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e-KNOWNET

Network for ICT-enabled non-formal science learning

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Summary / Contents: Guide for all parties interested in utilizing and/or developing a e-KNOWNET type of knowledge sharing network

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Foreword

The purpose of this manual is to collect and systematize the experience accumulated and the “lessons learnt” during the three year life-cycle of the e.Knownet project, and make it available for anyone interested to venture into similar networking initiatives.

As the e.Knownet project proved, carrying out a knowledge-sharing initiative bringing together partners and collaborators from different cultural and professional backgrounds and with diverse scientific expertise is a challenging mission. Since its inception, the e.Knownet project has been thought of as a learning process. The effort to find common ground and at the same time to come up with an inspired and motivating learning outcome, content and activities, should not be underestimated.

This manual is a record of the project experience, its shortfalls and novelties, its hindrances and successes. It is also an integral part of the knowledge-sharing and networking effort of the e.Knownet. In its pages, one can find the methodology followed, and implementation guidelines for futures activities.

The e.Knownet consortium hopes that the manual will become a means to expand and prolong the effects of the project in the field of non-formal science learning.

We believe that the e.Knownet concept and its main outcome, the ScienceTweets portal, have promising prospects in the lifelong learning field providing that all involved parties are willing to invest the proper amounts of time, creativity and interaction with users’ communities and relevant stakeholders.

Part I

1. Introduction

In contemporary societies a certain degree of science literacy is increasingly becoming a necessary condition to function as a citizen, an employer or employee, a participant in social activities, etc[1]. New knowledge produced through research needs to be efficiently disseminated through education and applied through innovation[2].

In Europe a network of more than 70 EU-funded Innovation Relay Centres, a number of R&D liaison offices[3] and dedicated sites and relevant projects (ISTResults, Technology Market Place cordis.europa.eu/marketplace, EU funded SINAPSE site, DARE programme) circulate information referring to on-going research or research results and encourage relationships between industry and research centres across member states.

However, information flow from the usual loci of science knowledge production (e.g. research centers, universities, sites of industrial research) to non-expert segments of society can take as long as two decades (about 20 year lagging for nuclear energy issues, 12-15 year for informatics, 8-10 for biotechnology)[4]. Scientists are often reluctant to share with non-expert audiences the product of their work in a comprehensible way, probably in an effort to defend the conventions and principles of the scientific method and the integrity of the scientific results[5]. At the same time, the science promoted and circulated by the media more often than not the criterion of newsworthiness and public attractiveness and less often that of real scientific value or innovative quality[6].

Restriction of knowledge within isolated "islands" is a hindrance to innovation holding back the potential of societies to advance their

[1] A blueprint for a new approach, Science, Technology and Innovation in the Media (STIM), Ministry of Flanders, Science and Innovation Administration, Crete - March 27, 2003.
[2] Communication from the Commission to the European Parliament, the Council and the European Economic and Social Committee, on scientific information in the digital age: access, dissemination and preservation, SEC(2007)181, 14.2.2007.
[3] In Greece there are two main networks: the Innovation Relay Centre and the Innovation Relay Centre Praxis (nonprofit organization under the auspices of Federation of Greek Industries (ΣΕΒ), Federation of Industries of Northern Greece (ΣΒΒΕ) and Foundation for Research and Technology – Hellas (ITE).
[4] There is evidence that between 15-20 years intervene between the moment of a scientific discovery and the peak of its representation in the mass media. Rudig W. (1990), Anti-nuclear movements: a world survey of opposition to nuclear energy, London, Longmans. Wright, S. (1986), Recombinant DNA technology and its social transformation 1972-1982, Osiris, 2, pg.303-360.
[5] CREST Report on Science and Society (CREST 1206/01), "Science, Society and the Citizen in Europe", SEC (2000) 1973.
[6] A blueprint for a new approach, Science, Technology and Innovation in the Media (STIM), Ministry of Flanders, Science and Innovation Administration, Crete - March 27, 2003.

learning environments, and improve their information and educational resources and practices.

There is a need for efficient networking among the major stakeholders of production and dissemination of new scientific knowledge through non-formal education, in order to accelerate the circulation pace of specialized information and minimize the influence of extra-scientific factors upon the development of non-formal learning resources which eventually reach the citizen. This process can be largely supported by the use of ICT, be it in the networking phase and/or during the phase of developing the information/learning resources. Intermediary organizations such as science centres, can play an important role as catalysts in this process encouraging public employment of ICT for life long learning activities, considering their significant outreach potential and public appeal.

The e.Knownet project, an initiative funded by the Lifelong Learning project, set up an innovative ICT-enabled mechanism to promote a fast and efficient sharing of new scientific knowledge among larger, non-expert segments of society, through non-formal learning activities.

The scientific domain was Photochemistry, which studies the interaction between molecules and light. Photochemistry has already found numerous applications to everyday life (e.g. photochromic glasses, solar energy conversion, medical imaging, cancer therapy etc.).

The use of ICT enabled the direct cooperation between knowledge producers (Photochemistry researchers), transformers of specialised knowledge (educational experts) and its end-users (learning communities). This direct cooperation aimed to accelerate the circulation pace of knowledge produced in the research laboratory. At the same time it allowed researchers themselves to decide upon what is ‘newsworthy’ by use of scientific standards and also decide upon the way that this knowledge should be shared with wider parts of society.

The content of the manual is structured in two main parts. The first part presents all information necessary to familiarize the reader with the basic concept, aims, actors and work phases of the e.Knownet project. It includes the project methodology and the outcomes achieved.

The second part presents the proposed stages of work to achieve efficiently a networking activity in the field of informal science learning enabled by information and communications technologies in a web 2.0 environment. This second part concludes with a set of recommendations for all interested parties.

2. About the e.Knownet

2.1. What is the e.Knownet

The e.Knownet project is a Lifelong Learning project which started in January 2008 and ended in December 2010. The project promoted cooperation and networking between 5 organizations from 4 European countries with diverse yet complementary experience on science dissemination and learning (e.g. a university institute, a university laboratory, a research organisation, a science centre and a technology provider to academic and school communities).

