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Educational Networking between Schools and Non-Formal Contexts

The NetS-EU Handbook

Edited by Mario Campanino

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Introduction

by *Mario Campanino*

The aim of this book is to circulate the results attained by the European NetS-EU project (Network to improve non-formal science teaching in Europe), developed between 2010 and 2013 by a group of eight organizations based in as many European countries. The project has been coordinated by the Italian partner of the network, the Fondazione IDIS-Città della Scienza of Naples[1].

The present work is divided into three parts. The first part briefly outlines the conditions applicable to school, education and culture (with special emphasis on their scientific side) in Europe: guidelines from the European Community, formal and informal education and teachers' role, the new teaching and learning technologies and the relationships between the various dimensions of scientific knowledge: research, communication, dissemination and didactics. The second part provides a critical overview of the main tools that can be adopted today in order to feed the networking among different institutions on a European scale: the use of special web 2.0 platforms, the organization of conferences and workshops, the collaborative research and analysis of the context, both at desk level and on field. Finally, the third part provides a summary overview of the project which represents the opportunity to bring this book to life – namely NetS-EU, a networking and research-action project on a European level – and a hypothetical formulation of what may be the scope of any future action targeting school in its broad institutional, social and cultural orientations.

The authors of this brief volume have all been involved in the NetS-EU project in many ways, in their function of managers of organizations dedicated to scientific divulgation or education, project managers, animators and didactic planners, professional training and counselling experts and trainers, university lecturers (with the most diverse educational backgrounds, including

1. For all information about the project, see CHAP. 11, *NetS-EU: A Network to Improve Non-Formal Science Teaching in Europe*, at p. 53 or join the online community: netseu.ning.com.

philosophy, psychology, sociology, literature, arts and music, as well as – naturally – science and maths). The choice to limit the authorship exclusively to those people, who actually took part in the project activities, has the intention of providing proof – already with the drafting of these written contributions – of the efficiency of the networking activity carried out by the key players starting from the *project* dimension of the intervention. With the conscious risk of a certain degree of heterogeneity among the contributions – to which the editor has attempted to give, in the most natural way possible, mainly only a hopefully coherent structure – such a diverse group of people as it is, without purporting to be a representative statistical sample, expresses how varied and rich it can be what we could define «the world in which the school expands»[2].

In its brief structure, the volume sets out – if it does not achieve the purpose – to go beyond the primary aim of its creation and provide a summary tool for confrontation and a more in-depth reflection or experimentation regarding networking methods and challenges among schools, museums, universities, associations and other non-formal organizations[3]; this in the certainty that, today, only networking represents a sound method of development and comparison among the various pressing issues posed by the so-called "knowledge society" in an educational, vocational, formative and professional sense.

2. See CHAP. 12, *New Projects for Education: An Organismic Perspective of Networking*, at p. 57.

3. Although the expression "non-formal" is preferred by the editor to designate the work of individuals and organizations that contribute to the realization of intentional structured learning opportunities, sometimes it is here replaced with the term "informal" in order to respect the terminology used in the original language, without the intention of suggesting meaning changes. The term assumes a different designation, however, in the cases where it is used in combination with "non-formal".

Part 1
Science, Education, Europe

1

Science and School in Europe: Research and Perspectives

by *Rossella Parente*

There is no doubt that science and education play a key role in everybody's lives. It is thanks to scientific and technological advances that many aspects of our life, such as entertainment and health, have improved over the last twenty years. Scientific discoveries have already changed and will continue to change our life styles with some profound effects on society. The world has never been so complex, and understanding what is happening, knowing how to choose and use technology, and gaining an understanding of scientific facts helps to make informed decisions. If it is true that over the last few years scientific and technological discoveries have increasingly shaped our daily lives, it is also fair to say that people can influence the work of scientists and engineers by taking decisions that will have an impact on future social structures and environmental choices. Thus, the publication *The Next Generation Science Standards*, developed by 26 American states, reads: «Science is also key to the United States' ability to continue to innovate, retain the role of leader of the global economy and create future employment opportunities»[1].

