Project no. 511165

Permanent EuropeaN resource Centre for Informal Learning

Structuring the European Research Area

Science & Society – European Science Education Initiative

Specific Support Actions

D26: TEACHER TRAINING DESIGN
WP25: TEACHER TRAINING

Due date of deliverable: M36
Actual submission date: M36

Start date of project: **October 2004** Duration: **36 months**

Project coordinator: **Catherine Franche, Ecsite** **Final**

Table of Contents

1 Foreword

This deliverable describes the web-based e-learning course developed for teachers from the findings of the Pencil project, currently online at http://moodle.eun.org and accessible through the Xplora portal www.xplora.org.

Indire, L'Agenzia Nazionale per lo Sviluppo dell'Autonomia Scolastica has, for some years, been the institution where the school and those who go there – teachers, pupils and families – can count on being able to experiment, share and grow together in a spirit of innovation and research. Since 2001 it develops and manages integrated online training environments used by hundreds of thousands of Italian teachers. Founded in 2001 with the first on-line course involving newly-hired Italian educators (62,000 teachers), Puntoedu has made a name for itself as one of Europe's foremost e-learning methods thanks to the thousands who have enrolled in its courses.

The model which is typically used for teachers' training is a blended e-learning one, where part of the activity of the trainees takes place on site, the other part online, in technological platforms that are developed internally by our technicians. The training contents do not only involve a theoretical learning, but play a significant role in the every day teaching activity with students.

Indire's task under the Pencil project was to create an e-learning course for the Xplora community where the formal dimension matches the informal one perfectly, emphasizing on the qualities and features of both. Indire used the findings of the Pencil pilot projects to develop a solid system of teaching and learning.

2 Background

2.1 Context

Education is no longer an exclusively scholastic field, if it ever was. The "new school" has to face difficult tasks, which may interfere with the main goals of education. If no exact objectives are pinpointed, if no trial's limits are established, if no method strategies are set and no evaluation criteria are agreed upon, students may risk focusing too lightly on too many things simultaneously.

The web offers a wide library, which anyone can access when they choose, and with no time limit. The web basically is:

- a *social* resource for teachers and students;
- an *information* resource, to be managed with caution, in the hopes of making learning a creative experience.

The organizational culture scholar John Seely Brown believes that a serious scientific education project cannot rest solely upon the disciplinary knowledge achieved in classrooms and laboratories. According to this American thinker, knowledge has two dimensions, the *explicit* and the *silent* one.[1] The *explicit* is performed in class or laboratory and aims at teaching scientific contents, also through trial experiments. The *silent* dimension concerns the way in which knowledge is achieved. The *silent* knowledge is the most important part and the most likely to resist the test of time; it allows us to write, read, perform experiments, solve scientific enigmas, build educational objects and multimedia products. John Seely Brown considers the *iceberg* a perfect metaphor to clarify the difference between *explicit* knowledge (the external part of the iceberg, easily deteriorated) and *silent* knowledge (the internal larger part of the iceberg) which allows us to face and solve every-day problems and which consolidates and changes daily, mainly in an *informal* manner. The *formal* teaching of science and other school subjects favors the *explicit* part over the larger and more solid perception: the unspoken one. The Pencil project intends to promote informal learning and therefore focus more on *silent* knowledge. Experimental science bases its education features upon logic, critical thinking and creativity; it builds silent knowledge by facing troublesome situations.

Investigation and research start from the very questions students ask about specific phenomena. This way, importance is given to *formal* educational patterns regarding the central ideas of scientific disciplines, as the right mental habits are developed, e.g.:

- curiosity;
- the need to verify that information is reliable;
- the respect for disciplinary logic and critical thinking;

[1] Learning, Working & Playing in the Digital Age, a talk by John Seely Brown, Chief Scientist of Xerox Corporation and the Director of its Palo Alto Research Center (PARC), at the 1999 Conference on Higher Education of the American Association for Higher Education. http://serendip.brynmawr.edu/sci_edu/seelybrown/

- comparing premises with consequences;
- the respect for historical contributions;
- the attention for accuracy and precision in methods, in the respect of security regulations;
- patience, caution and perseverance.

What are the development lines of a modern *informal* scientific training, as suggested by Pencil's several projects? For the Pencil teacher training courses, Indire considered the following as the aims in terms of informal learning:

1. Students are able to choose the topics to link to formal education; they host trial experiments and verify logic conclusions;
2. Students create educational interactive objects;
3. Evaluation criteria for informal education is multiple and based on questionnaires, charts, interviews and *focus groups*;
4. The history of scientific thinking must be made relevant for educational purposes;
5. Multimedia products, available or created by students, are available to the entire education community;
6. Information technology becomes the main connection ring with experimental schools allowing to exchange materials and interact *online*;
7. Students design and orchestrate exhibit centres similar to museums at school; they learn to both build the many educational objects of the museum and allow other students to use their exhibit product;
8. Dialogue planning (of experiments, charts or educational objects) among peers, with teachers and museum experts implying the use of all basic knowledge;
9. Teachers and students learn together;
10. The social dimension of learning is also encouraged to create, through the web, a strong sense of community.

These aims are essential notions in the development of the e-learning course for teachers.

2.2 Learning through museums: informal education and the Pencil project

One of the features of the pilot projects of Pencil is the collaboration between schools and science museums. Following are some of the crucial topics that need to be discussed in the training of teachers:

- how schools can be open to outside suggestions considering the pedagogical features of museum proposals, generally known as *informal education*:

- how schools can integrate *informal education* propositions in their training path.

The following is a brief overview of the training mission that museums wish to pursue.

2.2.1 To experiment, explore, discover: specific learning experience in museums

While in a traditional school context, learning is defined through memorizing notions, improving vocabulary, learning formal issues, following rules, etc., which all takes place by transferring teachers' knowledge on to students; in a museum, learning is explained in different terms.

Let us consider the declaration of Richard Gregory, British perceptionist and founder of one of the first European science centres, the Exploratory of Bristol, today At-Bristol:

> *"Most of us, as adults, cannot answer the simplest questions of science, or of how things work, though children continually experiment, while playing. They learn a wonderful lot in a very few years including, miraculously, language. But generally this learning slows and almost stops at adolescence, when for many people curiosity is dulled. Why this is so is mysterious – and of course it does not apply to everyone. How many of us, though, know how the most familiar gadgets work? For example, how their front door key turns the lock - and only with their key and not thousands of others looking almost the same. Ways of making locks recognise particular keys is a technology known to the Romans; (...) they embody principles of nature combined by human intelligence to solve our problem. Largely unnoticed, they are our richest inheritance. (...) But to see how it works, it may be necessary to open the lock and play with it, and take it to pieces.*
>
> *This is the essential point of the hands-on interactive approach to presenting science and technology in the Exploratory – to continue children's exploration of the world and themselves into adult life so that the adventure of discovering never ceases."*[2]

The key ingredients to contemporary museum pedagogy are: allowing the public to *freely* explore the world (as exposed, highlighted, symbolized, emulated or condensed) following their own wishes and curiosity, just as children do while they play and simultaneously discover reality. It is all about helping adults discover the pleasure of exploring, which they lost as the years went by; they must possess a mental boost for learning, instead of absorbing a series of predefined notions/information.