2.2. Main project objectives

The main aims of the e.Knownet project have been defined as the following:

- Produce an **innovative model of a European knowledge-sharing network** and trigger new dynamics in ICT-enabled life-long learning, through linking up fields that traditionally have been working in isolation, i.e. scientific research institutions, communities of pedagogical science experts and science centres. Knowledge-exchange among the e-KNOWNET partners will enable the consortium members to valorize their rich and complementary expertise in order to cooperatively produce ICT-enabled learning resources.
- Use **ICT tools to promote knowledge-sharing,** collective thinking and networking. Test bed of the knowledge-sharing network will be **the e-KNOWNET portal** with suited infrastructure to accommodate participatory media (blogs, wikis, RSS, tagging and social bookmarking, music-photo-video sharing, mashups, podcasts, etc). These tools will allow interaction across vertical and horizontal dimensions (public/private, expert/non-expert, national/European/regional).
- Promote the **educational role of ICT in non-formal environments and encourage digital literacy**, across the lines of gender mainstreaming. Learning communities (secondary education, adults) will be able to access knowledge in flexible educational formats with ICT tools and popular applications, such as: digital exhibits (e.g. 3D representations of science related objects/exhibits from EF collections and new science e-exhibits, virtual exhibitions, meta-collections (virtual collections thematically structured,

built upon material drawn from various virtual collections in the world), educational simulations and models.

- **Enhance the quality of educational services provided in non-formal environments**, such as the science centre/museum.
- **Tackle real needs for different learning communities**. A collection of best practices in the field, a segmentation analysis of the potential users and identification of their learning needs will feed into and facilitate the strategic development of the e-KNOWNET services.
- Offer **new incentives in science learning** (on selected topics of Physical Chemistry), users will be able to inform themselves about current knowledge in the field of Physical Chemistry, about the project itself and the partners of the e-KNOWNET, and to find interesting links, sites, events in the selected themes of Physical Chemistry.
- **Expand the human network involved in the e-KNOWNET** (exploitation phase). All partner organizations will deploy their multiple interconnections with national, European and international networks and their links with key stakeholders and influential multipliers' associations in the field of non-formal and ICT-assisted education in order to increase the impact of the project. The networking manual is an important tool towards this direction.

2.3. Main target audiences

The e.Knownet aimed to offer services to three target audiences.

- **Secondary education audiences**. Students have opportunities for study and online communication and, finally, for learning through a constructive, interactive and target-oriented way.
- **Lifelong learners.** The portal constitutes an environment where lifelong learners have opportunities to get to learn and know new realities and possibilities in ways that could be implemented on their daily activities.
- **Science educators, in formal and informal learning environments.** This project helps science educators in formal and informal learning settings to increase their positive impact to the public. They can search and find educational and course materials easily applied to their learning practices; The platform offers the possibility for rating resources, sharing content and educational material, discussing and exchanging ideas or experiences.

As main 'providers' of platform input are considered the group of researchers.

- **Researchers:** Members of the research community working in the field of Photochemistry, are offered a space to communicate with the public and their colleagues. Researchers can be the 'authors' of digital content based on their current research results in the form of 'digital exhibits'.

At the same, the three target groups can be active creators of resources and even contributors to the platform, according to the different profile of each learning community. **Students and Lifelong learners** can develop their own web collections, they can upload comments regarding platform materials, they can rate the digital exhibits, showing thus their preferences, they can share interesting resources with friends and colleagues. **Science educators** in formal and informal learning environments, providing they have the expertise and the scientific qualification to do so, may also develop and upload new digital exhibits and new web collections.

2.4. Photochemistry as pilot subject

The cooperation processes of the project have been tested over the production of knowledge-sharing services and learning products on the thematic focus of Photochemistry. This is a sub-field of Physical Chemistry which studies the interaction between molecules and light. Photochemistry has already found numerous applications to everyday life (e.g. photochromic glasses, solar energy conversion, medical imaging, cancer therapy etc.).

Students, lifelong learners and science educators (of formal education and informal learning environments) are introduced to new pioneering research results through ICT-enabled applications accessed both through the web.

The scientific content of the portal is provided by a number of research groups working in the Paris based, Francis Perrin Laboratory (a joint LFP/CNRS research laboratory) and also by research groups associated with the European Photochemistry Assiciation, a learned society promoting the science of Photochemistry in Europe and wordwide.

2.5. The role of science centres

Science centres are expected to act as catalysts in this process of knowledge sharing and circulation considering their significant outreach potential and public appeal. There is nowadays an evolving

convergence between the traditional learning resources and the new ICT[7] which, combined with web applications, may be a major support in the teaching of science content (e.g. the laws, theories, facts) and scientific processes (e.g. measuring, recording, processing data) through simulations (i.e. models that are created by others) and / or modelling (models created by pupils)[8].

Science centres can encourage their visitors to profit from ICT–enabled life long learning activities. ICT has increasingly entered the field of science museums and centres, furthering the attractiveness of the visit for visitors of all ages (web-based collections, on-line exhibitions, simulations, augmented reality applications, wikis, on-line seminars, etc).

[7] A blueprint for a new approach, Science, Technology and Innovation in the Media (STIM), Ministry of Flanders, Science and Innovation Administration, Crete - March 27, 2003.
[8] Wellington, J. 2000. Teaching and learning Secondary Science: contemporary issues and practical approaches. London: Routledge.

