Pollen spreads inquiry-based science education throughout Europe

Jasmin, D.; van den Berg, E.

Publication date
2010

Document Version
Final published version

Published in
E-learning Papers

Pollen Spreads Inquiry-Based Science Education throughout Europe

David Jasmin
Pollen European coordinator, Head of the La main à la pâte French program for science education reform (Académie des sciences - INRP - ENS Ulm)

Ed van den Berg, PhD
AMSTEL Institute

Summary

This case study reviews the activity carried out by Pollen, a European network for promoting Inquiry-Based Science Education. Pollen is a pilot program that worked with communities to develop a "hands on, minds on" approach to science education in primary schools. During the project ICT supported the project as a whole, with the wide use of an interactive web portal, as well as in concrete interventions, such as the introduction of sensors and computers into Amsterdam classrooms. The outcome is a promising model showing how innovative pedagogy can cultivate a desire for learning and discovery in the science classroom. The community-based approach, together with the circulation of experiences and resources through the web, are two key elements of that project that ensure the sustainability of this initiative.

Pollen was a European research and development project supported by the European Commission Directorate-General for Research, under the Science and Society part of the Sixth Framework Program for research, technological development and demonstration activities. The project began in January 2006 and lasted three and a half years. The research team was made up of a consortium of pedagogical and scientific organisations from 12 European countries and was launched in 12 European cities. Representing all areas of Europe (Northern, Southern, Eastern and Western), the network addressed their research questions in a diverse set of local educational contexts.

Keywords: Inquiry-Based Science Education (IBSE), curriculum innovation, primary education, educational technology

Seed Cities: a community-based initiative

The project's main aim was to stimulate and support inquiry-based teaching and learning in primary schools, providing tools, training, teaching and assessment. Pollen[1] focused on creating 12 Seed Cities to develop the pilot programs. These Seed Cities were considered

[1] The project was coordinated by La main à la pâte (Académie des sciences - INRP - ENS Ulm, France) and P.A.U. Education (Spain). Other consortium members were: Université Libre de Bruxelles (Belgium), University of Tartu (Estonia), Freie Universität Berlin (Germany), Apor Vilmos Catholic College (Hungary), 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), University of Ljubljana / School of Education (Slovenia), Royal Swedish Academy of Sciences (Sweden) and the University of Leicester (UK). The original 12 participating cities were: Saint-Etienne Métropole (France), Brussels (Belgium), Tartu (Estonia), Berlin (Germany), Vác (Hungary), Perugia (Italy), Amsterdam (The Netherlands), Loures (Portugal), Ljubljana (Slovenia), Girona (Spain), Stockholm (Sweden) and Leicester (UK).

educational territories that supported the project through the commitment of the whole community. This local strategy reflected an integral part of Pollen's philosophical and pedagogical vision. On one hand, a comprehensive community-based approach promoted efficiency and created relationships that could contribute to the project's sustainability beyond its limited time-frame. On the other hand, by demanding local support, not only educational institutions, but also families, scientific and industrial partners, municipalities, museums, cultural centres, and so on took on a vital role in the process.

Pollen commenced with an initial evaluation of science education in each Seed City and defined main objectives for each location. Each city developed a personalized key topic for the duration of the program. Technology was the main focus in Amsterdam, whose key topic was: "Enhancing inquiry-based science and technology education in primary schools with ICT". However, each city addressed topics relevant to their context. Themes explored social issues, such as the gender gap in science, education and immigrants, or the relationship between science education and active citizenship, among others. Other contexts studied curriculum and school innovation, focusing on themes related to the cross-disciplinary approach, special needs education, the involvement of the scientific community in primary, and so on, and in some instances considered issues related to science education in new European member states.

