PENCIL Report

Science centres and museums working with schools: new ways of cooperating

PENCIL

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Pencil : an introduction

The **Pencil** project worked to strengthen the operational relations on many levels between formal and informal science education, in schools and in science centres and museums. It also aimed at finding ways for science centres and museums to work with schools to improve the quality of science teaching methods. Pencil was funded by the European Commission's Directorate General for Research under the Sixth Framework Programme.

The project spanned three years and centred around three key elements :

- 14 **pilot projects** implemented by science centre and museum partners across Europe and further afield, validating innovative learning tools and new topics for science education. This included a wide range of ages from primary to secondary ;
- The **key findings** of the analysis work carried out on the pilot projects, namely the key findings extrapolated from the pilot project evaluations, as well as additional studies on motivation and gender ;
- The **resources**, opening up access to the results of the project to the community of science teachers and professionals in the field of science communication. These resources are made accessible through a permanent online portal, Xplora. They included teacher training e-courses developed specifically from pilot projects.

The technology employed in Pencil opens up these results and findings efficiently through Xplora and its teacher training e-courses, Xplora-Knoppix DVD and Moodle. The Pencil community now represents a significant European network of science education professionals, at the hub of which is Xplora, the European Science Education portal, enriched with the findings of the evaluation and analysis of these projects, as well as the tried and tested tools created by the pilot projects, now packed with over a thousand resources, and ever expanding as users further add to the content.

Much information has already been made available about the pilot projects themselves. This publication, for professionals in science education and science communication, aims to present the key findings of Pencil. The fruits of the three years of this project shed much light on the best practices for cooperation between formal and informal learning, among other areas of interest in this field.

14 groundbreaking pilot projects

Project partners

Lasting networks of science teachers

Making it work: 18 factors for success

PENCIL

Technopolis®
the Flemish Science Center
Mechelen, Belgium

Pilot project
"Interactive forensic science: Whodunit"

NEMO
Amsterdam, the Netherlands

Pilot project
"Science centre at school"

Project partners

Ecsite, the European Network for Science Centres and Museums, Brussels, Belgium Project coordinator	**www.ecsite.net**
National Marine Aquarium (NMA), Plymouth, UK Pilot project "Marine issues with climate change"	**www.national-aquarium.co.uk**
Istituto e Museo di Storia della Scienza (IMSS), Florence, Italy Pilot project "On-line access to history of science museums objects"	**www.imss.fi.it**
Explor@dome, Paris, France Pilot project "Middle school student's use of ICT in science learning"	**www.exploradome.com**
Heureka, the Finnish Science Center, Vantaa, Finland Pilot project "Chemistry for primary schools" and Motivation Survey	**www.heureka.fi**
NEMO, Amsterdam, Netherlands Pilot project "Science centre at school"	**www.e-NEMO.nl**
Deutsches Museum, Munich, Germany Pilot project "Mobility issues with climate change"	**www.deutsches-museum.de**
Experimentarium, Hellerup, Denmark Pilot project "Future science education"	**www.experimentarium.dk**
Pavilion of Knowledge - Ciência Viva, Lisbon, Portugal Pilot project "Ludo-mathematics"	**www.pavconhecimento.pt**
Fondazione IDIS-Città della Scienza, Naples, Italy Pilot project "Social dimension of science, diversity and gender issues"	**www.cittadellascienza.it**
Bloomfield Science Museum, Jerusalem, Israel Pilot project "Health matters"	**www.mada.org.il/en**
Cité de l'Espace, Toulouse, France Pilot project "Future technologies"	**www.cite-espace.com**
Technopolis®, the Flemish Science Center, Mechelen, Belgium Pilot project "Interactive forensic science : Whodunit"	**www.technopolis.be**
Universeum, Gothenburg, and **Teknikens Hus**, Luleå, Sweden Pilot project "Learning for a sustainable society"	**www.universeum.se www.teknikenshus.se**
Ellinogermaniki Agogi, Athens, Greece Pilot project "The virtual observatory"	**www.ellinogermaniki.gr**
European Schoolnet, Brussels, Belgium Development of Xplora	**www.eun.org**
Università degli Studi di Napoli "Federico II", Naples, Italy Evaluation and analysis of Pilot Projects	**www.unina.it**
King's College London, UK Evaluation and analysis of Pilot Projects	**www.kcl.ac.uk**
Agenzia per lo Sviluppo dell'Autonomia Scolastica (ex-Indire), Florence, Italy Development of e-learning teacher training courses	**www.agenziascuola.it**