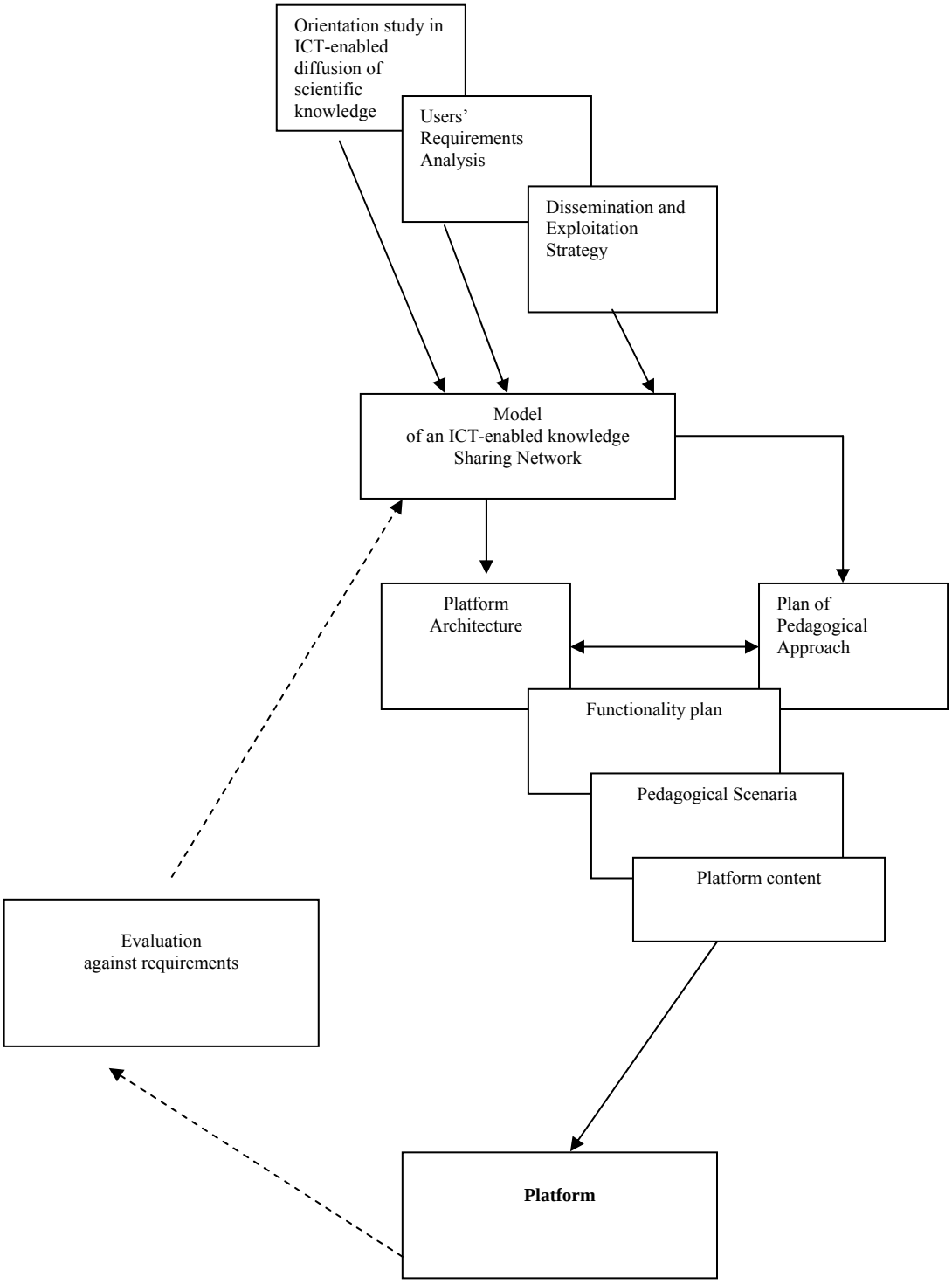
3. The building blocks of the e.Knownet work process

The process of developing the e.Knownet structure unfolded in three stages: the **orientation phase, the development phase and the expansion phase.**

The main components in this work effort has been:

- the active involvement of prospect users communities,
- a clear understanding of user and task requirements,
- an appropriate allocation of functions between users and technology,
- the iteration of design solutions
- multi-disciplinary design.

A series of key activities took place in this project and these are described in the following graph.



The activities were carried out in an iterative fashion, with the cycle being repeated until the particular usability objectives have been attained at a satisfactory level.

3.1. The orientation phase

During this phase, various deliverables provided input useful for designing an ICT-enabled knowledge-sharing network.

3.1.1. Mapping the field.

A cooperative study provided an overview of existing science dissemination routines and structures concerning ICT-enabled services and resources for informal science learning. The study also analysed the involvement in this process of non-formal intermediary organizations, such as science centres.

This study prepared the strategic development of a prototype network for the diffusion of new science knowledge to the citizen, through learning activities. The mapping identified experience and practices related to ICT-enabled LLL activities in non-formal environments and best practices and suggestions for what would make a “good network mix”. This orientation activity investigated main user communities served by these stakeholders, types of ICT used to facilitate the above processes and educational applications in use. The study explored key stakeholders and representative organizations (profile and function) in cross-cutting relevant fields, and also surveyed existing organizations and practices of science diffusion in non-formal environments, that could offer added value in the proposed networking scheme. Finally, it allowed tracking down possible learning needs of prospect e.Knownet users, which had not been met at that time and uncovered weaknesses in existing processes of circulation of new knowledge among life-long learning communities.

3.1.2. Deciding upon the pedagogical approach.

A pedagogical report offered a description of the pedagogical approach that would be followed in order to fulfil the project targets. The pedagogical report formed a set of general guidelines employed for the design of educational applications. This document was updated periodically in order to include any interdependencies with the various technological aspects of the project, in particular to the development of the ScienceTweets portal. The pedagogical orientation of the project included the design of pedagogical scenarios, a set of proposed activities that would realise the pedagogical guidelines which were set up by the pedagogical report. This report evolved in parallel with the various technical reports, too.

3.1.3. A users’ requirements analysis.

Various sessions with users were implemented in order to define users’ needs in relevance to informal web-based science learning. The requirement analysis sessions took place over the web and in actual settings.

3.1.4. Functionalities of the e.Knownet platform.

A special report identified and analyzed the different types of functionalities that would be realized via the e.Knownet platform, later titled as ScienceTweets platform. Functionalities correspond to different types of services provided by the ScienceTweets platform. These were determined on the basis of (i) requirements analysis performed in previous stages of the project work (ii) educational scenarios also determined previously and (iii) the report on the technical requirements and characteristics of an ICT-enabled knowledge-sharing network, centered around the ScienceTweets platform. The different functions and services of the e.Knownet platform foresee the possible roles that could be undertaken by the users of the ScienceTweets platform. The whole study of functionalities followed a human-centred design process.

The usability standards presented in the literature and principles for a human-centred design process were studied and adopted. The following five central activities took place during the project:

- plan the human centred process
- understand and specify the context of use
- specify user and organizational requirements
- produce design solutions and prototypes
- carry out user-based assessment - evaluate design against requirements[9].

3.2. The development phase

This stage of the work included efforts towards the direction of enhancing the human resources of the partenariat and developing the web-based learning and knowledge-sharing environment and the platform contents.

3.2.1. Exchange of know-how between partners and capacity building.

The human dimension of networking in this project was enhanced through **knowledge-sharing** and **capacity building** activities between partner organizations. These included **study visits** among partners which increased awareness of the professional circumstances, challenges, routines and other everyday parameters in each partner's reality. These experience and practices were all related to knowledge production, learning and knowledge distribution activities. Capacity building activities were implemented too, in the form of peer-training workshops on the production of material suitable for ICT supported life-long learning. These

[9] Tomas Berns, Usability and user-centred design, a necessity for efficient e-learning! International Journal of The Computer, the Internet and Management Vol. 12 No.2 (May-August, 2004) pp 20 -25, tomas.berns@ergolab.se

workshops increased the capacity of various consortium members to cooperatively produce ICT resources suitable for life-long learning activities. A series of science communication workshops for scientists/researchers were organized and hosted by all partner organizations addressing their expert staff. The workshops aimed to enhance awareness of the social context of life-long learning and covered a range of communication skills including the effective use of ICT mediated environments to communicate science, science communication in non-formal educational contexts, engaging in fruitful dialogue with diverse non-expert publics, communicating risk and controversy, using efficiently media interview techniques, etc.