This is something that can be said for all types of museums (including art-history museums); certain contemporary museums, such as *science centres* were designed and set to allow and stimulate a free and explorative learning potential. This way, new interactive centres, (born at the start of the seventies), introducing their training philosophy, can replace schools or museums and substitute the communication of the most traditional science, the *top-down* discipline.

> *"Museums usually house static displays to be admired from a distance. Even natural history collections, the primary contents of science museums, tend to require only a passive and reverential appreciation of the odd and various specimens someone has painstakingly assembled. Such exhibits can strike wonder at the right diversity*

[2] Richard Gregory, *Why are hands-on science centers needed?* The Exploratory Interactive Science Centre, Plan for Action, 1983

> *of the universe, but they tend also to encourage awe for the brilliance of the few adults who have been able to unravel its complexity. Science museums often glorify scientists more that they teach museumgoers the practice of science. Visitors are invited to admire the accomplishments of others, but not always to think that they might go and do likewise.*
>
> *The proposal that Oppenheimer brought (to San Francisco) was for a museum in which people would directly experience and manipulate things, instead of being told about them. The public was to interact with objects as an experimental scientist does in the natural world or in the laboratory. The museum was to teach that the subject matter of science is all around us and that its comprehension is available to all. It was to remove science from the exclusive domain of experts, to demystify it, and to restore it to the common sphere. It was to convince people that doing science can be interesting and fun for everyone."*[3]

The freedom of path, the personal decision to focus on a specific exhibit station because of an individual way of being: these are not simply optional but grounded features of the museum experience.

In view of an exploration of the outside world, *manual* and *laboratory* qualities are crucial. From *exhibit hands-on*, which are experimental exhibit gears where visitors can freely explore a phenomenon, to the many *workshops* and education laboratories offered to students, the museum fully concentrates on specific parts of the learning experience which is taken under strong consideration in the Pencil course.

- The visitor is the *key player of learning*, which is free in the process and has no univocal *outputs,* rather open ones.

- *Perception and sensorial experiences* are not a minor form of learning (e.g. compared to the lexical form) - they represent essential experiences, building other "theoretical" abilities such as inductive reasoning, the ability to formulate hypothesis and verify contexts, etc.

2.2.2 A classic distinction: formal and informal education

This museum pedagogy can be considered within the context of the so-called *informal education*. Two different educational environments with different features can be distinguished: *formal education* which takes place in teaching facilities, e.g. schools and universities, and *informal education*, allowing to learn processes in settings like museums, where there is no specific institutional purpose and where education happens almost as a side-effect.

The traditional distinction between the two contexts is exposed in Chart 1 and is taken from a classic article by Stephen Bitgood[4]. While some of the distinctive features of both

---

[3] Hilda Hein, *The Exploratorium: The Museum as Laboratory*, Washington DC: Smithsonian Institution Press, 1990.

[4] Stephen Bitgood, *A comparison of formal and informal learning*, Technical Report N. 88-10, Centre for Social Design, Jacksonville AL Nov. 1988. For a most recent classification, see: Enrico Miotto*, Museum and Schools; The Case of the National Museum of Science and Technology "Leonardo da Vinci" of Milan*, in: Maria

learning areas are less exclusive than could have been imagined at the beginning of the work on the Pencil teacher training course (even a "good" school encourages team work and has several types of fundamental stimulations - visual, tactile, experimental practice, etc.), one difference is crucial: a good *formal* education includes verbalized, analytically explored, clearly structured notions. Other components can also be included, e.g. motivation), whereas the key output to *informal* education is *emotional* and it concerns motivation, interest, involvement, and the discovery/rediscovery of capabilities and skills (notions and information can obviously be simultaneously absorbed.

Recently both contexts, *formal* and *informal*, are discussed not as two institutional groups with their main education purposes, but as two types of settings, which can be located in the same institution: a school can also present informal education situations.

With regards to undisciplined visitors, their freedom of movement (chaotic or even frantic!) is not the negative effect of the exhibit/amusement park, but represents a key ingredient of the learning experience not only known as *informal* (or *non-formal*) education, but also as free-choice learning:

"The terms "informal" and "non-formal" refer to learning situations, contrasted with the formal school classroom or the workplace, in which the learners are

- *encouraged to move freely around the learning environment, which is generally full of stimuli of many kinds – physical, three dimensional, and audiovisual*
- *dependent only to a limited extent on listening to or reading verbal messages*
- *free from disciplinary constraints applied by a classroom teacher, though remaining under a degree of social control*
- *allowed to make their own decisions about their route and pace of learning*
- *frequently working together in peer group or family units to develop their experience, knowledge and understanding"*[5]*.*

This free-choice learning, which mainly takes place outside classrooms, is also being increasingly considered inside schools, since information, habits and attitudes brought on by *mass-media* (among friends, families, etc.) become often (always?) more important than what learners are offered by traditional teaching. Based also on the extra-curricular world, which has a very strong emotional and cognitive impact, schools are increasingly encouraged to use external resources.

Xanthoudaki (ed), *Teaching science and technology with museums,* Foundation of the National Museum of Science and Technology "Leonardo da Vinci", Milan 2002.