Lasting networks of science teachers

Pencil developed science centres' and museums' existing local and national networks of science teachers, and brought them together, as an online European network, through Xplora. This network was enriched throughout the project with teachers and professionals from across Europe. Two European Science Teachers Conferences were held in the framework of the **Pencil** project: the first at CERN in Geneva, Switzerland, in June 2005; the second at Technopolis, Mechelen, Belgium, in June 2006.

These Conferences gave concrete examples of best practice from the 14 pilot projects, with pragmatic guidelines for teachers on the following key areas:

- **The introduction of new topics in science;**
- **New approaches to teaching and learning traditional subjects; and**
- **Building relationships between schools and science centres and museums.**

"This is a great resource, full of ideas"

A primary school teacher, Pencil Science Teachers Conference

"The methods used are truly hands-on, brains-on"

A science centre professional, Pencil Science Teachers Conference

"Xplora is a way to keep science teaching up-to-date with technological and sociological change"

A teacher, Pencil Science Teachers Conference

Making it work: 18 factors for success

The 14 **Pencil** pilot projects represent the breadth of contemporary practice in museum and science centre partnerships with schools across Europe and in Israel. In building such partnerships, the projects have explored new ways of working, developed innovative approaches and have, as a result, enhanced the teaching and learning of science and mathematics in their own local contexts. The lessons learned during the projects' lifetimes have a direct relevance to science and mathematics education in schools.

The 14 projects are documented as case studies, wherein the processes and outcomes of project activities are described across eight parameters or dimensions of analysis. The case study conclusions identify key factors responsible for the success of the projects and areas for improvement. These factors are summarised on the following pages.

These key factors promoting the success of **Pencil** pilot projects are taken from the **Pencil** report *Assessment of Pilot Projects* by King's College London and Università degli Studi di Napoli "Federico II" which can be found on **www.xplora.org/pencil**. These factors can be clustered into three sets: building on, or adding to, institutional capital; supporting partnerships; and, theoretical framework.

FACTORS FOR SUCCESS

1. BUILDING ON, OR ADDING TO, INSTITUTIONAL CAPITAL

>

Whilst not sufficient to guarantee the success of a collaborative project between science centres/museum and schools, certain forms of institutional support are necessary for building a strong project framework. For example, the support of management (within the museum/science centre, or school/local authority) can help to facilitate the active participation of individuals, thus also promoting their commitment. Building on the established expertise of an institution, meanwhile, provides advantages in terms of capitalising on an existing infrastructure, gaining access to resources, and utilising tried and tested communicative approach.

Also included in this cluster are those factors that help to embed effective project practices thus ensuring longevity. For example, projects that support the professional development of staff may help to ensure that the practices tested and refined by the projects are sustained in subsequent years.

Institutional factors for success	Exemplar pilot projects
1. Project builds on established expertise of the informal institution or school	*IMSS* *Experimentarium*
2. Project builds on the high profile/ reputation of the informal institution as viewed through the eyes of teachers	*NEMO* *Heureka*
3. Project is supported by high levels of internal support	*Technopolis* *Explor@dome*
4. Project builds on an existing programme which is already supported by an institutional infrastructure	*Explor@dome* *Heureka*
5. Project develops a working practice which could be readily transferred to other topics – ensuring audiences/interests in future years	*Technopolis* *Cité de l'espace*
6. Project provides professional development to informal institution staff and/or teachers	*Ciência Viva*
7. Project enjoys the support of external organisations such as professional teaching associations, or local teaching administrations	*NMA* *Ciência Viva* *Explor@dome*

FACTORS FOR SUCCESS
2. SUPPORTING PARTNERSHIPS

>

The second set of factors refers to issues relating to the ways in which the museums/science centre partnership with schools is developed and fostered. These factors include the importance of involving teachers in the development of projects, and working to ensure that the skills and expertise of both sides of the partnership are respected, establishing and sustaining strong relationships.