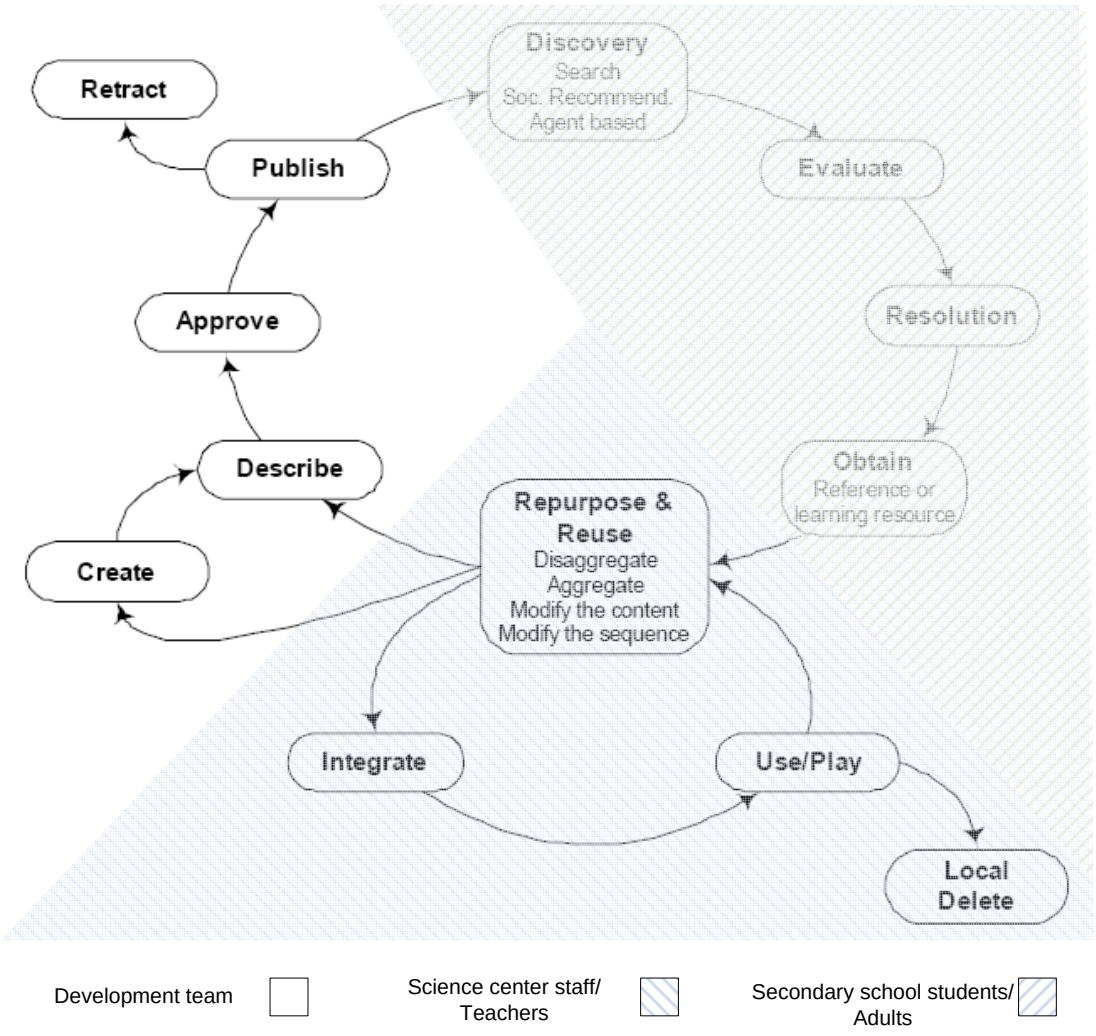
3.2.2. Developing a knowledge-sharing network.

This part of work was implemented after the completion of the design stage as was described before. First task was to identify the structure and functions of a knowledge-sharing network, operating in non-formal learning environments, by use of ICT. Among the issues studied were the definition of user environments and roles, security and intellectual property issues, description of functions and method of content development.

At a second phase, a dedicated e-platform was developed as the showcase of the learning services and resources which are integral part of the e.Knownet project. The platform was designed as a virtual repository for – and as hub for redistributing- new science knowledge available in various resource formats suitable for informal web-based learning.

In the following figure the processes related to the usage of a web-based learning environment are depicted as actions of a typical usage scenario involving categories of prospect users (both target communities and development team).

Figure 1: A typical usage scenario of learning environment and the involved users



The main actions depicted above are explained below.

Create: The creation of a digital learning resource might involve base material, tools, a methodology, and skilled persons. The creation process might differ very much on what one is creating; a picture might involve a simple click on a digital camera, a complete course might involve a complete team of subject experts, graphical artists, software engineers, etc.

Describe: Describing a learning resource is providing the metadata of it and follows nowadays usually a standard or a specification, more in particular the Dublin Core metadata scheme, the IEEE LOM standard (IEEE, 2002) or the DCMI metadata term specification (DCMI).

Approve: Approving a learning resource is the endorsement to make it available to the intended audience. The approval process may be more or less formal.

Publish: Once the learning resource is approved, it is made available, under commercial conditions or freely, to the intended audience.

Discover: While the publishing of a learning resource makes it available to someone, this person needs to become aware of its existence before she can make use of it.

Evaluate: After having discovered a learning resource a user would evaluate it according to his own criteria.

Resolve: Once a suitable learning resource has been found, a digital learning resource requires a handle (e.g. a token) in order to obtain it. Before getting such a handle it might be that a digital rights agreement needs to be generated and checked.

Obtain: There are various ways in which a digital learning resource can be obtained, but typically in a World Wide Web context it would be through downloading or accessing it remotely.

Repurpose & reuse: Before using a learning resource it might require some adaptation in terms of language, cultural, or pedagogic aspects, etc. In addition one might wish to use only parts of the learning resource or aggregate it with more material. In this way learning resources can be re-used in the creation of new ones that in turn can be described, approved, published, etc.