If Europe intends to make technological advances as well, improve the quality of life of its citizens and compete at the global level, its students must have a solid scientific education in preparation for their university studies and careers. On the contrary, however, the percentage of scientific graduates is falling. «The resulting lack of skills in these sectors is now perceived as a threat for the current economies, based on technology and science. Therefore, the majority of European countries have taken the increase in the number of graduate students in math, science and technology as one of their priorities» (Eurydice-EACEA, 2012). All the measures that may help to increase students' motivation to learn about science, math and technology are necessary actions to take. Yet few of these countries have developed

1. Achieve, Inc. on behalf of the Twenty-six States and Partners that collaborated on the NGSS (2013).

national strategies to elevate the scientific profile and are instead continuing to endorse non-system programs and initiatives.

The enhancement of teachers' competences is regarded as a key factor in the strategies that can be deployed in order to strengthen scientific education. And the enhancement of teachers' training is among the first actions taken by those European countries that pursue a national strategic framework aimed at the promotion of scientific education. In Europe, education authorities provide specific and constant training activities for teachers. «School partnership, associations, science centres and similar institutions contribute to teachers' informal training» (*ibid.*). In most of these countries, the knowledge and ability to teach scientific courses are considered to be the most important skills in teacher training. On the other hand, the management of diversity is given less importance: few countries have implemented national programmes addressed to talented students in the scientific field or in support of students with special needs.

School associations in partnership with universities, research institutes, museums and science centres are widespread in Europe. This cooperation can be extremely diverse – in terms of the partners involved, the way they are structured and the geographical areas they cover – however they all pursue at least one of the following objectives: promoting scientific culture, understanding what science is for, strengthening scientific education, increasing work in the scientific field: «The science centres share one or more of the afore-mentioned objectives and contribute towards the improvement of scientific education by providing students with activities that go beyond those usually offered in schools. Two thirds of the European countries under review declare to have scientific centres at the national level» (Eurydice-EACEA, 2011).

But how do we teach science in school? Almost anywhere in Europe, science is taught as a complementary subject throughout primary school education. However, in most countries this approach only lasts until the first two years of lower secondary education. Afterwards, science education is divided into the following subjects: biology, chemistry and physics. Moreover, while most European countries recommend that scientific education be put in context and in relation to contemporary society and its issues, traditional teaching methods are still prevailing. Methods which, according to some research reports, not just at European level, should be combined with active and participatory approaches based on inquiry processes (IBSE, Inquiry-Based Science Education) aimed to make science teaching/learning more effective.

With regards to evaluation methods, although the best practices should combine both traditional and project-based evaluations, the former are predominantly used. Furthermore, specific techniques for scientific knowledge evaluation are recommended in half of the European countries. However, it is interesting to note that it is perhaps not possible to make a distinction between scientific evaluation and the evaluation of all other subjects. In all countries, official documents available to evaluate the skills acquired by science students is scarce.

As we have already mentioned, the promotion of science education is a priority for all countries and, in order to increase it, it would be necessary to make more and better investments of human and financial resources in scientific education. However, we have been plagued by a strong economic crisis over the last few years that has resulted in a deficit increase for many countries with consequent drastic cuts on public expenditure. But what impact is the crisis having on European education and training systems? Concluding our brief exposition, we must be aware that all our future reflections on education should face this:

> In total, in 2011 and/or 2012, cuts in education budget were made in twenty European countries/regions for which data are available. Cuts of more than 5% were observed. During 2011 and 2012, the numbers of teachers decreased in one third of countries for a variety of reasons. The main cause reported was a fall in pupil/student numbers, but the reductions in public funding for education also contributed. Salary cuts and freezes have been used as one of the main mechanisms to reduce education expenditure. But, in eighteen European countries, funding for continuing professional development increases in line with the general policy objective of improving teacher's skills (Eurydice-EACEA, 2013).