Implemented in over 400 schools (36,000 pupils), Pollen trained more than 2,000 teachers by the close of the project. In addition, community outreach succeeded in producing numerous partnerships between schools and local organizations or businesses, thus furthering the reach and strength of Pollen's activities. To support the project, an interactive web portal (E-centre) was developed in order to stimulate the mutual exchange of experiences and support at local, national and European levels. The E-centre provided a space for each seed city as well as a cooperative workspace that facilitated the development of joint projects, a set of resources, tools and documents relating to good practices, and an agenda of different cities' events. Today, the portal provides public access to the teaching and training materials developed and tested during the project, and offers a comprehensive guide to the project and its results.[2]

Five pillars for building an IBSE program in the classroom

European authorities and the international scientific community acknowledge the importance of IBSE for developing an integrated strategy for scientific literacy and awareness at primary school. In order to introduce this approach into schools in a meaningful way, Pollen structured the pilot program on 5 pillars. It was tested and refined during the project and the final results are based on the successful experiences of the pilot program.

1. IBSE

IBSE is the pedagogical model supported by Pollen. By combining global research, scientific learning, experimentation and evidence-based reasoning with language and debating skills, IBSE enables pupils to gain an understanding of the objects and phenomena around them, while nourishing their curiosity, creativity and critical skills. Experimental, evidence-based and inquiry-based teaching and learning are powerful methods that encourage learners to comprehend the very nature of science. Although centred in the study of natural sciences, IBSE allows for a cross-disciplinary approach in the development of school activities, involving maths, languages and other subjects. This movement through disciplines also transcends classrooms walls; IBSE connects the school to its external environment by focusing on issues that relate science to relevant topics in the real world. However, as demonstrated in Pollen, it is important to remember that IBSE takes time to implement. A clear teaching and long-term planning methodology is necessary in order for teachers to gain experience and create relationships with community members.

[2] Access via: www.pollen-europa.net.

2. Teacher Training

Research has clearly established that teacher training and tutoring are the main components required for effecting a profound change in classroom practices. This is especially true when you take into consideration the reluctance many primary teachers feel about teaching science. Pollen recognised the importance training would have in the project and appointed a “local trainer” to each community. This trainer was not an “outsider” to the school but was familiar with a school's culture and development processes. Their role also played a part in enhancing community interaction between the school and other local contexts.

By providing in-service training sessions and tutoring in the classroom, Pollen has enhanced IBSE teaching skills, which contributed to achieving lasting change in practices. The teacher training that took place in Pollen, and which the project demonstrated as successful, included classroom simulations, during which teachers were encourage to experiment directly with the inquiry-based approach. Pollen also reports that progressive and consistent training sessions are most effective when it comes to changing practices. Pollen members have observed that experienced teachers are effective trainers and peer-to-peer best practice exchange has also proven effective.

3. Community involvement

In Pollen, IBSE involved recognizing that schools are part of a broader network, one in which local stakeholders are an important resource who have the potential to strengthen educational innovation through their interaction with the schools. This philosophy positioned schools not as individual settings but as part of a bigger community, where local stakeholders could interact with pupils and have a role in enhancing their skills. In each Pollen Seed City, community liaisons, local coordinators and the local community boards, facilitated community support and participation throughout the duration of the project. A local community board was responsible for bringing together representatives of the various actors involved in the local project. Leading the community board was a local coordinator, a person familiar with the organisation and dynamics of the local community and its processes. This coordinator was a liaison between school and board, ensuring daily contact between the two, as well as taking on other management tasks.

Pollen was also aware that initiatives that are well integrated in local policies enable innovation and effective changes. In this manner, the project strived to foster community participation, involving families, the scientific community, universities, public services, industries, and other entities. By working on a local level, science education policy is better incorporated into the city agenda, and teachers and pupils have greater chances of setting up field experience and visits. The involvement of the scientific community in a way that supported teachers was a key factor in making the Seed Cities sustainable. During Pollen, teachers were able to contact institutions and develop working relationships with them that brought their expertise and ‘real-world’ awareness of science into the classroom. These outreach activities were important for succeeding in getting clear support from major institutions. Pollen observed that public events have a catalyst effect when it comes to achieving consensus.