Integrate: The learning resource, whether modified or not, is used in a variety of technical contexts, e.g. using an interactive whiteboard or being incorporated into one of the hundreds of virtual learning environments available.

Using: Eventually the learning resource is used in a learning setting which may be at home, in collaboration with others, etc. The learning context is often constructivist and activities encourage active, learner-centred pedagogies.

Local delete: In a scenario where a teacher or learner has obtained a learning resource, she eventually may dispose it.

Retract: The persons/ organizations that published a learning resource might decide to retract it. In figure 1, there are two cycles intersecting at the modifying point (actually running in parallel through finding, evaluating and obtaining):

- The product development and promotion cycle: creating, publishing, discovery, evaluating, resolution, obtaining, modifying.
- The learning cycle: finding, evaluating, obtaining learning resources, and then modifying, integrating and using learning resources.

While in smaller settings not every action described above is necessary, success of a complete online learning environment depends on the success of all actions.

- to communicate with learning communities and people that share the same interests; to discuss about the most engaging exhibits and other resources, to post comments and suggestions, and help scientists communicate their ideas!

The ScienceTweets platform was designed so as to provide the following main types of functionalities (service category):

- **Learning - informing**: Users explore learning material in the form of digital exhibits and web collections and learn more about Photochemistry. They discover a variety of educational and entertaining digital resources, such as information links, images and videos, interactive games, and other forms of content material. Also, they have the opportunity to develop digital resources about Photochemistry, share them with friends and colleagues, or use them for enjoyment and learning purposes. Especially the digital resources offered can be used for science education, at school or in a non-formal learning environment (for example, a science museum or an adult learning program).
- **Networking – Community Building**: Services related with networking and sharing of the content. This type of services will allow users to communicate and to submit their feedback on a specific content. Users have the opportunity to share relevant digital material developed by the ScienceTweets participants or resources that one discovered on the web. Photochemistry experts have the opportunity to share their research findings with non-experts in a creative and entertaining way: they can develop their own exhibit using a simple editorial tool provided by ScienceTweets.
- **Dissemination**: Services that concern constant online presentation and dissemination of the project progress and results.
- **Administration**: Services that allow content and user management of the e-KNOWNET portal.

Each type of functionality was operationally translated into one or more functions.

An important decision was to identify the rights of the users' communities involved. Grouping the potential users of e.Knownet portal was directed by the allocation of different rights and the foreseen type of participation.

Rights allocation takes place upon signing up as ScienceTweets member and according to the profile defined by the user.

The main categories of rights were the following:

- **Visitors**: Limited access,
- **Registered members**: Users that can participate in activities,
- **Accredited members**: Users that can start new activities, evaluate content, call or disqualify members from an activity,
- **Administrators:** Users that have full rights,
- **Administration support:** Users responsible for technical support, scientific validation, facilitation, info etc.

For the phase of full exploitation of the project, it is expected that the rights allocation will have to be modified, as the ScienceTweets platform will cease to operate in the pilot mode and enter a self-sustained mode of function.

Example from the e.Knownet experience - This matrix was used in the e.Knownet project to map the network groups according to different rights allocation.

	Contractual Actors		Non-contractual actors												
			Beneficiaries				Active users					Sponsors	Supporters	Disseminators	
			Target Groups			Other									
	Development Team	Administration	Secondary school students	Adult	Science center staff	Science centre visitors	European networks relevant to the project (e.g. EUN,	Practitioners / experts involved in ICT-enabled	Users of science popularisation	Formal education communities	Learned societies			Multiplier groups	Mass media
Users groups / rights allocation															
Visitors (Limited access rights. Observing)															
Registered members (participation in activities)															
Accredited members (They can start new activities, evaluate content, call or disqualify members from an activity)															
Administrators (full rights, users administration)															
Administration support (technical support, scientific validation, facilitation, info etc)															

After grouping the users with regards to their rights, involved users for each functionality type were determined.

In the following table a presentation of foreseen portal functionalities for each category is reported along with the involved users.

Table 2: Grouping users according to type of participation

	Contractual Actors		Non-contractual actors												
			Beneficiaries				Active users					Sponsors	Supporters	Disseminators	
			Target Groups			Other									
	Development Team	Administration	Secondary school students	Adult	Science center staff	Science centre visitors	European networks relevant to the project	Practitioners / experts involved in ICT-enabled science	Users of science popularisation portals	Formal education communities	Learned societies	Sponsors	Supporters	Various multiplier groups	Mass media
FUNCTIONALITY TYPE															
1. Learning – informing															
Material development / editing															
Educational content supervision															
Approval of content															
Use of existing material (interact, discover etc)															
Obtain															
Adapt & Reuse															
Evaluation															
Feedback															
2. Networking – Community Building															

Promoting portal to new networks															
Experts - Offer expert opinions.															
Facilitating – moderating – monitoring members' activities / participation, Registering members opinions. Filtering inappropriate or non relevant messages.															
3. Dissemination (valorization and management of e-Knownet site)															
Supervision of info-site (www.e-Knownet.eu)															
Promoting portal to new communities															
Obtain															
4. Administration															
Technical supervision															
General content supervision - management															
(Non-expert) content production / editing															
Approval of (non-expert) content															
Uploading of content															
Members management															
Help desk															

3.2.3. Collaborative development of educational content on Photochemistry

The ScienceTweets platform did not have as a main objective to offer content to the public. Rather it was designed as a show-case to demonstrate the outcome of knowledge-sharing and collaborative production of simplified new science knowledge among researchers, lifelong learners, students and science educators. Therefore, on-going feeding of the platform was nor an objective, neither feasible in the context of the particular project concept.

As part of presenting the potential of the ScienceTweets concept, original learning material in the field of Photochemistry was produced. This part of work was implemented following the requirements of the pedagogic framework and directions developed in the orientation phase.

Students, lifelong learners and educators are introduced to new research findings in the domain of Photochemistry through exciting web-based applications and are offered a variety of multimodal resources to experiment with and deepen understanding. This work effort results roughly in the following material:

- 15 digital exhibits, featuring the work of more than 65 researchers
- 3000 web-accessed resources available at no cost (games, activities, interactives etc.)
- 6 web-collections of photos and explanatory texts
- 9 original live experiments explaining aspects of the scientific content of the platform
- 120 original videos presenting the project researchers
- 300 photos dedicated to the project
- 200 original photos presenting the project researchers and the laboratories
- 1500 terms hyperlinked to additional resources
- 250 terms with glossary explanation.