2

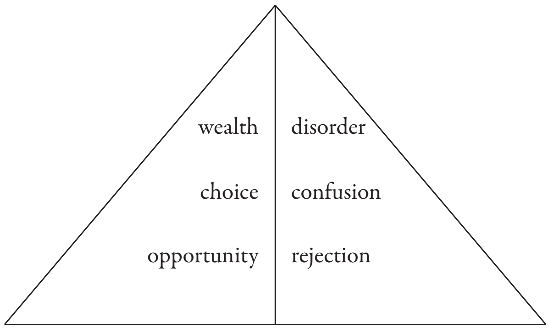
Science Education in Europe: Formal, Informal and the Role of the Teacher

by *Mario Campanino*

The complexity of the topic addressed here is due to different aspects that both *compose* this complexity, and, once they are explained, resolve them. Despite the brevity of this explanation, we must cite these aspects, and we will do so by indicating their elements actually conditioning the strategies in question.

On one hand, there is the aspect of true disciplinary difficulty, the preconception that scientific disciplines would be “difficult” or “more difficult” than social and humanistic ones. This discourages its study, in particular by female students; they may see themselves, among other things, penetrating with difficulty into an unwelcoming scientific professional world, and thus opt not to follow the path to in-depth knowledge. On the other hand, there is the plurality of the contexts and means in which the European social and cultural reality is manifested (the school, the university, the agencies of non-formal education and various informal contexts), and the multiplicity of identities expressed by the European of today (the student, the school teacher, the expert, the researcher). Each one can be teacher, student, chat friend or member of the same learning community at the same time, breaking down and confusing barriers among categories of people (and of positions about knowledge) that had held firm for decades. There is finally, closely interwoven in all this, the profound differentiation (ethnic, social, cultural, economic) among the countries that compose the European Union. This diversity characterizes and is the very essence of the Union, from which the Union nourishes itself and from which it seeks to gather inspiration and means of development.

All this, the professed difficulty of sciences, the diversity and overlapping of contexts and identities, the intrinsic differentiation of the Union, indicate a perspective that is open to two different interpretations, one positive and the other negative, which are not necessarily mutually exclusive and can be represented this way:



The intersection of all the variants we have just mentioned gives rise to a very rich context of learning/teaching opportunities, in which the boundaries among formal, informal and non-formal are blurred (think of the difficulty of classifying a brief explanation provided by a teacher to one of his/her students during a visit to a science museum). This wealth can be perceived, however, as a crowding of elements "in disorder" that invalidate the organizational stability of the means of transmission/propagation of knowledge: a student may be undecided about which information is important to remember in relation to a specific topic: the information provided by the teacher during the preparation for the visit? or the different views just expressed by the guide? and, additionally, they may further confuse ideas with regard to the content: why were they different? This wealth/disorder always requires making a choice: choosing which information to remember and which to ignore, which teacher to follow eventually as a primary figure of direction and which to consider complementary in the hierarchy of one's own references; which cognitive line and strategy to prefer above another, how to move in the field of opportunities also with reference to different evaluation criteria that can come from various contexts or people. The inability or impossibility of making the choice hides the danger of the confusion of styles and directions, the nebulous nature of epistemological overlaps, and the vagueness of the very goals of learning: from whom should I learn, what and why? The great field of learning occasions, much greater, richer and multiform than before, opens before us, with opportunities to select, sort in priority order, benefit from and recompose in what is and will be our own personal knowledge. We can also get an unfortunate lack of knowledge in discerning through the dazzle, and confusion in facing that nebulous (the *cloud*?) of opportunities for learning. This may result in opting perhaps for a renunciation, even partial, a refusal not so much of the content but rather of the means of learning (the means of learning, we note, and not just that of teaching).

Yes, the man or woman of today, the student of today, even facing a wealth of opportunities never seen before, runs the risk of remaining outside, because today's challenge is always that of *complex* knowledge. This is why all the programmatic guidelines of the school in Europe place complexity in the first place among the elements conditioning knowledge, and indicate the school as the first agent – perhaps only after the family, in the specific case of childhood – of decoding and interpreting the complexity in which the knowledge today is hidden (in the books and in the various tangible and intangible media that convey it).