In addition to working with teachers, engaging students in the design of the project, or targeting students directly (rather than providing resources for teachers to use) can serve to enhance student motivation and thus help to ensure that the project achieves a positive effect.

Finally, projects that seek to support particular aspects of the curriculum are more likely to be successful than projects that offer resources surplus to or unconnected to curriculum requirements.

	Institutional factors for success	Exemplar pilot projects
8.	Teachers involved in the development of the project from the outset	*IDIS-Città della Scienza* *Bloomfield Science Museum*
9.	Project involves building a strong relationship with schools	*Universeum – Teknikens Hus* *Deutsches Museum* *Experimentarium*
10.	Students involved in the design of the project	*NMA* *Experimentarium* *Deutsches Museum*
11.	Project offers museum/science centre staff an opportunity to understand the practices of teachers (including the constraints under which they work)	*Ciência Viva*
12.	Project supports curriculum	*Ellinogermaniki Agogi* *NEMO* *Heureka*

3. THEORETICAL FRAMEWORK

>

The third set of factors highlights the necessity of a strong theoretical and practical framework to ensure the success of a project.

The project framework needs to be supported by both an understanding and application of current theories of teaching and learning, and the use of evaluation processes to provide a mechanism for reflection. As such, factors for success include active engagement with theory, and working in partnership with academics. This cluster also notes the significance of sharing good practice with other institutions in order to enhance the impact of project initiatives.

Institutional factors for success	Exemplar pilot projects
13. Project is based on a sound understanding of theories of learning and teaching of science and technology	*Experimentarium* *NEMO* *Deutsches Museum*
14. Project benefits from working closely with academic partners	*Cité de l'espace* *IDIS-Città della Scienza*
15. Project uses an evaluation protocol that examines the needs, outcomes and the processes of learning and teaching using both qualitative and quantitative methods	*Bloomfield Science Museum* *Deutsches Museum*
16. Project involves an outreach component thus spreading the reach of the initiative still further	*Bloomfield Science Museum* *IMSS* *Heureka* *Ellinogermaniki Agogi*
17. Project staff mediate the communication between practicing scientists and science teachers	*Bloomfield Science Museum* *Universeum - Teknikens Hus*
18. Project develops cross curriculum links thus supporting students to make connections and construct meaning	*Universeum - Teknikens Hus*

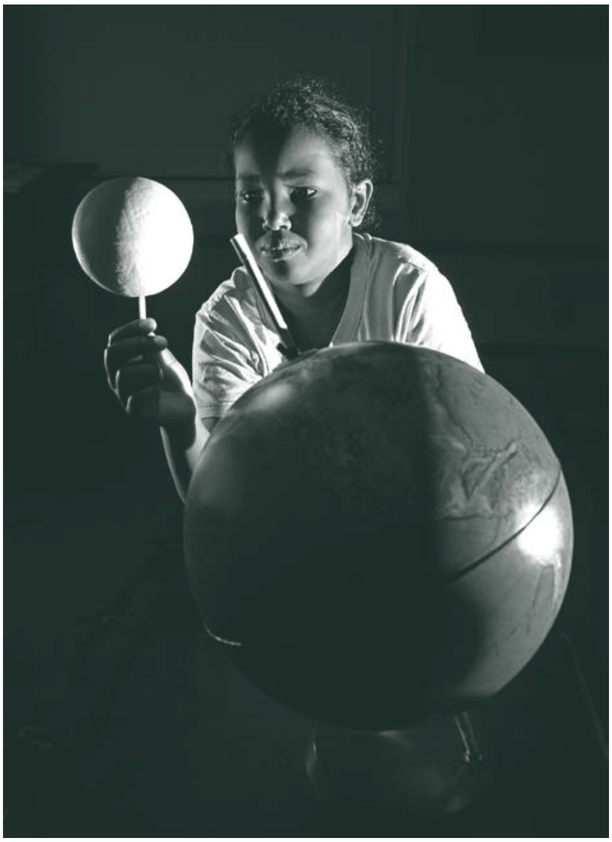
Pencil key findings:

Criteria of Quality and Innovation

Motivation study

Boys learning, girls learning: Interpretation of gender differences

Elements of evaluation



Cité de l'Espace
Toulouse, France

Pilot project
"Future technologies"

The **Pencil** consortium included academic partners whose role included the evaluation of the pilot projects and in-depth analysis of the results. The outcome is a set of reports, available on **www.xplora.org/pencil**, which document these findings.