4. Resources and Material

School equipment is a key factor for a successful IBSE curriculum, although it does not necessarily have to be expensive or based on advanced technology. Pollen provided teachers sets of basic scientific material for the classroom, as well as ready-to-use protocols based on this material. These kits or boxes contained all the necessary elements for teachers and pupils to start with, and they reduced the practical difficulties teachers are usually afraid of, as well as helped organise practices around the common frameworks. In fact, providing resources and material creates a structuring effect that contributes to the homogeneity, coherence and dissemination of IBSE, which is helpful for schools that work within the constraints of local curriculum agendas.

Quality resources and material, in the form of ready-to-use experimental kits, were an important part of Pollen's success. The fact that they were easily available to teachers made the new proposed activities more accessible, especially for those teachers that were less familiar with science concepts. Experienced teachers became involved in the design of quality homemade resources and material that were then shared throughout the network. During the project, schools and teachers received: dozens of hours of teacher training per year, educational materials, specially designed class activities, experimental materials for the classroom, and other resources. In addition, the structure of the project served as a permanent advisory service for carrying out the different activities. Further support and materials could be found on the web.

5. Follow-up and evaluation

Formative assessment of how teachers react and perform in the classroom is essential to educational innovation. In Pollen, it helped teachers become aware of the kind of specific difficulties they face when implementing innovation and whether, and under which conditions, they may benefit from changing their teaching practices. During the project, follow-up of teachers' response and performance was required, but the project intended that this practice not be seen to be judgemental. Rather, a formative approach was used, where feedback both from and for teachers was used to work towards improvement. Teacher training sessions were accompanied by visits to schools in order to more closely support teachers in their daily environment.

Evaluation is necessary for quality-based scaling up of the pilot program. An overall evaluation addressed to policy-makers and education authorities about the global impact of the project was carried out. This study allowed Pollen to recommend changes in support of IBSE based on concrete evidence. Both aspects of evaluation were taken into account: first, through close follow-up of teachers in the classroom, and then through a questionnaire filled in by teachers and pupils participating in the project, thus measuring how their attitudes towards science were affected by their participation in the project. The quality of community participation in each Seed City was also assessed in order to identify the most important factors involved in the successful commitment of local actors. This large sample, in a diverse set of schools, has allowed the Pollen team to do extensive research on the possible benefits and feasibility of IBSE.

Pollen in action: looking at Amsterdam's program

The main problems in the Netherlands were identified as teachers' low level of science knowledge and skills and their low self-confidence in implementing inquiry. Amsterdam's network of teachers recognised that going from textbook science to science inquiry would be a very large step, both in terms of science and in terms of pedagogy. Therefore the project proposal was arranged to guide the teachers through small steps towards hands-on and minds-on science and technology investigations. Technology was an important factor in Amsterdam's project from the start. Working from the Pollen objective to relate science to real-life situations, Amsterdam focused on including sensors and computers in the primary education curriculum as a tool for students to observe and learn about the world around them. Using technology allowed students to gain valuable skills and also allowed them to carry out experiments they wouldn't otherwise have been able to do.

The project faced obstacles and it had a slow start. Pollen observed that for participating schools, many of which had a high percentage of immigrant students, main attention in class was given to language, arithmetic and solving social problems. The main issues were time and priority; teachers were very busy dealing with the everyday, pressing issues that arise at school, like finding ways to include new, often migrant learners into their classroom, among other principle concerns. As a result, they had little time for developing different, and unfamiliar, science and technology programs.