This large quantity of diverse material was organised in a meaningful way in the form of thematically discrete units called ‘digital exhibits’. Selected research results served as points of departure to form ‘**digital exhibits**’. Each digital exhibit is a **learning module**, with a simple structure, presented in a web-learning friendly mode: texts as short as possible, divided in self-contained chunks, use of titles and hypertext, pages with clear information structure, hyperlinks leading to further resources, unambiguous relation between text, photo and other resources, etc.

All digital exhibits were structured following an agreed ‘template’, a grid with information ‘shelves’ designed to serve learning purposes. A template common for all digital exhibits was the guideline for collaborative

development of the core material. All researchers were asked to provide input to categories such as the following:

Heading	Description
Title	A short, precise, non-technical eye-catching phrase.
Subtitle - Objective	Use sub-title to improve deliverance of the message if and when needed. A short statement (4-5 lines) informing the user about the topic(s)/main questions that are to be examined / explained.
Key words	A list of terms (5-10) corresponding to the core concepts/ideas structuring the specific module.
About	Short introduction to the theme
Links with society	
Research innovation	Promote scientific importance of the research example
Description of the method	A short and as simple as possible introduction to the scientific method used to achieve the results
Historical background	Some historical background in research, in the specific field. The forefathers of research, Nobel prizes, achievements etc.
The "face" of science	Who is who behind the scientific effort of the particular research result presented, be it individual or collective effort. Presentation of the institution behind the researcher/s work. Presentation of identification information with interest for a non-expert. Other information of social character (if provided) to stress the "human" face of the scientists.
Editing team	

A process of interaction followed between researchers and science communicators and science educators in order to produce a comprehensible text that would be simple enough without losing its scientific value and integrity. This text was combined with added features such as:

Teasers: Provocative questions to keep the interest high

Resources: Easily accessible web resources and non-technical references, relevant to each module.

Self evaluation activities

Glossary: A glossary for each exhibit

The digital exhibits followed two main formats: a generic one to develop exhibits for lifelong learners, and a second template to develop exhibits for students. The template for students leads to simpler texts, with more relevance to the school science and student reality. The two types of exhibits were embedded in different environments, each one for the corresponding user group.

A third environment was developed to address the needs of science educators, teachers and science centre/museum staff involved in learning. This environment contained mostly material of methodological orientation, as well as a wealth of resources in order to facilitate the development of informal web-based learning and other material.

3.2.4. Evaluation of the project

A coherent evaluation system was designed and implemented in order to ensure a high quality level for all the e.Knownet components (e.g. orientation, networking, pedagogical approach, technological aspects, etc.). Both internal and external evaluation was performed. The quality instrument utilised by the external evaluator for the ScienceTweets platform used the following set of indicators:

- usefulness and utility
- learning support and scaffolding (Jonassen, 2006) for learners in different learning contexts
- instructional and learning organization according to specific objectives
- development of learning skills (e.g., interaction with other actors in the platform, collaborative learning, autonomous and self-directed learning etc.).

The evaluation system developed for the needs of the e.Knownet project consisted of **five dimensions** and consequent **criteria** for the assessment of the key elements of the project. These criteria corresponded to portal features considered as critical success factors for learning purposes. They reflect the main elements identified in the previous section and they are detailed to specific sub-criteria which fall under the main categories.

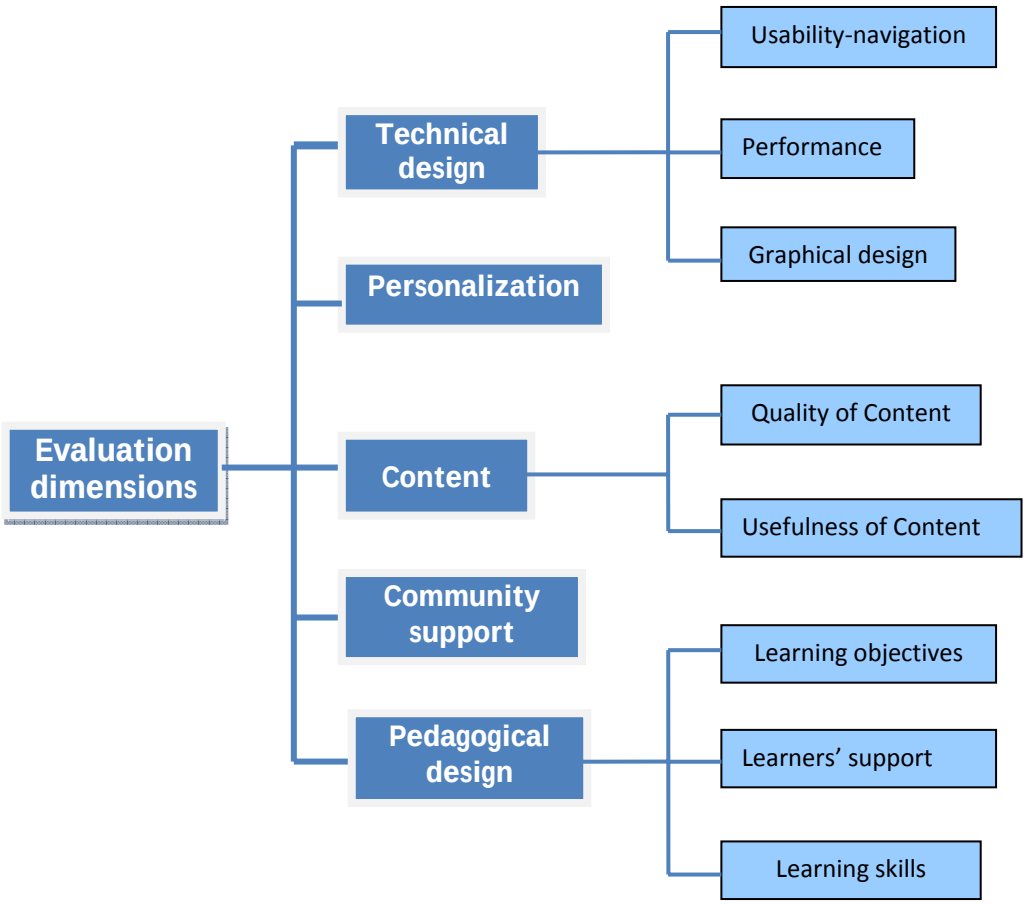


Figure 2: Ensuring high quality of a portal-based networking project for lifelong learning

3.3.1. The expansion phase: Awareness raising, networking and exploitation activities.

At this final stage of the e.Knownet project, the preconditions were set for an efficient exploitation of the project outcomes, and especially the ScienceTweets platform.