In this brochure, we present an abridged version of the Criteria of Quality and Innovation, which outlines the eight indicators defined by **Pencil**. We outline the results of the Motivation Study, which looked at the motivating effects of science centre and museum visits, and present further reports on evaluation and gender which are available on Xplora.

For the complete version of this document, including the full set of references, please see www.xplora.org/pencil

Criteria of Quality and Innovation

Science centres and museums, together with the schools with whom they partner, are keen to improve the ways in which they support science learning and teaching. Staff from informal science institutions seek to enhance their day-to-day practice and design of programmes and exhibits, whilst teachers continually look for ways to enhance their delivery of the curriculum. By working in partnership, museums / science centres and schools have the opportunity to address such objectives, and it is to this end that a set of criteria for assessing the quality of joint activities is offered.

The criteria produced as part of **Pencil** are derived from the assessment of the 14 pilot projects. As such, they build on the experiences of a wide range of contemporary European and Israeli initiatives, each with different issues, context and problems. The broad criteria are exemplified by sets of indicators against which projects may measure their progress towards developing quality practices.

Each criterion with its constituent indicators addresses a particular aspect of practice. However, when taken together, these criteria offer a framework for innovative or best practice for projects aiming to support science learning and teaching at the intersection between formal and informal learning contexts. The criteria can thus be considered a set of 'tools' for shaping the design of future projects.

Teachers are involved in the design phase of museum / science centre education projects aimed at schools

criterion **01**

Teachers' involvement in the design phase of educational projects emerges as a crucial criterion of quality when considering the development of a successful partnership between schools and a museum/science centre.

In working in partnership, teachers are able to communicate their needs, share their expertise, and plan how the experience will integrate within their wider curriculum requirements. Such levels of involvement enhance the motivation of teachers. Museum / science centre staff, meanwhile, benefit from the curriculum knowledge of teachers, advice regarding practical issues, and the collegiality that such partnerships provide when facing new challenges and creating new educational ventures.

In summary, a fruitful partnership starts by building consensus and promoting a positive perception of the project from the outset. Working with teachers in the design phase of a project allows strong partnerships to develop resulting in highly effective project outcomes.

SUCCESS IN CRITERION 01 MAY BE JUDGED USING THE FOLLOWING INDICATORS :

Museum / science centre staff commit time and resources to recruiting partner teachers.

—

Museum / science centre staff work closely with teachers to ascertain their needs, requirements and expectations.

—

Front-end evaluation tools are used as a systematic way to collect teachers' views.

—

Discussions about pedagogy form an important part of project planning.

—

The professional development of teachers is an explicit goal of the partnership.

Evaluation forms an integral part of the educational project

criterion **02**

From planning and project design, to implementation and the reporting of results, evaluation processes are essential for ensuring the success, and continuing enhancement of educational projects linking museums/ science centres and schools.

Both formative and summative evaluation processes help to ascertain teachers' needs, leading to better understandings of what kinds of learning should be fostered. In employing these processes, informal institution educators have the opportunity to reflect upon their practice and disseminate their results with greater clarity.

Evaluation processes also provide a line of reasoning, or mechanism by which to improve communication between museum / science centre staff and teachers, and with external partners such as university academics or expert scientists. At the same time, evaluation processes also constitute a source of evidence for making decisions about areas for improvement, future partnerships and target audiences.

In addition, they can inform museum / science centre staff on how to better allocate human resources and money for future projects.

Contemporary understandings about learning and facilitation techniques are incorporated into projects

SUCCESS IN CRITERION 02
MAY BE JUDGED USING
THE FOLLOWING INDICATORS :

Regular reflection on use of tools, and on advice from experts in evaluation.

