols.

5 Follow-up and evaluation

A formative assessment of **how teachers react and perform in the classroom** is essential to educational innovation. It shows the kind of specific difficulties they face when implementing innovation and whether and under which conditions they benefit from changing their teaching practices. An overall evaluation dealing with the global impact of the project is also necessary in order to justify changes based on concrete evidence to policy-makers and education authorities.
The quality of community participation in each Seed City was also assessed.

Together, they constitute the Seed Cities for Science Education Charter. The objective of this charter is to promote and disseminate common principles and standards throughout Europe based on the successful experiences of the Pollen project. **Make it yours. A complete version of the charter is available in 12 languages on the Pollen website.**

Lessons learnt and recommendations with regard to the Pollen principles

The European dimension and factor

- IBSE is a common Pollen priority. Considering the differences existing between educational systems in Europe, the project supported every Seed City in a different way to reach this objective, taking into account the local context in terms of curricula, institutional frameworks or education policies.
- Being part of a European project gives individuals a sense of partnership and a unique opportunity to share experiences and to find better solutions for the countries involved.
- The support from a group of international experts and the status of a European project help project managers to introduce and promote new ways of teaching science among local education authorities.

Inquiry-based science education

- Experimental-, evidence- and inquiry-based teaching and learning are powerful ways to understand the very nature of science, in close parallel with research activities. Gaining confidence, pupils respond enthusiastically and effectively to IBSE which in turn encourages the teachers to teach more science.
- IBSE allows for a cross-disciplinary approach, in which maths, language and other subjects are part of the process. It also connects the school to its external environment by focusing on relevant questions.
- IBSE takes time to implement. Clear methodologies for teaching and long-term planning are necessary. Constant dialogue must be ensured with teachers and regular activities throughout the years should be designed to keep their interest alive.
- Project managers should listen to schools, to teachers and to pupils and choose to develop actions based on existing conditions.

Teacher training

- Teachers are the key actors of innovation and change. The training process enables teachers to overcome their fear of teaching science.
- Sustained and consistent training sessions over several years are most effective when it comes to changing practices. Short in-service sessions of one or two days do not have a lasting impact.
- Choose activities in the training sessions that relate to the teachers' immediate concerns.
- Teacher training should include classroom simulations, during which teachers experiment directly with the inquiry-based approach.
- Experienced teachers are effective trainers. Peer-to-peer exchange and team teaching are effective methods.

Resources and material

- Resources and material have a structuring effect that contributes to the homogeneity, coherence and dissemination of IBSE. Quality resources and material, with ready-to-use experimental kits, should be easily available to teachers.
- Adapting resources to the local curricula and the school project is important.
- Experienced teachers can be involved in the design of quality homemade resources and material.
- Publishing books based on teaching and training activities and recording videos of teaching practices, are useful strategies in order to reach a large number of teachers and involve local policy-makers.

Community involvement

- Sustainability is obtained through multi-partner agreements, with clear support from major institutions. The commitment of the education authorities (from the head teacher to the minister) is a key factor in terms of implementing and scaling up the project.
- Public events have a catalyst effect when it comes to achieving consensus.
- Collaboration and communication between partners (municipalities, museums, companies, foundations, parents, teachers, etc.) is essential. They should put their resources in common in order to foster a profound change in science education.
- The involvement of the scientific community as a stakeholder and to support teachers is fundamental. Outreach activities involving science students provide effective support for teachers.
- Making sure parents know how much their children enjoy IBSE helps to ensure sustainability.

Follow-up and evaluation

- After each training session, follow-up of how teachers respond and perform is required; however, this should not be judgemental. A formative approach is necessary, whereby feedback from teachers can be used as a positive means for improvement.
- Best results are achieved when the communication between the teachers and trainers is open and the feedback is used for continuous progress in classroom practice.
- Evaluation is necessary for quality-based scaling up.

To be taken into consideration

- Pollen was a 3-year pilot project. More time is needed to achieve a sustainable change and ensure that the teachers are completely autonomous when it comes to teaching science.
- The shortage of human and financial resources prevented the local project coordinators from involving even more teachers and pupils.
- The pupils, teachers, parents and the scientific community are ready for a new scientific approach in education. Further efforts should target national education authorities looking for major change on a broader scale (curricula, textbooks).

Beyond Pollen

Pollen was a 3-year pilot project to stimulate and support IBSE teaching and learning in primary schools. However, several years are necessary to have a lasting impact on pupils. In order to increase the sustainability of the project and ensure the continuity beyond the period of support provided by the European Commission, many initiatives were taken, as shown above. However, the need for a broader and collective action rapidly emerged, taking into account the European dimensions as the proper framework for science education reform. In this perspective, Pollen and the FP 6 Scienceduc project network upon which it is built have paved the way for the further expansion of inquiry-based scientific education across Europe.

A scheme was designed which is ready for large-scale ownership of an investigative approach in a number of schools in the same local territory, based on a network of *Reference Centres* throughout Europe with recognised expertise. Exchanges with other centres looking for best practices could take place through twinning and peer-learning by means of visits, tutoring, resources and strategy transfer. The spread of innovation would thus be neither top-down nor bottom-up, but rather a transfer of semi-formalised practices and experiences that have reached a satisfactory level of recognition, expertise and sustainability on a local scale.

In order to put these principles into practice, a consortium of 25 partners from 21 countries, including nine Pollen partners and four Pollen observers, as well as members from the SINUS network, answered in January 2009 under the project name of FIBONACCI a call for proposals launched by the European Commission (FP7 programme).

The main objective is to design, implement and test a process of dissemination in Europe of inquiry-based teaching methods for mathematics and natural science education at primary and secondary schools, relying on reference centres that will serve as dissemination agents in Europe. The proposed dissemination plan will deal with 60 focal points of four different kinds, for a total of about 2,500 teachers and 45,000 pupils.

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The 12 consortium members involved in the project and the contact person for each institution are as follows:

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EUROPEAN COMMISSION

SIXTH FRAMEWORK PROGRAMME

The Pollen project is endorsed by the French Academy of Sciences

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