Initially, Amsterdam Pollen had a very hard time recruiting teachers for the project. In 2006 11 teachers participated in a training while only a handful of others were involved in trying out IBSE lessons. However, in late 2007, a large national project to train 5000 teachers nationwide and 350 in Amsterdam was initiated. The Amsterdam Pollen team, together with partners Artis Zoo and NEMO science centre, became responsible for training 350 teachers during a two year period and through this opportunity, was able to influence the Science and Technology component of pre-service programs in Amsterdam and the province of North-Holland. This occurrence meant that Pollen had to grow very quickly. From the start, it was clear that just in-service training would not be sufficient to achieve the Pollen objective of real hands-on and minds-on learning in the classroom. The Pollen group knew that it needed to offer support in the classroom through mentoring and classroom visits were built in, although they were limited. In some instances, schools and teachers were able to get additional funding for mentoring and for research on classroom implementation.

In addition to teacher training, Pollen activity in Amsterdam focused on the development and implementation of lessons, activities and material for science and technology (S&T) education accompanied sensors and computers. The AMSTEL Institute of the University of Amsterdam, the leader of the Amsterdam Pollen group, specializes in the application of ICT in S&T education at the primary and secondary level. During the project, AMSTEL Institute developed a sensor set specifically for primary S&T education, developed activities and software, and tried them in schools with children from grades 4 - 6. Summaries of lessons, with accompanying material such as free software, instructions for pupils and lesson plans for teachers, can be found on the Amsterdam Pollen website in English.[3] The Amsterdam group also experimented with digital microscopes. In all these activities, children quickly learned to use the hardware, software, and graphs productively. Notably, they were also quick to each other. However, for teachers ICT S&T activities have a high threshold. For example, an IBSE module on mirrors[4] for Kindergarten - grade 2 that does not incorporate ICT is now widely used by teachers, whereas ICT activities that had obvious success with children are less commonly used. Several strategies could lead the way out of this dilemma such as: a) working through the children and allowing them to teach each other, b) including sensors and digital microscopes in pre-service teacher education, c) keep using in-service and every other available opportunity to familiarize teachers with this technology.

The case in Amsterdam illustrates how the European project supported pedagogical innovation at a local level. Pollen provided the seeds, ambition, and valuable experience garnered from other international Pollen partners. Fortunately, the germination of the seeds coincided with a large national initiative aimed at improving primary S&T education. This nation-wide project provided the incentive for schools to take S&T seriously at the primary level. It provided opportunities to link pre-service and in-service teacher education for S&T as well as funds to work with many schools. This experience, along with the teaching and training material from the project that is available via the Pollen website[5], provides an insightful look into how Pollen affected and supported science education in primary schools.

Evaluation: How did Pollen affect children's and teachers' attitudes toward science?

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. Continuous evaluation was also carried out by the local staff, with the participation of the community board and occasionally with representatives of the different stakeholders. The evaluation process in Pollen was mostly quantitative; questionnaires were given to participants to measure the project's educative value and its impact on children's and teachers' attitudes towards science. A five point Likert scale was used that allowed the team to easily collate and analyse responses, even though the surveys were

[3] Access via: http://pollen-europa.nl/wiki/EuroSenseEn/Startpagina?action=browse.
[4] http://www.nsta.org/SC0912 or http://tinyurl.com/mirrorpollen
[5] Access via: http://www.pollen-europa.net/?page=D6MKJPGjt1o%3D

conducted in 12 languages.[6] Qualitative evaluation was used to assess the social impact of the project and the outreach dimension, the level of community participation. The main aim of the evaluation process was to create a replicable framework, and questionnaires were specially designed to this end.

The first round of questionnaires was administered before participants began their involvement, forming a baseline picture of the teachers, community members and pupils. Teachers responded to questions that rated their confidence in teaching science and their views as a science teacher, answering questions about their views on science, investigations and in-service training, among other items. Community members answered questions about their feelings on Science Education while pupils were asked about their feelings on science in school and society. All 12 countries participated in this initial cycle of data collection. In addition, after one year and after two years into the project, interim in-depth case studies were carried out. Leicester provided data in 2007, and then, on a wider scale, in 2008 Germany, UK and Sweden undertook case studies. Results of these processes were analysed and discussed by the team in order to detect any errors in methodology before the major post-project data collection and evaluation.