[5] Colin Johnson, *Science centers as learning environments*, Online resources of the America Association of Technology and Science Centers, http://www.astcs.org/resource/education/jhonson_scicentres.html

Chart 1: Differences between formal and informal education

ASPECTS	FORMAL EDUCATION	INFORMAL EDUCATION
Type of stimulation	Texts Dialogues Demonstrations Experiments (few)	In museums: Texts Dialogues Experiments (many) Objects Multimedia
Environment	In practice always the same: the classroom	Steadily different environments
Attitude	Predetermined attitudes: (interrogation, explanation, test...)	Free movements Undetermined free attitude
Social relationships	Limited social environment (no family, no outsiders); Learning as a personal experience; Internal hierarchical relationships	Relations between people of different ages, without hierarchical patterns; Family, friends
Learning consequences	Strengthening and "punishments" Qualifications Life choices	Non-predictable consequences - pleasure, fun, updates, Motivation to continue
Objectives	Pre-determined programs Highlight on quantity	Focus on the quality of experiences Fun, stimulation
Type of knowledge achieved	Verbal, analytical, structured	Attitudes (curiosity, ability to make assumptions, to observe…) Information

3 Objectives of the e-learning course

3.1 Knowledge, capabilities and skills to be developed in teachers

Training for teachers needs to have a diverse series of education strategies which teachers create and exchange over the internet, developing abilities and skills, e.g.:

- Studying *experimental paths*, which need direct attention from teachers and/or students investigating objects and phenomena (laboratory experiments, classroom demonstrations, building educational and multimedia objects, virtual laboratories, use of simulation and animation tools, science museum multimedia products);
- Planning teaching modules using all types of languages (oral, visual, cineaesthetic).
- Encouraging *online discussion* of the community on the activities studied by individual teachers or groups of teachers.
- Planning and propagating *learning objects* (see below), experiments, *problem–solving*;
- Planning and propagating *evaluation rehearsal* and expert *conceptual maps*.

Learning Object (LO) is a term which refers to an educational object. Digital resources are dealt with, built from experimental situations, which represent a great support in the teaching-learning process. Educational objects have specific training goals and include evaluation criteria to verify their learning effectiveness.

The LOs in the e-learning course have been built to stimulate curiosity and interest. Main opportunities to produce a LO are: guided research, project experiments, class demonstrations, *problem-solving*, case studying, animation and simulation activity, building of conceptual maps, evaluation tests.

At the end of an educational action, a LO archive is at everyone's disposal. It is created in collaboration with the virtual community.

In the specific development of the e-learning teacher training courses for the Pencil project, three aspects have been taken into consideration:

1. The LO needs to be built in collaboration with the persons in charge of the Pilot Projects of Science Museums;
2. The LO needs to be sufficiently concrete in order to be inserted into easily accessible *metadata*;
3. Through this collaborative building of LO, the right coordination between formal and informal education can take place.

Language is simple and accurate. For each educational object, text organization, insertion of images and audio/video features are described in detail. The interaction between different channels (image, text, sound) creates a new language which can be studied to verify exactly how effective it is.

An important aspect of planning and developing an educational object is ensuring what has been learned, by both the actor and the coordinator of the education process.

An evaluation tool may be planned in several ways, based on the course being self-instructed or learned through collaboration.

The most simple evaluation tests are the ones with automatic correction: formative, summary, self-evaluative tests, questionnaires, expert conceptual maps.

Products created can be sent to a tutor, an educational expert, but can also be discussed and compared with colleagues through a self-evaluation dynamic.

Problem Solving and case studies have a positive effect on motivation needed to solve science enigmas. Other factors are in favour of this educational strategy, which is promoted by the OCSE – PISA evaluation project (Programme for International Student Assessment - www.pisa.oecd.org). Which goals do problem-solving and case studies achieve?

- Improve ability to solve real problems;
- Enable cognitive processes, e.g. reading and understanding the problem, while critically analyzing its solution;
- Enrich disciplinary and communication abilities;
- Improve analytical, quantitative and analogical thinking capabilities;
- Consolidate the skill to create charts, graphics and to collect data.

Certain teachers watching the work of scientists believe science is based more on "doing" than on "describing". Researchers have diverse opinions: some claim that science cannot be "done" without a communication and final explanation of the scientific event. Responsible teachers are cautious when they link manual activities to communicative aspects. This is a highly productive and compelling procedure which the Pencil project encourages, always keeping under consideration the PISA evaluation project.

3.2 Knowledge, capabilities and skills to be developed in students

Pedagogy for the student has little to do with the differences among students themselves but rather aims at building a new culture, surpassing the simple reality of classes and studies.

To improve learning abilities, one can act upon 5 parameters:

- On the student's learning ability;
- On basic knowledge;
- On strategies students possess to solve issues, in order to enrich and correct them if necessary;
- On meta-cognition, that is to say on tools (e.g. the building of conceptual or collective maps) to consolidate what they learned weighing in what they already knew;
- On the motivation needed to successfully achieve learning.

No doubt, environmental factors (e.g. *cooperative learning*) can encourage the first of these parameters, the learning capabilities.

The second parameter has to do with basic knowledge, which can be improved if the *explicit* knowledge is transformed into *silent* knowledge through a series of experimental cases (e.g. building *Learning Objects*, actions promoted by science museums) and observations on what has been learned. These thoughts can be completed in the classroom with the teacher's help, personal studying, cooperation with other students, or through the internet. A fusion of the three strategies can be convenient and allow a positive change. The professor can intervene based on his own expert skill, easing off the shift from explicit to silent knowledge and suggesting solution strategies, practical advice and examples to emulate.

Certain teachers suggest the introduction of meta-cognitive strategies prior, during and after the education process. Pre-learning strategies refer to listing the specific goals you want to achieve, which should not be too ambitious, the concepts to be learned, the comparison of the new concepts with what is already known, and, eventually, how the new knowledge can be used in different environments. Strategies to be used during a learning process must identify, analyze, and interpret the main concepts. The post-learning strategies include meta-cognitive observations, their grid organization and hierarchy. In this phase, concept maps become a tool allowing the student to match learned concepts with the ones he/she already possessed.

Theoretical and experimental *problem-solving* can improve the many aspects of knowledge acquisition and organization, and can improve motivation (see D23-30 Motivation Survey). The science programs for primary and secondary schools must highlight the two key phases of teaching and learning: experiments and theory. Students learn when they can apply themselves working in groups and when they are guided into discovering new concepts. The proposed experiences must allow students to interact as much as possible with the natural world, to build correct explanations of that world. This approach allows the use of *problem-solving* and *case studies*, building of educational objects, development of scientific attitudes, learning scientific contents and improved knowledge of science language.

A good scientific education demands an understanding of relations, processes and applications of concepts to real-life situations, as the Pencil projects suggest.

Scientific education is built around central topics and does not forget to consider the *informal* aspects of education. Teachers have a dual role:

1. to help students find a link between *formal* education (central ideas) and *informal* education (the Pencil projects).
2. to allow students to develop those abilities which are typical of scientific research, that is to say being the main characters of experiments and of their scientific explanation.

The main objective of this education strategy is to ensure students *understand concepts and key processes, applying them to real life situations*. Research should start from questions and arguments important to them, like the ones suggested by the Pilot Projects.

3.3 Educational objectives

The educational objectives can be summarized as follows:

- To develop a comprehensive teacher training approach.
- To design and develop teacher training models to be offered to motivated European science teachers.