In this situation, a key figure at the crossroads of formal, non-formal and informal opportunities for learning is that of the teacher, now forced to reconsider his/her own professional identity. Now, like it or not, he or she is a member of a learning community – the school – that is contaminated by other learning communities that have reached it and perhaps overcome its pervasiveness: the family, peers, members of the same volunteer association, viewers of the same educational television program, followers of the same YouTube channel. The teacher is thus transformed from a transmitter of content to be learned into a critical guide for travelling the paths (multi-linguistic, multi-sensory, multi-media, multi-ethnic) of acquisition, creation and development of knowledge. It is no coincidence that pedagogical post-cognitivist approaches place emphasis on the reduction of the asymmetry between the roles of the teacher and that of the student: in the contextualist and even more culturalist visions of the learning group, the teacher takes on the role of co-builder of learning, the content and modality of which are the result of a work of mediation in which the teacher collaborates and sometimes guides, but not always in a predominant position.

In conclusion, it is possible to state that the teacher is primarily responsible for allowing and encouraging each one to investigate opportunities for learning in the field, make their own choices and play the "game of the knowledge". The teacher is the guarantor of the educational and training offerings supported by the school. The teacher is a mediator between the interior world and the external one: within, the mechanisms of learning, the thoughts and emotions, the individual and group cognitive styles; outside, the knowledge structured in a culture that gives it, in various ways, and the culture and its media as keys of de-structuring and appropriation of knowledge. The complexity of the relationships and links among formal, non-formal and informal learning contexts, toward which educational research and didactic experimentation tend today, can be managed only thanks to the role of these teachers, with their function of harmonizers of contexts and opportunities.

3

Dissemination and Scientific "Knowledge": The "How" and the "Why"

by *Luigi Amodio* and *Vincenzo Lipardi*

In the world of science, dissemination was often understood more as a technique for simplification and popularization of complex scientific research than as a tool to provide the useful "keys" for understanding "the secrets of nature", as a means capable of building technical and social involvement models and cultural integration between the humanistic and the more precisely scientific culture; i.e., to pursue the goal of democratising society.

Over the centuries, changes were seen in both the "why" and the "how" of this dissemination or, as it was otherwise called, scientific communication. A first why, obviously, lies in the intersubjective nature of science as a human activity: science being done – through observations, experiments, formalizations etc. – makes no sense if not communicated to others, thus verified, discussed, validated or rejected. This aspect of scientific communication, the so-called "intrascientific communication", has not changed substantially despite the change in the tools; in practice, the use of the Internet had a great impact not only on the times and the tools but also, as we will see below, on the actors involved. However, regarding the public communication of science outside the community of scientists, things have changed radically.

But here we must take a quick look at the past and see what happened in the prior centuries. It is useful to recall that one of the works that most revolutionized the (not only scientific) Italian and European culture is, at the same time, an outstanding example of scientific communication, so much so that the radicalism of the content is connected strongly to that of the expression. We are referring to Galileo's *Dialogue of the Two World Systems*, in which the choice of the dialogue form, which is part of the tradition, becomes a tool for the introduction of innovative and daring theories. Dissemination in the 1500s established a means of communication that we may call modern thanks to the conference/show. One name known to all was French potter Bernard Palissy, famous, among other things, for his public lectures on natural history. Let us recall that people paid a crown for a ticket to listen to his lesson; that was a significant amount in those days. But it was in 1600 that scientific dissemination was firmly established, thanks to the proliferation of experiments in the *cabinet de curiosités* and in the salons.

It was in the 1800s that the modern concept of scientific dissemination truly began. Michael Faraday was emblematic of the spirit of the time; with his Friday and Christmas lectures he demonstrated perhaps the most significant example of scientific dissemination as the "forerunner" of modern media. His lectures at the Royal Institution of Great Britain, including the famous *Chemical history of a candle*, became a Christmas reading cult among young English people. The Royal Institution Christmas Lectures he began in 1825 still continue today. Faraday grasped the importance of education and was very attentive to the academic system of his country. In 1862 he had a famous meeting with the Public Schools Commission to express his innovative ideas on the educational system of Great Britain, and finally, as a modern scientist, he refused for ethical reasons to participate in the production of chemical weapons in the Crimean War.

What is common to these experiences is certainly both the positivist and illuminist tension of enhancing the scientific culture among the "common people" and the utilitarian idea, developed in the 1800s, that increased scientific skills could qualify the labour class.