—

Barriers to success are communicated in evaluation reports alongside achievements.

—

Project budgets are strategically apportioned to evaluation.

—

Evaluation results from across the field of science learning are shared.

criterion **03**

In developing joint educational projects, both teachers and informal institution staff need to consider how best to foster students' opportunities to learn. Such opportunities require an understanding about different modes of learning and facilitation techniques, clear ideas about the science which underpins the initiative, and a knowledge of the ways in which the science content may be linked to the curriculum.

In responding to this challenge, museum and science centre staff build on their knowledge of how the institution's objects or exhibits may enhance students' experiences, whilst teachers rely on their understanding of curriculum links and the abilities of the student group.

When successfully working together, both partners bring their respective areas of expertise to develop an enriched programme of activities and pedagogical actions in order to best facilitate student learning.

SUCCESS IN CRITERION 03
MAY BE JUDGED USING
THE FOLLOWING INDICATORS :

Approaches to teaching and learning employed by museum and science centre educators complement those used at schools.

—

A range of facilitation techniques are employed by museum / science centre staff and teachers.

—

Target content is combined with other topic areas.

Contemporary views about the nature and practice of science are promoted by projects

criterion **04**

Science is a specialised practice whereby people use evidence to construct, evaluate, communicate and reason about phenomena in the physical world.

To support students' learning of science, activities developed by museums and science centres in partnership with schools need to highlight both the practice of science and the way in which scientific knowledge develops.

SUCCESS IN CRITERION 04
MAY BE JUDGED USING
THE FOLLOWING INDICATORS :

The 'nature' of science forms a key part of the topic(s) addressed in the project.

—

Scientific content is contextualized : science is a human endeavour.

Changes in attitudes and motivation towards science are included in measures of efficacy alongside knowledge gain and levels of enjoyment

criterion **05**

Recent research studies have commented on the low popularity of school science across Europe (cf Jacobs and Simpkins, 2006). Museums and science centres offer resources and activities which could help to reverse this trend, by, for example, designing programmes which seek to enhance students' motivation towards science.

Museums and science centres also have a tradition of valuing the interest of learners rather than simply noting their performance (as is required by the formal education system).

Thus partnerships between museums / science centres and schools, can help to promote an approach whereby enhanced attitudes and general interest in the application of science are valued as much as increments in knowledge.

SUCCESS IN CRITERION 05
MAY BE JUDGED USING
THE FOLLOWING INDICATORS :

Interests of students are actively solicited when designing content of the project, or aspects of the activity.

—

The project aims to enhance attitudes towards, and interests in, science.

Impact of project is enhanced as a result of involvement with networks or communities

criterion **06**

Museums and science centres across Europe have long been committed to working in close partnerships with schools. Whilst some initiatives are publicised and shared more widely, many remain within individual institutions and isolated from the view of their professional peers. In this way, their potential audience is limited and so is the possibility to improve as result of peer's suggestions.

By participating in professional networks, however, the insights, and lessons learnt in one institution can be shared more broadly, and effective programmes can be replicated elsewhere.

In addition, by widening links with local communities, the impact of the original programme is extended to reach many new audiences supporting the enhancement of the initiative.

SUCCESS IN CRITERION 06
MAY BE JUDGED USING
THE FOLLOWING INDICATORS :

Museums / science centres are involved in professional networks.

—

Local networks comprising schools, education authorities, centres for higher education and informal institutions are established.

The initiative is sustainable

criterion **07**

The extent to which an educational project may be sustained in the long-term is an important factor for gaining the support, commitment and motivation of both teachers and informal educator staff. Whilst the availability of money and staff time inevitably impacts upon the sustainability of any venture, other components in a project's design also play an important role.

For example, decisions about the target audience, or how aspects of the project may be transferred or repeated in other future initiatives affect a project's long-term success.

The sustainability of a project is also affected by the choice of activity, the topicality of content area chosen, and the degree to which new expertise is developed as a result of the programme. Both the informal institution and partner schools are in a position to affect these aspects and to make strategic decisions to foster the sustainability of a project.