A first step towards efficient exploitation of the project was the implementation of a cohesive awareness raising and dissemination programme across the various fields related to non-formal education and ICT-enabled learning, in order to mobilize all relevant parties.

This was followed by concerted activities to strengthen the network identity of the e.Knownet project. All partners took under their responsibility and carried out a programme of contacts and activities along with local/ European/international key partners that could import added value in the proposed networking scheme. The target was to valorise existing good relations of the e.Knownet partners and also advance the project outcomes in cross-cutting relevant areas of expertise and fields of interest. Organisations and networks of European and worldwide radiance were approached for the purpose of networking and exploitation, such as

the European Photochemistry Association, the European Network of Science Centres and Museums (ECSITE), the Association of Science and Technology Centres (ASTC), the ONLINE EDUCA BERLIN, and also major projects specialised in bridging formal and non-formal learning, i.e. the EXPLOAR and the OpenScienceResources (OSR) projects. These entities offered their cooperation in various instances and facilitated the furthering of the networking activities of the e.Knownet project.

Finally, more than 13 Photochemistry laboratories across Europe and more than 65 researchers joint forces to realise the e.Knownet project. This effort was largely facilitated by the European Photochemistry Association.

The consortium sought to achieve multiplication effects through the involvement of, amongst others, influential multipliers and journalists specializing in ICT-enhanced education, administrators of educational portals/nets, ICT experts specializing in education, museum educators and learned societies.

The issue of the present networking manual was part of this effort.

Part II

1. Introduction

In the late twentieth century changes in the sphere of technology, economy, distribution of labour and culture have largely affected various fields of social and personal experience related to knowledge (Bernstein & Solomon, 1999). These transformations in the globalised knowledge society are to a certain extent connected to the fact that the volume and complexity of **specialised knowledge** have increased exponentially (Singh, 2002).

New discoveries in sciences accumulate every day and strongly influence the social, economic, political and ethical structures of our life. **Science literacy**, or at least a certain degree of it, has become a necessary condition if we are to function as citizens, as employers or employees, as social beings. Citizens are required to make themselves available for re-education and re-trainability for the duration of life.

Public access to school and other agents of formal education alone is not able to fulfil the need for universal acquisition of this ever increasing specialised knowledge (Singh, 2002). **Intermediary agencies**, such as the mass media, research councils, industry, various professional and scientific bodies (like NASA, CERN and ESA), science museums and also web-based initiatives provide the 'translation' of specialised knowledge and distribute it to non-expert publics.

Everyday it becomes more and more apparent that the pedagogical landscape is experiencing a radical transformation. New forms and practices of pedagogic communication arise. This is partly due to the advent of the electronic networks of information and communication and the rapidly evolving web-based applications. This new reality includes e-classes, digital learning objects, augmented reality applications, wikis, on-line seminars, and also on-line exhibitions, simulations and a variety of web-based activities.

Learning today seems to be carried out almost everywhere. It can occur on a particular time-line or on a one-time exchange mode. Boundaries between institutions and disciplines become less fixed. The concept of age-specific learning cohort subsides. Learning opportunities are available for –almost- everyone through an incredible variety of means and practices.

Pedagogic relations are also undergoing a deep transformation. Learning maybe state, community, economy, or participant-driven. Peer-to-peer learning seems to be gaining space, through formal or informal social networks facilitating two-way communication and interaction. Every participant can be a teacher and a learner. Collaborative design and development of material with a learning orientation is gradually becoming a required practice.

There is an evolving convergence between the traditional learning resources, the new digital technologies and web applications. These, when

combined may produce powerful learning tools that can be used for science teaching for visitors of all ages.

2. Networking in the field of non-formal science learning

In the transformed pedagogic landscape of today, successful science learning depends largely on the development of networks that allow knowledge-sharing between actors with different expertise and skills, as well as development of learning resources in collaborative schemes and environments.

Network organisation is the best way to bring together diverse actors but with compatible learning interests. It is an effective way of linking autonomous but interdependent actors to each other. Moreover, network organization is ideal for exchanging complex knowledge and information that cannot be passed on easily by more hierarchical forms of organizing.

Web based networks provide additional advantages since they can reach wider audiences and facilitate ties between multiple actors from different institutional or social settings and geographic areas, with diverse learning needs. ICT-enabled networks make it possible to present the relevant material in a more interesting and stimulating way.

3. What to aim for when designing an web-based networking activity

1. Increase the viability of the activity, through fostering bonds with strategic allies with complimentary activity and targets.
2. Mobilize directly or indirectly, the human capital involved in the new activity (partners' staff, stakeholders, civil society, learning communities, mass media etc).
3. Achieve constant and harmonious cooperation among the core network of the project partenariat and the attracted stakeholders.
4. Further promote the vision of the new activity and inspire a culture of knowledge sharing among all involved parties.
5. Promote and make known the new activity to final users who will benefit from the services to be offered.
6. Create opportunities for cross-disciplinary dialogue upon issues such as the theory and practice of life-long learning and e-learning, the role of formal education institutions in this LLL field, comparative analyses of various European LLL systems, identify trends and prospects of LLL, ICT applications, e-learning, developing special learning material for ICT use, training of LLL educators especially for adult learners, VR systems in le-learning, evaluation of LLL, innovative case studies etc.
7. Achieve multiplication effects through the involvement of administrators of educational portals/nets, ICT experts specializing

in education, museum educators, journalists specializing in ICT-enhanced education, etc.

4. Networking Actors

When considering the establishment of a knowledge-sharing network we need to think of it as something larger than the immediate partnership. It needs to be envisioned as encompassing other actors that will benefit from the network, engage in exchanging information, contribute in enriching the content of the platform or provide different kinds of support to the network. In order to set up a successful knowledge sharing network we need to identify:

- Who the target audience is so that we are aware of its needs and preferences.
- Who are the main stakeholders involved in non-formal science learning and the ties that exist between them.

This is necessary both in order to understand the role played by different stakeholders, how they could relate to a network, identify existing gaps in the ties between stakeholders and consider how these can be bridged.

We shall proceed by identifying two categories of network actors. In order to fulfil its main objectives, any networking initiative needs to form ties with actors that are outside the official partnership. This means that in the long run the network will consist of both **contractual and non-contractual** actors.
Contractual partners have the primary responsibility for setting up the knowledge exchange network. These institutions are officially and legally bound by commonly accepted obligations as part of a European or other (co-) funded project.
However the viability of the network will depend on its ability to extent its ties to non-contractual actors that will provide in the long run the resources needed for the network to be sustained. Non – contractual actors involve all actors that will become part of the larger network either as users, providers of various resources, or both. Different non-contractual actors are likely to perform different roles and their relationship with the network is likely to differ depending on the type of function that they will perform. Non-contractual actors are linked to each other through bonds of varying degrees of formality and even non formal ones.
Networking actors are described in more detail below.