The above objectives translate themselves into the analysis and identification of the didactic value of the informal learning which took place within pilot projects and in the identification of methods for transferring the results achieved within the pilot projects into teachers' education practice. The course must thus contribute to:

- systematically propagate, within the teacher's community, **new methods and innovative educational practices** approached during Pilot projects;
- facilitate the exchange between formal and informal teaching;
- stimulate the relations between school and museum;
- support and strengthen the Xplora teachers' community;
- develop a common idea on the State of the Art of science education in Europe.

4 Methodology

4.1 Diversity of material

The European Teachers' education pattern as per the Pencil project is part of a complex reality. Pilot Projects have created a tight link between universities, science museums and schools, defined the contents, methods and new approaches based on informal education which aims to give a new boost to formal education and to science learning for European students. The Xplora portal is a reference for European science teachers, thanks to a full table of contents, software, case studies, collaboration projects and communities, etc.

A first analysis of the project has brought up the following constraints inherent to the design of the e-training course:

1. Heterogeneous reference target: the courses are available to "all" teachers of all European countries, working in schools of any type and level, since Xplora is a European resource;
2. Non-compulsory training: at this stage, it does not seem possible to introduce the training as compulsory, unless it becomes part of specific training programs in each single country.
3. Self-training versus common practices: if on one side, the complexity of the target and of the context led to an idea of training intended as self-training, the idea at the basis of Xplora, the portal which supports the birth, the development and the support of groups of professionals sharing a common interest or objective, is preserved also with reference to training.
4. Heterogeneous contents: the training model mainly referred to the results coming from the 14 pilot projects, which have seen the establishment of a network between museum/science centre-school-university. On the other side, this meant working with materials that were different and heterogeneous in terms of didactic approach, target, and teaching contents.
5. Relation to the *Xplora* portal: the training is included within the Xplora portal, not only from a technological point of view (the Moodle platform is installed on the EUN server), but also from the point of view of contents and objectives.

A first observation of the aims and constraints led to the following choices:

- **Customization of the path** - Given the heterogeneous target (based on nationality and on the schools of origin) and considered the many different needs, the platform provides customizable 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.

- **Method contents** - Considering the heterogeneous contents coming from Pilot Projects, education concentrates on methods and innovative approaches, rather than on single disciplinary contents. Motivating teachers means creating *common ground centres*. This should help introducing these interest centres outside the Pilot projects.
- **Self-training** – The impossibility to have training moments on site (not considering the meeting which took place during the Teacher Conference in Mechelen, on June 14-16, 2007) and the incertitude with respect to the going on of the project after its end, led to the idea of two training phases, one supported by expert tutors (up to the end of September 2007), the other one intended as self-training (starting from the end of September on).
- ***Community*** – Training supports the idea of *community*, which, directed and managed by Indire until the end of the project, integrates with the idea of the Xplora portal, without any superimposition. The peculiarity consists in focusing the discussion on methodological contents and on the sharing of experiences, in the best circumstances up to supporting the birth of important practices communities with a collaborative approach to the construction of the platform.
- **"Learning by doing"** - The education pattern has little to do with the simple idea of education supply, since the goal is to invest in a learning by doing approach where teachers have to be able to do, in addition to their theoretical knowledge. The focus is on education contents intended to highlight and support the project dimension of teaching; it is important for teachers to experiment first hand new methods and approaches suggested by the project.
- **Portal Xplora** – the relations with the Xplora portal are of several types:
    - Technological: the Moodle platform on which the training has been implemented by EUN technicians on an internal server.
    - The training can be accessed by the Xplora portal, directly from HP;

Expert teachers, who had already cooperated for the Xplora project, worked with the developers on the training courses.

4.2 Education recipients

European teachers in scientific subjects in primary and secondary schools are the recipients of the e-learning course. While the first addressees of training must be the teachers, Pencil's training is reflected immediately into the everyday teaching activity of teachers with the students.

The teachers involved at the beginning were those belonging to the network of the 14 pilot projects and those enrolled in the Xplora portal before it opened to all motivated, European, science teachers who can be involved in the activities of the Xplora portal.

During the Pencil Science Teachers' Conference in Mechelen, June 2007, a group of teachers tested the first materials uploaded and thus gave a preliminary feedback.

Teachers who participated in the plenary meeting voiced the following requirements:

- the materials showing the experiences of informal education in collaboration with museums must be translated into each single partner's language;
- allow comparison of curricula relating to science subjects at least on European scale.

Throughout the workshop, 41 European teachers expressed their interest in training and sharing further experiences and materials related to the aims of the Pencil project. This allowed an increase in the network of contacts and the level of sharing, on top of having the teachers themselves as both players and makers of the training.

4.3 Registration

Although this is a completely free education, registration is important, just as it is for users of the Xplora portal. It allows monitoring of education steps, and it gives students the opportunity to trace their personal activity pattern. This is perfectly compatible with the tools offered by Moodle technology.

Registration is free and personal for teachers; it does not have to go through the school or institution.

4.4 Teacher conference

During the final Teacher Conference in Mechelen, Indire led a plenary conference session and two workshops in collaboration with EUN.

The presentation, entitled "Professional Development", was held by Elena Mosa and Serena Goracci, Researchers of Indire.

The workshop was about the training activities addressed to European science teachers, which are available in the www.xplora.org portal. For the part concerning Indire, the workshop was held by Elena Mosa and Serena Goracci (Researchers of Indire) and by Palmira Ronchi (teacher in science subjects and consultant of Indire).

For a detailed breakdown of what was discussed please see D33-34 Science teachers' conference, sections 3.2.6.1 and 3.2.9.

4.5 Fruition language

As for the Xplora Portal, the platform's principal language is English, with translations in French and German. Efforts are being made to make the e-learning materials available also in French and German. Considering the four Italian parties participating in the project, there is the possibility of an Italian version as well.

With reference to the specific Pilot Project contents, some are available also in the original language.

4.6 Technology

Education is offered through an open source platform Moodle, on EUN server, thus managed by EUN. This choice consolidates teacher communities and creates local sharing and stronger education environments.

EUN is replicating the installation also on USB support (USB MOUSE), in order to distribute it to teachers.