SUCCESS IN CRITERION 07
MAY BE JUDGED USING
THE FOLLOWING INDICATORS :

Lessons learnt during one project are applied to other projects.

—

New audiences are reached.

—

New expertise is fostered by the project.

—

Core/high impact areas are addressed by the project.

—

Opportunities to extend the initiative beyond the initial funding period are researched and fostered.

—

External funding is received.

Issues of social inclusion and gender equity are addressed by the project

criterion **08**

SUCCESS IN CRITERION 07
MAY BE JUDGED USING
THE FOLLOWING INDICATORS :

As publicly funded institutions, museums and science centres have a responsibility to serve all members of the local public. Traditionally, museums were the preserve of the middle and upper classes, and visitors from immigrant communities or less wealthy neighbourhoods were rare. The image of science that such museums presented was one of authority and elitism. The original science centres, on the other hand, were designed to present science as a democratic and universal pursuit, and hoped to welcome individuals from all parts of the community.

Today, both museums and science centres share a common commitment of supporting the public's intellectual access to their programmes. Many informal institutions have also made considerable efforts to facilitate the physical access of visitors creating large text panels for the visually impaired, building lifts, ramps or widening doorways for the mobility-impaired and so on. Whilst such efforts are to be applauded, it is relevant to note that the social class of the majority of visitors to such institutions has not changed (Arts Council England, 2007 : MORI, 2001)

Museums and science centres, together with schools need to actively address the imbalance. They need to consider ways of engaging or serving new audiences, and responding to the needs of all learners.

Target audiences are selected with deliberate reference to issues of social inclusion and equity.

—

Methods of learning and teaching should reflect contemporary views with respect to equity and inclusion.

—

Evaluation strategy seeks to capture issues relating to social inclusion, equity and gender differences.

—

Project findings and insights are shared broadly across a range of dissemination channels.

For the complete version
of this document,
including the full set of references,
please see www.xplora.org/pencil

Do Pencil activities benefit learning? Motivation study

The aims of science centres and museums include advancing the public understanding of science, creating positive attitudes towards science and technology, encouraging – especially – young people to learn science and take up careers in science and technology, and maximising the opportunities in society for scientific applications. How much evidence do we have to show that these main goals are realised in the everyday functions of a science centre? Everyday experience suggests that these pragmatic outcomes can be achieved.

The **Pencil** Motivation Study was run in four of the **Pencil** pilot projects: The National Marine Aquarium, Plymouth, UK; Ellinogermaniki Agogi, Athens, Greece; Cité de l'espace, Toulouse, France and Heureka, the Finnish Science Centre, Vantaa, Finland. It investigated the following questions:

1. What is the motivational background of students visiting the science centre exhibition?
2. How do science centre/museum visits affect the motivation of students?
3. Do well-planned visits to a science centre/museum create deep or superficial learning strategies for the students?
4. Is there a difference in the motivational patterns of the students according to their school success?
5. Are results of the gender differences in learning similar in school and in science centre/museum learning?

The conclusions drawn from the four case studies are based on clear results: in all the four countries, the academic success in school, according to the teachers grades, and the results measured by the independent Visual and Cognitive Reasoning Ability test (RAVEN) showed a clear, statistically significant ($p < .05$) correlation. This was important for the reliability and validity of the survey.

1. The importance of preparation: Preparing properly for the visit at school beforehand turned out to be the key element both for the motivation and cognitive knowledge learning.

2. Main effects in motivation: All the pupils demonstrated strong situational motivation during their science centre/museum visits, but the best results were received among the pupils that also had the pre-lesson before the visit.

3. Lessons before and after: The cognitive and knowledge learning of the pupils visiting the science centre/museum was only slightly better than the comparison group at school classroom or by similar web-based activities. However, the cognitive learning results related to chemistry became much better only if the pupils had a pre- and post-lesson at school.

4. Motivation and ability: Pupils who manage well at school feel more positive than the others about classroom science education. However, science centres seem to give new challenges also for "non-academically-orientated" students, who can utilise their personal learning strategies. The results especially in Greece and Finland showed that the pupils who were below average in their school success experienced the visit as a meaningful learning experience the most.