On the other hand, regarding museums, with their nature of supporting scientific research after the era of the "chambers of marvels", it is interesting to recall here Leibniz's description of an ideal scientific museum, practically a modern science centre:

> magic lanterns, flights, artificial meteors and all sorts of optical marvels; a representation of the sky, the stars and the comets; fireworks, water fountains, strange-shaped boats, automatons drinking water, demonstrations on the telescope, calculating machines, exhibitions of the dark room, experiments consisting of shattering a glass by shouting and demonstrating the balance of the pendulum's oscillations. This theatre of nature or art will stimulate inventions, offer beautiful views, and educate people with an infinite number of useful and ingenious novelties, exhibiting in this way a true museum of what it is possible to imagine (1675).

In Europe, as noted above, the cabinet spread, beginning in 1550, as the "cabinet of curiosities"; in Germany it was the *Kunst und Wunderkammer*, the "room of art and marvels", and in Italy it was the *studiolo*. In 1683, the University of Oxford inaugurated the Musaeum Ashmolianum, Schola Naturalis Historiae, Chemical Laboratory. It was a museum that, beginning with the collection of Elias Ashmole, implemented and created a modern institution. The form of administration also anticipated a modern museum: its staff included a "curator" and an "under-curator" paid with the revenues from ticket sales. A place was created where, commented German scholar Conrad von Uffenbach, «people touch everything [...] and even women are admitted [...] for 6 pence». In 1719, at the wish of Peter the Great, a public cabinet was inaugurated in Saint Petersburg, with the goal of "people seeing it and going inside". It is recalled that Leibniz also sent a memorandum to the Tsar in which he wrote: «these cabinets do not serve only for curiosity, but to be first of all a means of perfecting science and the arts».

The 1700s were a vibrant period and Paris saw increased interest by the aristocratic and bourgeois public toward the new philosophy. Nicolas Lemery, a French chemist, held lessons in the scientific cabinets where he "demonstrated chemistry" and thus the art of pharmaceutical preparation, while Jean-Antoine Nollet, better known as "the abbot Nollet", was the first professor of experimental physics at the University of Paris. Then there was the French naturalist Jacques-Christophe Valmont de Bomare, a passionate student of natural sciences. After a trip to Lapland and Iceland, where he had studied the functioning of the volcanoes, he returned to Paris and starting June 16, 1756, for approximately 30 years, «from the first days of December to April 15, Tuesday, Thursday and Saturday morning at 11:30» held natural history lessons as a demonstrator/professor.

Marvelling, making known, demonstrating the power of technology, science and art, in a word of rising capitalism was an imperative that was affirmed between the end of the 1800s and the beginning of the 1900s, also in connection with the experience of major Universal Expositions, that created, among other things, "permanent marks". In London, after the Universal Exposition of 1851, thanks to the surplus of 186,000 pounds sterling, the Science Museum and the Natural History Museum were founded.

The museums also, once they became tools for public communication of science, obviously did not escape the "educational" tension of which it was first said: let us think about the entirely political motivations that led to the birth of the Palais de la Découverte of Paris as a place of cultural growth of the workers and labourers in the era of the Popular Front. The Palais de la Découverte represents a particularly interesting example because as early as the 1930s all the elements were present in it that characterise the modern science centre: interactivity, the role of the scientific guide, the entertainment value of knowledge, the use of reproduction of experiments as well as collections of historic objects. It was not an accident if Frank Oppenheimer, the founder of the Exploratorium of San Francisco, acquired from the visit to this and other European museum institutions (in Munich and London) the theoretical basis for his famous science centre.