4.7 Development phases

The actual planning phase, which started in 2006, went through the following steps:

- January – May 2006: a group of experts, Indire's consultants – among whom university teachers, high school teachers and experts in museum's teaching – conducted an analysis on the state of the art of the projects, of the documents supplied by the universities, on the state of the art of scientific teaching in Europe; the result was a preliminary report, complete with a first project draft.
- 30th of May 2006: the same group attended meetings with the universities' and EUN's contacts to discuss the theoretical, methodological and technological foundations of Pencil's training;
- September-October 2006: some grids have been prepared and shared with the Pencil steering committee (23rd of November 2006), to be submitted to the persons in charge of pilot projects and involved teachers, in order to obtain useful information.
- January-March 2007: materials have been progressively analysed upon receipt by the group of experts, together with Indire's co-ordinators; this led to work out the strategies to be adopted in order to translate the materials and the results into training activities.
- April 2007: two suitable strategies have been identified that translate the projects results into training activities for other teachers. The two approaches are the case study and the webquest.
- April-June 2007: based on these strategies, the materials have been reprocessed and reorganized by the group of experts and have been implemented in a multimedia format.

- June 2007: Communication of the relevant opening during the Teachers Conference in and through a mailing list to teachers enrolled in Xplora.
- July-August 2007: Opening of the first training experimental modules.
- July 2007: other materials suitable for training have been selected.
- May-September 2007: implementation of the platform in Moodle.

  Continuation of the implementation.

4.8 Interaction with partners

University of Naples – King's College London

The universities who worked in a tight relationship with the 14 pilot projects were an important point of reference with respect to the theoretical reference context, since they were the partners in charge of identifying the emerging innovation criteria. As far as possible, Indire shared with them the approach to projects analysis. Indire also received the documentation relating to the monitoring and evaluation of projects.

EUN

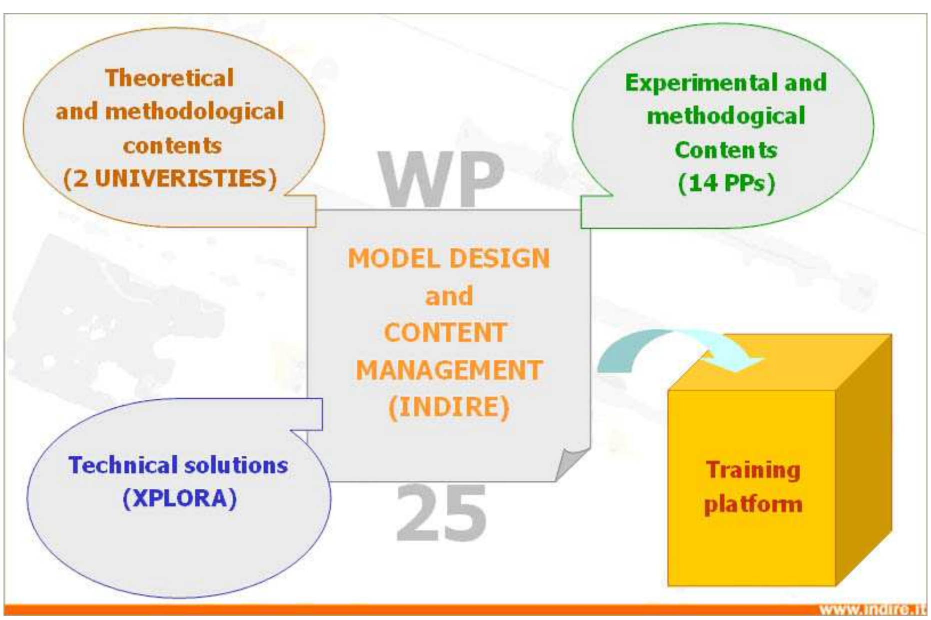
Indire cooperated for both technical and platform implementation solutions and for involving teachers and spreading the produced material.

Ecsite

Ecsite created the channel for communicating and interacting with other partners.

14 museums and science centres

Museums and science centres were the suppliers of contents. Besides the material that was made available for the projects, the people in charge of the projects and some selected teachers were submitted proper grids aimed at identifying the data and information which were necessary for planning the training.

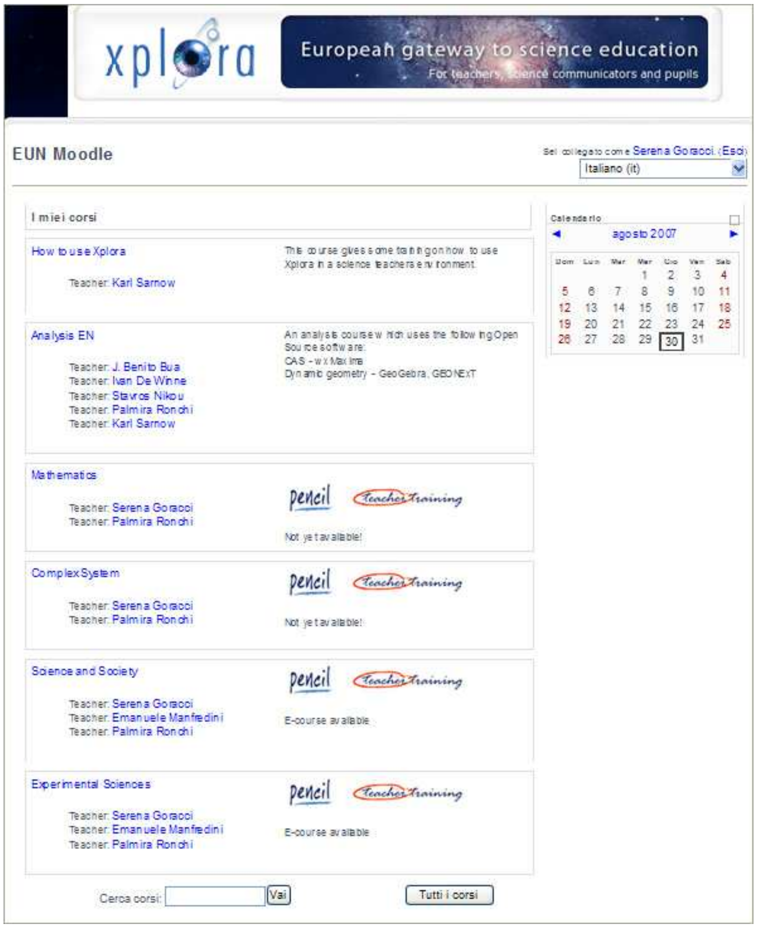


5 Results

5.1 Training structure and contents

Training contents have been organized over four big macro-areas that may be considered as some of the themes serving as bridges between informal and formal & curricular teaching. Within these four macro-areas it is possible to include the 14 pilot projects:

1. **Experimental science**
    a. *"Online Access to Objects at the Museum of the History of Science"* - IMSS - Florence – Italy
    b. *"Use of ICT in Science Learning"* - Explor@dome, Paris, France
    c. *"Science Centre on School"* – NEMO, Amsterdam, Holland
    d. *"Xciters"* – Experimentarium, Hellerup, Denmark
    e. *"Future technologies for science learning"* - Cité de l'espace Toulouse – France
2. **Science and society**
    a. *"Traffic and climate change"* - Deutsches Museum –Munich – Germany
    b. *"Health matters!"* - Bloomfield Science Museum, Jerusalem, Israel
    c. *"Who did it?"* – Technopolis, Mechelen – Belgium
    d. *"So... Science! Social dimension of science, diversity and gender issues"* – Fondazione IDIS - Città della Scienza, Naples, Italy
    e. *"Learning for a sustainable society"* - Universeum, Göteborg – Teknikens Hus, Luleå - Sweden
3. **Mathematics**
    a. "Ludomathematics" - Pavilhão do Conhecimento - Ciência Viva, Lisbon, Portugal
4. **Complex systems**
    a. *"Investigating Marine Issues with Climate Change"* - The National Marine Aquarium, Plymouth, UK
    b. *"The virtual observatory"* - Ellinogermaniki Agogi, Athens, Greece



The heterogeneity of project contents, but also the focus of Pencil showed that it was essential to focus not only on education contents, but above all on methodological and didactic aspects. For this reason, transversally to the 4 macro-areas, special attention was paid to the following aspects when analysing the materials:

1. *Updating of the knowledge/didactics of disciplinary subjects.*
2. *Informal "laboratory" teaching activities* (use of exhibits in schools).
3. *Use of ICT in teaching.*
4. *Use of online resources* (*Xplora* and others…)
5. *Cooperative learning activities.*
6. *Academic research papers.*

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

- Training materials and activities
- Communication tools
- Sharing tools

5.2 Training materials and activities

The education offer has been structured through modules resulting from pilot projects; each module can include:

- **Study materials** - theoretical scheme and hyper-textualized material. This is the State of the Art, a presentation of the different theories on the topics discussed in modules, in addition to specific tools such as bibliographies and reference websites. Their purpose is to:
  - discuss the treated topics offering the possibility to choose among a broad educational offer (with many view-points);
  - confront with the experts on the treated subjects (museum and university science experts) by means of a dedicated *forum* (direct line with the expert);
  - allow an easier learning of the treated topics through media tools: audio/video, documents to be downloaded from the platform.
- **Activities** – they represent the heart of education and should contain and deploy all pilot project's results. Activities are based on the method of *learning by doing*. Students apply the methods taken from the projects and use the activities suggested to obtain specific results. They are devised and created to achieve two goals:
  - allow learners to focus on discussed subjects, using tools and methods which emphasize the dimension of *doing*
  - relate the knowledge acquired to the education *practice* (with students in schools), stimulating the teacher's projects.

  Activities can use several strategies based on different contents or methods:
  - webquest
  - case studies
  - education paths
  - problem solving
  - …
- **Resources –** each module and topic presents a resource area offering websites and commented bibliographies.

5.3 Communication tools

The modules contain tool-like forums and chats that are moderated by tutors experienced with the contents. They are the places for exchanging ideas and requesting further information on the structure and contents of the course. In this area, learners can discuss and also cross-check the understanding of the activities, they can learn to learn. This area also allows learners to critically and autonomously confront themselves on the contents of the course and propose solutions and comparative analyses. Based on individual availability, forums are also managed by science and museums experts.

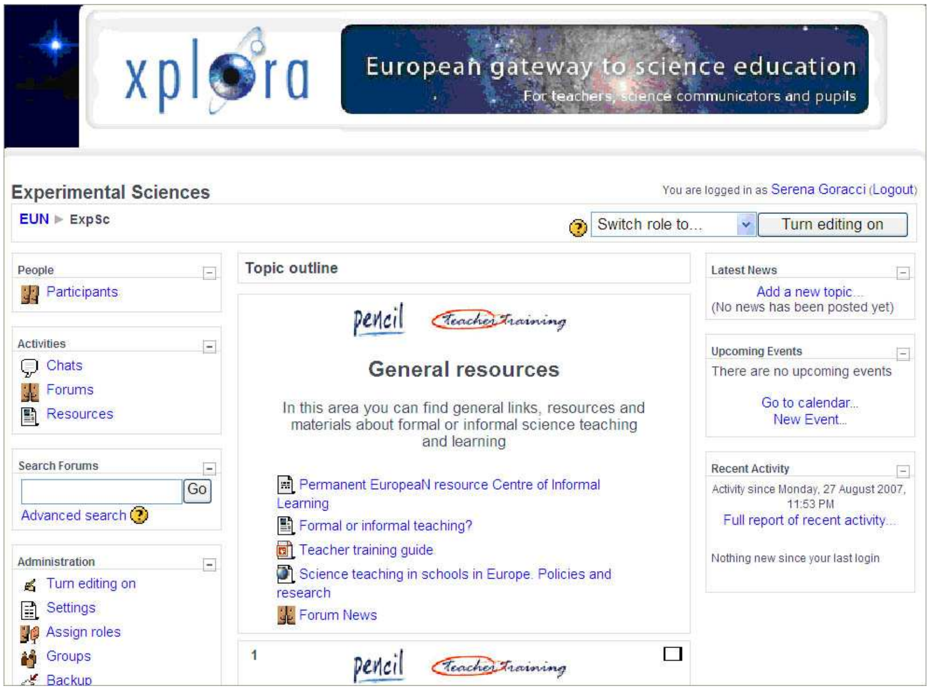
5.4 Sharing tools

Proper forms to be filled in and sent to tutors and colleagues allow trainees to describe and submit one's own didactic experience to other people (case studies, materials, etc.). It is also a useful documentation exercise allowing them to think of their work while explaining it.

5.5 The modules

Each macro-area was organized in training modules, each of them characterized by a specific subject reference. In each macro-area there is a common module containing the following:

- materials for introducing the theme "informal learning";
- link to the Pencil Resource Centre;
- guide to the Platform Navigation;
- link to materials relating to the state of the art of science teaching in Europe;
- a general discussion forum.