5. Gender effects: The girls had stronger intrinsic motivation, and the boys had higher level in instrumental motivation (with exception the results in UK).

Can we take advantage of the motivating effects of science centres/museums? Several informal learning institutes in Europe are facing this question. The main challenge is for the educational programmes of the science centres to convert the strong situational motivation into real interest in science as an intrinsic motivation. Hands-on materials, in sessions before and after the visit, are the key tools in this process both for cognitive knowledge learning and motivation. Only intrinsic motivation combined with deep-learning strategy can lead to long-term learning results.

For the complete version
of this document,
including the full set of references,
please see www.xplora.org/pencil

Boys learning, girls learning: Interpretation of gender differences

This report, available on Xplora, presents the results achieved in the framework of **Pencil** for what concerns identifying and dealing with gender difference in science learning. The gender difference issue was transversal to all the **Pencil** Pilot Projects and all of them were asked to keep track of gender when performing their internal evaluation studies. The findings, and the results of a subsequent general analysis, give some final recommendations aimed at informing future efforts in developing educational programmes which could succeed in seeing gender differences as an enrichment rather than a barrier to science teaching and learning.

Elements of evaluation

This report, available on Xplora, presents a series of findings emerging from the experiences gathered by **Pencil**'s 14 pilot projects in carrying out educational programmes at the intersection between formal and informal learning environments and methodologies. For each finding, evaluators propose a recommendation by which future projects may build upon lessons learned throughout **Pencil**.
The data sources include interviews conducted during two evaluation visits to each pilot project, online chats, discussion groups and pilot project internal evaluation reports. Findings and recommendations fall into eight categories covering aspects of interest in the pilot project, including relationships between key players involved in the projects, models and practice of teaching and learning adopted, use of evaluation tools and emphasis on issues of gender equity and social justice.

Heureka,
the Finnish Science Center
Vantaa, Finland

Pilot project
"Chemistry for primary schools"

Ellinogermaniki Agogi
Athens, Greece

Pilot project
"The virtual observatory"

Resources for teachers and educators :

www.xplora.org

E-learning teacher training courses

Easy access to these resources

Pencil : an integrated project

www.xplora.org

Xplora, the European Science Education Gateway was developed within the framework of the **Pencil** project and launched on 10 June 2005 during the Ecsite Annual Conference in Vantaa, Finland. Its services are focused on serving teachers of science, as a resource to stimulate compelling, innovative teaching, to raise interest in science acting and scientific careers among young people. Run, maintained and continually developed by European Schoolnet, the Xplora gateway itself offers activities, tools, resources, background articles and other teaching material. It has a team of teachers from across Europe, representing the users of Xplora, who develop material, disseminate it in their regions and continue the evolution of the gateway.

The portal itself is multilingual, with the site translated into English, French and German, and a much greater variety of languages reflected in its content. There is no limit on the amount of content a user may upload.

THE PORTAL PROVIDES SERVICES FOR VISITORS TO :

- **Read science education news, pedagogical tips and ideas for teachers**
- **Participate in the teacher training e-learning courses developed as part of Pencil**
- **Download content for a DVD called Xplora-Knoppix, with software for science education**
- **Search the database of websites and digital learning resources for science education**
- **Register to use tools for creating online communities and join online discussions**
- **Get insight into innovative practical science approaches and projects**
- **Obtain guidance on freely available Open Source tools for science education**
- **Find out about the Pencil and Nucleus projects that support the Xplora portal**

XPLORA CONTENT AT THE END OF THE PENCIL PROJECT

These figures apply only to the core languages of the portal: English, French and German. A significant number of resources have also been added in non-core languages but are not counted here.

Number of resources available in the Xplora resource database in English	**1189**
Number of resources available in the Xplora -resource database in French	**612**
Number of resources available in the Xplora resource database in German	**634**
Total number of resources available in these three languages	**2435**
Number of users in the community after the three years of the project	**4885**

e-Learning teacher training courses

Pencil created a set of e-learning courses for the Xplora community where the formal dimension complements the informal one perfectly, emphasising the qualities and features of both. The findings of the **Pencil** pilot projects were used to develop a solid system of teaching and learning. The results are currently online at **http://moodle.eun.org** and also accessible through the Xplora portal **www.xplora.org**.