The final evaluation was carried out in a limited number of cities in order to allow the project to work with more in-depth qualitative results. In 2009, the evaluation process reached an end and three final evaluation reports were produced. The first, Changes in pupils' attitudes towards science during two years within the Pollen project presents the methods followed during the evaluation of pupils' attitudes and publishes seven countries' results, those from Germany, France, Hungary, Portugal, Slovenia, Sweden and UK. The second report on teachers' changing practice focused on 10 countries: Belgium, Estonia, Germany, Hungary, Italy, France, Portugal, Slovenia, Sweden and UK. The evaluation report assesses teachers' confidence and attitudes regarding science education and other different aspects. It presents the main findings and makes recommendations. The last report addressing community participation in science education resulted in a report on the school-community collaboration. These reports are available on the Pollen website.[7] These evaluations show that the Pollen objectives have been positively achieved.

The pollination effect: Conclusions and a vision of the future

The positive results arising from Pollen are many. The methods used by Pollen have proven to raise primary teachers' interest, self-confidence and skills in science teaching and therefore the quality and quantity of science teaching sessions. Pollen increased children's interest in science learning activities. Particularly, the gender gap in science was reduced as a higher share of girls tended to actively participate in science-related activities. The increased interest and participation was even stronger with weaker students and those from disadvantaged backgrounds. On a mechanical level, participating cities received teacher training, specific resources for the classroom (learning units, teachers' guides, material and resources database, information booklets, and more), as well as a web support resource. Exchanges between teachers, scientists and pedagogical experts were strongly encouraged and schools and classrooms developed lasting relationships with the scientific community. In addition, Pollen proved itself capable of obtaining strong support from both community and scientific institutions (Academies of Sciences, higher education institutions). On a European level, Pollen demonstrated how its approach can be applied in different national settings. Pollen partners, while following the same philosophical approach (IBSE), implemented it in different ways, demonstrating flexibility while achieving consistent results.

[6] The questionnaire was based on an existing instrument with a science attitude scale of 49 items with 0.96 reliability: Pell A. & Jarvis T (2003) Developing attitude to science scales for use with primary teachers. *International Journal of Science Education*, 25(10), pp. 1273-1295.
[7] Access via: http://www.pollen-europa.net/?page=AsiqsHZTASM%3D

What changes took place in the classroom?
Results showed that the confidence of teachers teaching science in primary schools improved significantly.[8] Prior to participating in the project, teachers reported that they were more comfortable teaching mathematics or their home language, rather than science, with confidence in physics and chemistry rated as particularly low. While overall attitudes remained stable, attitudes regarding specific Pollen objectives showed significant improvements for those teachers who had been in the program for two years. All science components witnessed a rise in confidence whereas, in contrast, there was no change in confidence in teaching math or language. Notably, information technology and design technology also improved (those subjects were often developed alongside science as part of the intention to show the relevance of science in society). In addition to raising confidence, Pollen researchers saw teachers' attitudes towards science became more positive. The surveys showed a decline in the view that teachers should keep tight control of their classes and an increase in their agreement that pupils should carry out their own experiments to develop science concepts involving the local community. This indicates that Pollen objectives were being achieved.

As one may expect, this positive change in teachers had an effect on their students. Pupils in the English case study (2007) were more positive about finding out what happens in experiments and feeling that science is not so difficult. In both 2007 and in later case studies, there were changes in pupil's views of science in society which indicates that they came to appreciate more the relevance of science.

How can positive results be achieved?
Factors related to the Pollen project, such as the quality of in-service and the design of the kit-boxes affected teachers' experiences. Interviews indicated that high quality in-service, where teachers experience the hands-on IBSE approach for themselves, was essential for developing confidence and improved attitudes. Teachers appreciated the opportunities to trying the pupils' activities as it gave them the personal confidence to work with their students doing practical activities. Confidence was also positively linked to those in-service programs that covered a range of topics, more so than to those that had a more narrow focus. It was observed that in-service is more advantageous when this training is staged over several years. The first stage focusing on teachers' science knowledge and skills, and should be responsive to teachers' needs, with a second stage, at a later date, that enhances the IBSE approach with strategies for community outreach and cross-disciplinary projects. This second stage is key for engaging and challenging experienced teachers.