The Exploratorium represents an important step in the history of scientific museology. Its first characteristic is, naturally, interactivity based on exhibition of experiences as well as of objects of intrinsic value, such as those traditionally kept in museums. The hands-on exhibit, i.e., the objects that we must "put our hands on" to generate the reproduction of phenomena, represents the creative evolution of similar devices already present in the major European scientific museums and, for many years, the primary point of attraction of the science centre for everyone. Interactivity, beyond the banality often generated by a minimal use of the potential of the hands on exhibits themselves, naturally claims the characteristics of science itself, and thus its experimental nature. Its second characteristic is that of a democratic vocation of science and its socialization. The museum, i.e., the science centre, is not only a place open to participation by all people in order to share science and its effects as much as possible; even more, it is a gymnasium of equality that is exercised first on the cognitive and educational plane, in a society, such as that of the United States and in today's Europe, characterized by proverbial ethnic and cultural melting pot. A third aspect, and last here, is the aesthetic dimension. The Exploratorium, created as a "museum of art, science and human perception", plays explicitly on the relationship with its own visitors with the implicit beauty and elegance of the natural phenomena that represent a sort of "bait" to capture the attention through marvels to lead, afterward, toward the understanding of scientific laws. This beauty returns, this time explicitly, in the choice of the curators of Exploratorium's exhibits (and other museums and science centres) to entrust to true artists the production of hands on exhibits.

On this basis, here extremely summarized, an entire generation of museum institutions arose, or traditional museums were renewed, with unprecedented success at least until the mid-1990's, when the transformations linked to the role of science and technology in the contemporary society became explicit and imposed on those responsible for the work the need for new responses. The first transformation is that of the epistemological assets of scientific research and technology that we may summarize as the transition of academic science to its new post-academic condition. We define with the label of "academic science" what we usually think of when we use the term "pure science" or "general science", the characteristics of which emerged in Eastern Europe during the scientific revolution of the 17^{th} century and the regulations of which – formalized by Robert Merton – are well known: communitarianism (the common ownership of scientific discoveries and world of science's practice of renouncing to intellectual property of discoveries and sharing it to get back recognition and respect), universalism, disinterest and humility, originality and scepticism. The advent of post-academic science, which emerged late after World War II and became evident in quite recent times, depends both on factors external to science and for internal reasons, thus by increasingly fast scientific and technological progress and increasingly greater interdependence between science and technology. According to the physicist and humanist John Ziman, the characteristics of this new condition of science are: collectivization, limits to the development of science, benefiting from the knowledge, politicization of science, industrialization and bureaucratization.

But what most interests us, in this context, is that the plurality of actors participating in the scientific work in the post-academic dimension is increasingly larger, to the extent of being able to say that the same communication of science to the non-experts becomes an activity entirely internal to the "doing" of science itself, a relevant activity for its same development. As Pietro Greco says:

> This new era in the way scientists work involves a redefinition of the role that the communication of science to the public of non-experts plays for the development of science itself, as well as for the cultural and civil growth of the society overall. The hypothesis, thus, is that the public communication of science assumes a relevant role for the development of science itself (Greco, 1999).

Secondly, the nature of contemporary science and the change of paradigm determined by the arrival of the new life science, decidedly reposition the topic of the impact of science on daily life and on society. The current perception of science is increasingly connected with its possibility of reaching the roots of existence itself, through the modern biotechnology, nanotechnology etc., opening, in this way, unknown problems of social, political, legal, philosophical nature. In this environment, the limits and deficiencies became evident both of a technocratic approach, on which the "experts" are the only ones authorized to speak about science, and of a bioethical approach, that definitely leads back to the moral values of the individual. The need is increasingly noted for construction of new forms of dialogue and meetings among science, society and citizens, much more structured than what has occurred so far.

One last aspect to consider in this exposition is the information and telecommunication revolution, the premises and consequences of which could be read as early as the 1960s and '70s in the backlight. The increasingly widespread use of new information and communication technology in the production both of tangible goods (automated factory) and of intangible goods and services (and relational) has given "language", and more in general the manipulation of symbols, a central role. This characteristic of contemporary capitalism and the system of organising mass communication media, first and foremost Internet, represents one of the main peculiarities with regard to the increasingly massive introduction of new technologies in daily life. Manuel Castells, theorist of the information society, says:

> The processes of social transformation summarized in the ideal type of network society, go well beyond the sphere of social and technical production relationships, also deeply influencing culture and power. Cultural expressions are abstracted by history and geography and in great measure mediated by the electronic communication networks that interact with and through the public in a variety of codes and values, finally being assumed into a giant audio-visual digital hypertext (Castells, 2004).