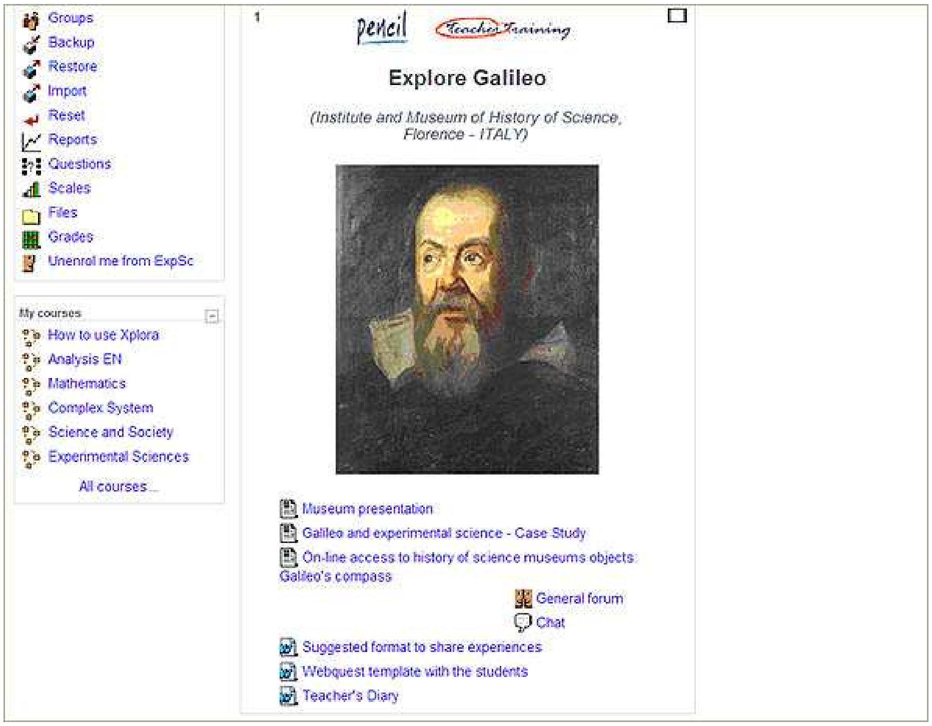


5.6 Specific modules

Besides this, the macro-area presents a list of modules, each of them linked to a specific pilot project. Each module was prepared with the aim of providing information on the project which should be as much complete as possible:

- presentation of the museum or science centre with links and contacts;
- training activities:
  - a *case study* based on the pilot project and on the direct experience of administrators, teachers and students. A precious contribution was offered here by the pilot projects themselves;
  - a *webquest* based on the resources available in the museums' and science centres' websites;
- communication tools to discuss the contents of training activities together with the tutor and the colleagues and to share past and future experiences:
  - chat;
  - forum.
- Some grids prepared to get a feedback and share the training module within the forum:
  - one grid for documenting the experience with students in the class;
  - one grid for preparing a webquest relating to the pilot project together with the students;

- one grid to plan experiences that are similar to those analyzed within the case study to be conducted in class with students.



5.7 The training approach

The museum/science centre was identified as a double resource available to school and teachers. The museum/science centre represents an occasional resource, a physical and theoretical place of reference where it is possible not only to have important informal education experiences, but also to find materials and resources for the teaching activity before and after the visit to the museum.

If in some cases, the museum plays a more important role for those schools that are reachable from a territory point of view, thanks to internet websites and the availability of digital contents, virtual paths and others, the museum becomes a permanent resource for all those schools that can access the web. Thanks to the contents it makes available, the museum becomes a useful support and at times a point of reference for the teaching activity of all teachers.

The case study on one side and the webquest on the other side are therefore two suitable approaches for spreading the two aspects and these two points of view on the museum.

Case study - The case study is one of the tools used to enhance the doing dimension and promote critical reflection.

In the Pencil project experience it is a real case, fully experienced, with all the individuals involved. The fact that the case has been fully experienced includes elements of complexity, such as the taking of decisions in a given context with problematic situations or dealing with a requirement that has arisen from the school context. It also means that the material is real and alive, and that each trainee may assess the supporting documentation in a different manner.

The objective therefore is to overcome the level of "good solutions" to reach a higher level in which there are profound changes in attitude. This involves having students grasp the "transferability" of the situation, i.e. seeking out the common factor in diversity, stimulating thought processes that help individuals to intervene autonomously in the professional context, activating and refining specific skills, such as the ability to examine, highlight, grasp the specificity, identify problems, foresee developments, hypothesise solutions, construct hypotheses, put oneself into play.

The proposed case study format represents a good practice in science teaching involving experimental aspects, new methods, hands-on activities, explorative learning contexts or other significant or innovative experiences, described through a narrative style and focusing on the aspects of innovation, quality and transferability.

Each case study is structured as follows:

- *Introduction*:
  - training aims;
  - Pencil project goals.

- *Case Narration*:
  - context;
  - Pencil project structure.

- *Experimental activities* with a description of:

- teachers' role;
- students' role;
- teachers' voices;
- students' report at science centre.

- *Methodology*:
  - a description of the Pencil project didactic approach.

- *Online material* about the project that can be analysed by the trainee.

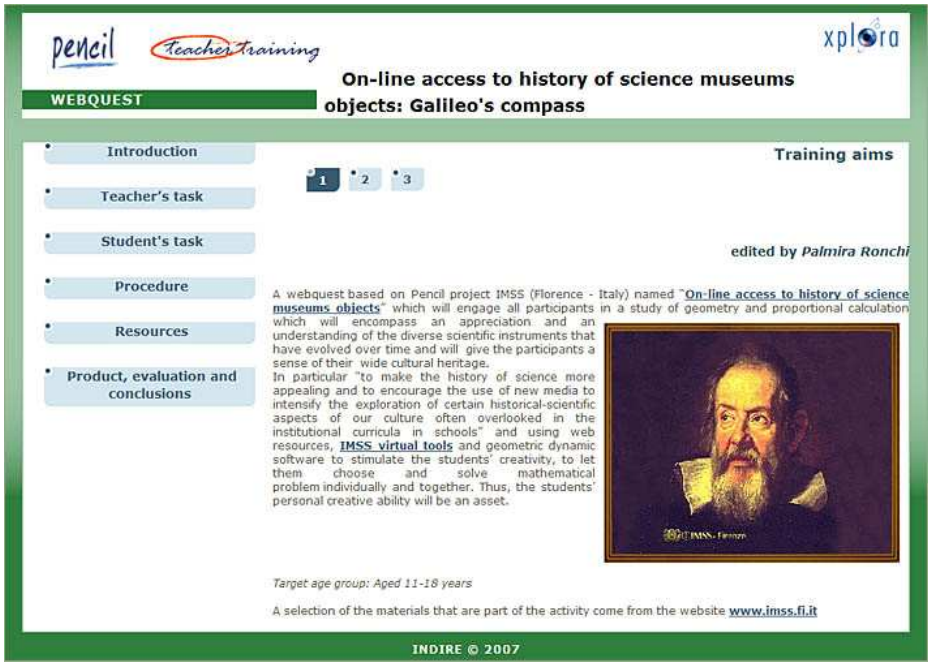
- *Trainees activity*:
  the trainee should evaluate the Case, referring to:
  - the didactic objectives;
  - the potentiality of the relation between school and science centre underlining the cross-curricular perspective;
  - the adopted methodologies;
  - in addition, following the methodological general lines introduced in the narration of the case, elaborate a didactic pathway, articulate it in such a way that it could be developed in various school contexts and to various levels, proposing new practices, explorations, guided discoveries and considerations; as evaluation methodologies, consider one or more of those presented in the following section.