The kit-boxes were considered more useful if there were enough topics to cover all or most of the science curriculum in a year. When that was the case, more hands-on practice took place in the classroom. Some experienced teachers found the kits restrictive but when Pollen allowed flexibility to adapt and extend them, they were found to be useful. As a general rule, the longer teachers were in the program, the more time they had to assimilate the material and work on community outreach. Teachers in the program for longer periods of time reflected greater positive changes related to the project objectives.

The most influential factors, external to Pollen, that affected teachers' experiences in the local context were related to the level of support given to the project. Teachers who felt supported by their school management were generally more positive about the project, whereas there was a negative effect when the management or school colleagues were uninterested or dismissive of a teacher's work or ability. This was important on both a national and local level. To help foster external support, Pollen tried to match Pollen activities and training to national and local initiatives, wherever possible, because teachers were more likely to be given a chance to use their skills if they were seen as relating to existing agendas or curricula. Finally, interviews and data indicate that limited improvement in confidence may relate to teachers' original level of knowledge. Those teachers with higher original knowledge appeared to experience the most

[8] Analyses of the results, in addition to more precise statistical data and analyses by country, can be found in: http://www.pollen-europa.net/?page=AsiqsHZTASM%3D

positive change in their attitudes and confidence and took less time to adapt to the pedagogical model.

Are Seed Cities taking root all across Europe?

Pollen has already showed potential for scaling up. Indeed, after having been tried at local levels, it has already been scaled up twice (at the national French level first, then at the European level), with federating national and local pre-existing initiatives (in United Kingdom, Portugal and Sweden). The strongest point of Pollen is probably its ability to disseminate usable techniques while at the same time respecting the diversity of local contexts: Pollen has demonstrated that its methods are particularly well-adapted and effective in this context.

The outcome of Pollen was seen as positive not only by local schools and teachers, but also by the European Commission that funded the research and development project; the Pollen consortium was successful in obtaining funding from the 7th Framework Program. The FP7 Fibonacci Project (2010-2012) is now taking over the main objectives and outcomes of Pollen. Fibonacci members bring together more than 36 higher education institutions in Europe in order to foster an even larger dissemination of Inquiry-Based Science and Mathematics Education, in both primary and secondary schools. Fibonacci will continue to work closely with local contexts to develop community-supported inquiry-based education throughout Europe. Further information available at www.fibonacci-project.eu

References

Pollen Charter, available at http://www.pollen-europa.net/?page=NmRQUQ87rUI%3D

Pollen: Overview of main activities and achievements, 2006-2009, available at http://www.pollen-europa.net/?page=CjpQoyi6rZY%3D

Support Handbook for a Seed City, http://www.pollen-europa.net/?page=puM4nWOcCck%3D

Pell A. & Jarvis T (2003) Developing attitude to science scales for use with primary teachers. *International Journal of Science Education*, 25(10), pp. 1273-1295.

Authors

David Jasmin
Pollen European coordinator, Head of the La main à la pâte French program for science education reform (Académie des sciences - INRP - ENS Ulm)
david.jasmin@inrp.fr

Ed van den Berg, PhD
Senior lecturer, AMSTEL Institute, University of Amsterdam
e.vandenberg@uva.nl

Copyrights

Edition and production

Name of the publication: eLearning Papers
ISSN: 1887-1542
Publisher: elearningeuropa.info
Edited by: P.A.U. Education, S.L.
Postal address: C/ Muntaner 262, 3º, 08021 Barcelona, Spain
Telephone: +34 933 670 400
Email: editorial@elearningeuropa.info
Internet: www.elearningpapers.eu