All this also has an evident effect on the practices of communication in science museums. If, in fact, it is possible to say that in an era of academic science the placement of science in a museum essentially happens in the major scientific and naturalistic museums and thus in the science centre, the era of post-academic science and the widespread use of the new information and communication technology sees the affirmation in these institutions, obviously subject to significant innovations, of new practices, both in terms of exhibition display and in the use of the museum setting.

The awareness of a change emerges also in the approach to education and science by the European Commission on the topic of the knowledge society. As in the case of the NetS-EU project, in the context of which this exposition is carried out, EC initiatives mostly consist in research-action projects that involve many institutions belonging to the "community" of science centres and scientific museums, as well as to the world of the school, the university and research, and that are based on the use, adaptation or participative means of discussion that often choose the museum environment as a place for performing participative activities. This is not only due to the neutrality of the setting, but especially for the possibility of making available to the participating public "resources" (material, expositive, human, informative) useful for filling the knowledge gap, often revealed by research and investigation, in marginal science topics and in contemporary research that the media manages, increasingly less often, to fill.

The proposed model is based on the idea that the knowledge society is a form of economy, but in parallel is a social custom that tends to create relationships, connections, work in networks, language and practices. Science centres in Europe and in the world – including the Città della Scienza of Naples, the institute that conceived and coordinated the NetS-EU project – imagine a social "value chain", which connects scientific education and communication, continuing training, and creation of work and of businesses. This is an innovative idea of the relationship between science, knowledge and society based on the close relationship between scientific and technological culture, innovation and economic development. In this sense, it is seen that an increasingly widespread tendency is that of the revaluation of the museum/science centre as a "plaza", a meeting place, an arena for the exchange of ideas, and a network hub. This conclusion introduces the need to deinstitutionalize science and its communication to the public and in this way to give back to the citizens the possibility of controlling choices and development. This will be possible only through the joint work of a series of organizations, including, first of all, the school, that together may form the critical conscience of the citizens of today and tomorrow.

4
School Systems and Technologies Today: Challenges and Threats

by *Maria Luisa Iavarone*

Our time and the current European scenario, marked by economic uncertainty and volatility, along with the instability of social roles and political and governmental institutions, more than ever must be characterized by the need to provide investments to improve the training of young people, strengthen the quality of research & development (R&D), especially through international meetings and intercultural exchanges.

The task of those in charge of education and training, at all levels and in different realms, then becomes strategic in that it must constitute, for prestige and recognition, the strategic drive to create development and innovation. However, despite these statements, in the past years didactic work has undergone a progressive process of de-legitimization or, in any case, strong erosion of its reputation since many European countries were struggling to establish education and training policies in order to meet the need to obtain better results from the students with those of improving investments in the field of professionalism of teachers.

In the schools, but also in the universities, a policy of continuous changes was enacted in the last decade preventing the correct verification of the effects of these interventions and the acquisition of the necessary information to implement educational and didactic actions for an improvement based on evidence. This has split the relationship between scientific research and the world of the school and training institutions. Another cogent concern is certainly traceable to the short circuit between school and employment. The labour market, expression of an economic and social model unable to offer hope and prospects for the future, clearly harms motivations for study and learning, transforming the school into an increasingly inadequate and inefficient place for preparation for future life. On the other hand, reducing the role of training to the transfer of *skills* immediately marketable in work, risks calling into question the ability of the school to launch young people into scientific research, stimulating them to put into play not so much their receptive, but rather their critical and creative skills.

A similar error also takes place when, after less-than stellar academic performance of students that may emerge from international (PISA-OCSE) research, it is considered possible to raise the level by better preparing them to retake the tests instead of teaching them the critical skills necessary to face them.

The last element, extraordinarily important for the understanding of the present time, concerns the explosion of the technology and Internet in study, work and life experiences. This event ends up re-determining not only the alphabet but also the grammar and the syntax of the school as it is traditionally understood, imposing, on educators and teachers, a new capacity of integration of skills (didactic, disciplinary, digital) and learning contexts (formal, not formal, informal), also to guide young students through a critical and knowledgeable use of technological media. Today we often use engaging expressions such as "digital school", "classes 2.0", "a tablet for every student", with the risk of leading to the consideration that innovation lies in the technical and instrumental skills and not in the teaching methods to improve learning and especially in adequate consistency between educational means and ends for a real check between projects and results.