The teacher training model is that of blended e-learning, where one part of the activity of the trainees takes place on site; the other part online, on technological platforms. The training contents involve not only theoretical learning, but play a significant role in everyday teaching activity with students.

The teacher training platform provides customisable education paths. Every learner, based on his/her educational needs, creates his/her own path choosing certain contents instead of others. This is made possible by the modularity of training packages. The training concentrates on methods and innovative approaches, rather than on single disciplinary contents. This helps to introduce these interest centres outside the Pilot projects.

The course also supports the idea of community, integrating with the Xplora portal. The peculiarity consists in focusing the discussion on methodological contents and on the sharing of experiences, in order to allow the development of communities with a collaborative approach.

These training courses are organised across four thematic areas:

1. **Experimental science**
2. **Science and society**
3. **Mathematics**
4. **Complex systems**

The training environment consists of modules that are focused on thematic areas. Each module presents:

- **Training materials and activities**
- **Communication tools**
- **Sharing tools**

The e-learning course makes use of a "learning by doing" approach where teachers are able to "do", in addition to developing their theoretical knowledge. The focus is on education contents intended to highlight and support the project dimension of teaching.

Easy access to these resources

The Xplora team developed a live bootable DVD – called Xplora-Knoppix, completely contained on a self booting DVD. This Knoppix version was especially mastered for Xplora and contains software applications focused on science education, as well as a number of educational materials from the Xplora repository. As it is open source software it can be given away freely and be copied as well. The Xplora – Knoppix release 2.0 has multilingual support – English, French, and German. The content is freely downloadable from www.xplora.org.

In order to allow the use of an LMS with Xplora's Moodle courses even without installing the software, Xplora has extended the Xplora-Knoppix concept to the MOUSE (Moodle On USB Stick Environment) concept. For the latter, a bootable USB memory stick - containing Knoppix and Moodle - starts when inserted before the computer's booting process.

Students are thus able to work within this environment on any type of computer system. At the end of the electronic lesson, the teacher closes the Moodle course and removes the USB memory stick from the computer. At home, the teacher can evaluate the students' work on any personal computer, booting from the USB memory stick in the same way as at school.

This MOUSE concept overcomes the most common obstacles using electronic courses in the classroom by a set of important features:

- **Content based on curricular needs**
- **Easy-to-use technology**
- **Content adjustable to the teacher's individual course profile with a minimum of work**
- **The ability to hide unneeded content**
- **Connecting teacher and students**
- **Running in any computer environment without configuration**
- **Content presented within the computer network, not to the outside world**

The eCourse on the MOUSE is fully adaptable to the teachers needs.

Pencil – an integrated project

Pencil was part of Nucleus, a cluster of EU projects funded by the European Commission's Directorate General for Research, as part of the European Science Education Initiative. The cluster also includes the following projects, whose findings complement the **Pencil** outcomes.

Cinema and Science (CISCI)

www.cisci.net

CISCI combined the two most popular media among youngsters, namely movies and the internet, aiming to raise the attractiveness of science while dispelling widely-spread misconceptions that arise from pseudo-science.

Volvox

www.eurovolvox.org

The Volvox network provides teachers with authoritative briefings, proven laboratory protocols, classroom activities addressing the social impact of bioscience, accounts of the careers of young scientists and numerous other educational resources to help motivate them and their students.

European Science Teaching Initiative (ESTI)

www.science-on-stage.net
www.scienceinschool.org
www.eurovolvox.org

Coordinated by the EIROforum, ESTI combined three elements: Science on Stage (SOS), a Journal of European Science Teaching (Science in School) and the Volvox network for biosciences.

Scienceduc

www.etwinning.net/ww/en/pub/xplora/nucleus_home/scienceduc.htm

Scienceduc aimed at renovating science education in elementary schools through the establishment of a network, allowing exchanges and enhancing the development of good practices: teacher's training, evaluation, on line project and dissemination.

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