Contractual Actors

- Development Team (the work group of the project that actively implements development of resources for the project portal or platform).
- Administration Team (the official Administration work group of the project).

Non-contractual actors

- **Beneficiaries**. They profit directly from the project services and resources.
- **Active users.** They contribute by expanding existing content or providing new content (e.g. scientists, educators, practitioners / experts involved in ICT-enabled learning, users of portals of relevant fields, formal education communities, learned societies).
- **Disseminators.** Multiplier groups and mass media.
- **Sponsors**. They co-finance network activities (national and regional authorities, private sponsors).
- **Supporters.** Individuals or institutions willing to support the project by distributing information or mainstream network results (decision and policy makers).

5. Main functions of a web-based networking activity

A portal-based activity in the domain of lifelong learning founded on the concept of networking should be able to provide services along the following axes:

- **Learning - informing:** this type of activities is related with services that allow browsing and interacting with content (learning and simply informative) with varying degrees of interaction.
- **Social networking**: this type of services is related with examples of two-way communication flow and interaction, involving cross-field and/or interdisciplinary activities, exchanges among users, learning role alternation, knowledge-sharing and cooperative systems for production of resources.
    - **Internal networking:** this kind of activities imply knowledge sharing, capacity building, developing common vocabulary and fostering bonds of cooperation among partners of the same networking project.
    - **External networking - Community Building:** this kind of activities may involve portal-facilitated interconnection among various learning communities leading to fruitful co-operations usually of strategic importance for the viability of a networking project.
- **Dissemination**: these services concern presentation and dissemination of project progress and results. They enhance the visibility of the project concept and scope and its appeal for new users.
- **Administration**: these services are vital for enabling any web-based networking initiative, e.g. for the management of the work flow, the coordination of content, and the user management concerning communication flow among users, allocation of users'

rights, settling of disputes, safeguarding issues of ethics, safety and etiquette, intellectual property rights etc.

6. Facilitating interaction: means and methods

When designing a networking project, an aspect that needs special attention is the human dimension, even if the project is at a large extent enabled by use of ICT. A series of actions should be taken in order to strengthen bonds between all involved parties.

- **Internal networking**

It is vital to dedicate part of the work effort in order to build (or enhance) a common project identity, the sense of 'belonging' and 'ownership' of the project concept among partners. Drawing on the e.Knownet experience, this may well be achieved through:

- **Study visits between partner organizations.** Organise knowledge sharing activities among partners concerning useful experience and practices related to project concept. This exchange will also help generate bonds on an organisational level. In each study visit it is vital to involve co-workers and colleagues from each partner organisation that are not directly –or at all- involved in the project, but who could influence the course of the partner involvement, e.g. colleagues from financial departments, influential figures from the partner institution who could help with new ideas or support the project at a higher representation level within the partner organisation.
- **Peer-training workshops.** In case the project requires the development of resources of any type, capacity building workshops directly contribute to the success of project. These type of workshops apart from enhancing the competence of the staff involved in the project, create a sense of 'belonging' among the colleagues in the project work group, within the partner organisation.

- **External networking**

External networking may be pursued through the following means and methods:

- **Project platform:** Use of the project portal as a hub to develop a participatory system of privileged interlocutors through the platform. The portal will be the "show case" of the project attracting public attention on its open-to-all educational resources. The portal facilities link up the network and its events with science venues and science centres all over Europe, and anyone with Internet access.
- **Signing MoUs.** Signing Memoranda of Understanding with key stakeholders is one more means to achieve stable frameworks of cooperation throughout the life-cycle of a new project. Through

various stable co-operations, the project will benefit in various ways, such as:

- acquiring extra sources for input/content for the project portal
- trace possible opportunities for joint organisation of general or targeted dissemination / exploitation activities. This type of cooperation will multiply the dissemination capacity of the project, without laying extra burden on the project budget and possibly release funds for other activities.
- ensure efficient penetration of the project results into various learning communities.
- pave the way for a continuing use of project results after the official project termination.

- **Valorize existing and develop new links and practices.** Partners have their own pool of collaborators, stakeholders and privileged interlocutors. They also have their own tested practices to tackle various issues. These links and practices should be valorised and become part of the project methodology.
- **Establish the project's 'memory pack'.** Compile the project experience in formats that allow knowledge-sharing. This could be an interactive portal-based guide, and/or a manual uploaded in the project portal available also in a printable version. This resource could help passing on the project experience to any interested party. This activity is expected to prolong the effects of the project and provide an outcome with long lasting effects.
- **Clustering with other European projects**, where synergies can be foreseen. Design and/or participate in joint dissemination activities that will further increase the impact of the project and mobilize all relevant parties.

7. Possible challenges

Setting up a successful network entails overcoming challenges, such as the following:

- **Epistemic, professional and cultural boundaries**. A successful networking activity in the lifelong learning domain brings together actors from different fields that do not necessarily share the same goals, values, professional practices and institutional culture etc, even when they fulfil complementary tasks.
- **Sustainability**. While European programmes provide an incentive for bringing diverse actors together their success will depend on their ability to be sustained even after the project is over. The upgrade and further enhancement of the web tools developed in the framework of a networking project are not feasible after the conclusion of the project and the termination of the financial resources.

Recommendations

- Define early on the specifications that will ensure the **viability** of the network, for example possible income sources, economies of scale, sponsorship, synergies with other projects, support from the private or public sector. Alternatively, find an organization willing to host and upgrade the portal, and also undertake the maintenance costs.
- Consider carefully the **added value** of the new network against already existing ones.
- Dedicate effort to enhancing the **collaborative** features of any web-based networking tool, so that to offer the opportunity for novel learning applications performed in cooperative modes.
- Provide functionalities and Web 2.0 supportive tools (e.g. forum, blog, wiki) that support learning community operation and allow interaction and sharing of knowledge, content and experiences as well. Offer synchronous and asynchronous communication tools (forum, e-mail, chat, newsletter, mailing list etc.) for the communication between the users and the platform administrator, and among the whole community members as well.
- Integrate content of high quality from multiple sources, in appealing user-friendly format. All specialised material should be clear and well documented.
- Develop web-based platforms that require minimum effort to use.