Webquest - The Webquest is a teaching strategy which includes the construction approach linked with new learning opportunities.

The Webquest is an activity leading trainees to execute searches on the web, with the target to discover more information about a specific subject or theme and to execute some tasks by using the collected information.

Bernie Dodge, professor at the San Diego State University, has been studying learning environments since 1995 and developed this model, which has become one of the most widely used and effective learning models based on the extensive use of internet (Internet–based project models/ approaches). This education strategy describes the process of a "learning experience" motivating and involving trainees. A Webquest mixes some elements of the construction approach, some of the inquiry-based learning and, in some cases, also some of the cooperative learning.

Thanks to this activity, the trainees acquire the ability to search specific information in the web sites of museums and science centres, to select the most pertinent information and apply what they have learnt to the education context.



5.8 The e-tutor

All training activities are supported and monitored by a group of experienced e-tutors who have been trained by Indire. E-tutors are teachers in science subjects with a proven knowledge and experience in online training and a deep knowledge of the contents proposed by training modules. Some of them are also part of the Xplora team.

The e-tutor is a facilitator accompanying the trainee along the chosen path, by showing him/her the tools and functions of the technological platform, recalling the deadlines of his/her path, if any, and moderating the relevant interactions. The e-tutor is able to manage on-line education by practically facilitating the trainee's learning processes thanks to a deep knowledge of the online environment and of tutoring models.

5.9 Training time schedules

The platform was launched in July 2007 and remains open after the project. Up to the end of the project, e-tutors support trainees in training activities.

The training contains 4 macroareas with the following Pencil project modules:

1. Experimental Sciences:
    - *Explore Galileo* (Institute and Museum of History of Science, Florence – ITALY)
        - *Museum presentation*
        - *Galileo and experimental science - Case Study*

- *On-line access to history of science museums objects: Galileo's compass – Webquest*
- *Suggested format to share experiences*
- *Webquest template with the students*
- *Teacher's Diary*
- General forum
- Chat

E-tutors: Emanuele Manfredini, Palmira Ronchi
Trainers: 19 (Spain-2, Portugal – 1, Italy-4, France- 1, Belgium- 4, Israel- 1, Greece- 2, Hungary-1, Belarus-1, Romania-2, Finland-1).

2. Science and society:
    - *Learning for a sustainable society* (Universeum, Göteborg, Sweden - Teknikens Hus, Luleå, Sweden)
        - *Science centre presentation*
        - *Learning for a sustainable society - Case study*
        - *Suggested format to share experiences*
        - *Webquest template with the students*
        - *Teacher's Diary*
        - General forum
        - Chat

E-tutors: Emanuele Manfredini, Palmira Ronchi
Trainers: 15 (Spain-2, Portugal – 1, Poland – 1, Italy, 3, France- 1, Belgium- 3, Israel-1, Greece- 2, UK-1).

3. Mathematics
    - Ludomathematics (Pavilion of Knowledge - Ciencia Viva, Lisbon, Portugal)
        - *Science centre presentation*
        - *• Ludomathematics - Case study*
        - *Suggested format to share experiences*
        - *Webquest template with the students*
        - *Teacher's Diary*
        - General forum
        - Chat

E-tutors: Emanuele Manfredini, Palmira Ronchi
Trainers: to be confirmed

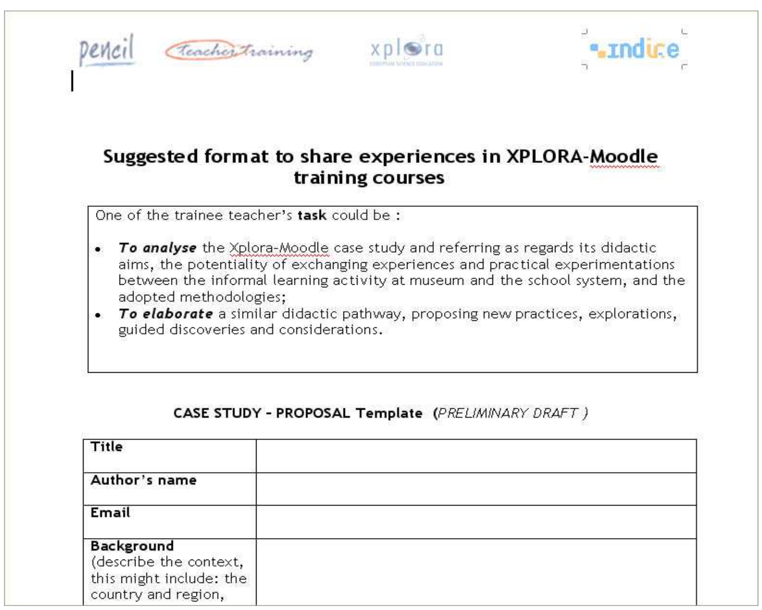
4. Complex system:
    - *The virtual observatory* (Ellinogermaniki Agogi, Athens, Greece)
        - *Science centre presentation*
        - *The virtual observatory - Case study*
        - *Suggested format to share experiences*
        - *Webquest template with the students*
        - *Teacher's Diary*
        - General forum
        - Chat

E-tutors: Emanuele Manfredini, Palmira Ronchi
Trainers: to be confirmed

5.10 Evolution of the product

The training product should go towards the generation of new practices and new approaches in education able to last in time, to enable discussion within the teachers' community and to create new quality products that can be developed after the project and used by a higher number of teachers.

Personal works can be shared with other learners and contents experts (in the community area and in the materials sharing area). The best works might become part of the education offer with valid case studies. A shared working area (e.g. through wiki technology) also allows a commented glossary on scientific education and on science museums, to be built and progressively developed by different people.



Suggested format to share experiences in XPLORA-Moodle training courses

One of the trainee teacher's **task** could be :

- ***To analyse*** the Xplora-Moodle case study and referring as regards its didactic aims, the potentiality of exchanging experiences and practical experimentations between the informal learning activity at museum and the school system, and the adopted methodologies;
- ***To elaborate*** a similar didactic pathway, proposing new practices, explorations, guided discoveries and considerations.

CASE STUDY - PROPOSAL Template (*PRELIMINARY DRAFT*)

Title	
Author's name	
Email	
Background (describe the context, this might include: the country and region,	

Teacher training platform: www.xplora.org/moodle