In this regard there are already projects in many European schools that provide the assignment of a tablet to every single student in order to completely replace text books with more cost-effective digital versions (of the same), until such extremes as the use of *Mobile Internet Devices*[1] in academic life.

The virtually complete abolishment of books and notebooks from the school, classwork and paper and pencils to take notes with, together with the advantage of a system in which everything is digitized, but also rarefied and virtualized, including the school-family conversations replaced by e-mail communications between teachers and parents, is an absolutely critical point of concern. Parents also have the possibility of monitoring and supervising the conduct and the progress of their own children through the possession of a login and a password giving them access to the school platform from which monitoring the grades of their assignments, the questions, the number of absences and even the training activity directly performed via streaming. However, this fact must not "dazzle" us, blinding our educational conscience. The above mentioned examples also show how the drift of the

1. The term *Mobile Internet Device* (MID) indicates some particular devices specifically intended for Internet navigation and especially designed for a non-professional audience, the development of which began in 2007. MIDs are generally used not as true replacements for notebooks or palmtops, but mostly as devices offering open access to the Internet. The touchscreen is between 4.5 and the 6 inches and these devices are generally also used as music players or for access to social networks (MySpace, Facebook etc.). In this sense, they may be seen as a cross-over between the Smartphone and the true UMPC.

use of technology in school can constitute a matter for concern with the risk of transforming school activity into a sort of "Big Brother" where even face-to-face educational relationships are subject to the excessive (media) power of technology.

The antidote to this scenario may, as always, be a sense of balance and measure; making the school a place open to technology and to innovations of the knowledge society by is now undeniable, but distorting the sense of educational relationships in considering that this must change only by increasing the possession and the use of the technology is misleading as well as pernicious. It is just as dangerous to confine the school within a procedural and technological world that risks making it a closed place impermeable to external contaminations. And this consideration is, furthermore, in line with the opinion of Umberto Eco who, in responding to the provocative question of a student «will professors be of any use in the era of the Internet?», wrote that certainly the information that the Internet makes available is immensely broader and often more in-depth than that which a professor can provide; however, an important point is being missed: the Internet says "nearly everything", except how to search, filter, select, accept or refuse that information[2]. We are all capable of storing new information, as long as we have a good memory. But deciding which should be remembered, and which shouldn't, is a subtle art.

2. Regarding the educational relationship and the role of the teacher in the dynamics of learning, this contribution follows and continues that of Mario Campanino that precedes it (see p. 16).

Part 2
Aspects of Networking

5

Inquiry-Based Science Education and Teachers: Researching and Questioning

by *Sofia Lucas*

Studies carried out in recent year's show that young people are away from key areas such as science and mathematics as they are choosing less scientific courses, although in the last decade the number of university students has increased. Many efforts have been made to counteract this trend but without much success. The European capacity to innovate, as well as the quality of its research is declining. The early contact of children with science seems to be crucial on the development of later attitudes towards science. However, although younger children feel a natural curiosity about scientific disciplines, education can restrain this interest (Rocard *et al.*, 2007).

Educators must understand that schools need to go beyond data and information accumulation and move toward the generation of useful and applicable knowledge. A good teacher's worksheet enables students to increase their study skills by providing different ways of viewing the world, communicating with it, and successfully introducing new questions and issues of daily life and finding answers to them. Questioning and finding answers is an extremely important factor of inquiry-based learning as it aids you in effectively generating knowledge (TeAch-nology.com). According to Deleuze (Deleuze, Parnet, 1977), teacher and students should be able to unleash the problematic field that affects them, invent a problem before finding a solution because the art of building problems is very important to achieve a greater understanding of the world. Integrating science in education means proceeding as a scientist when faced with a problem. The scientist is the one who is faced with a problem, formulates hypotheses, raises ideas and then confirms or does not confirm. The idea of reflective thought is based on this vision of scientific work where everything is in motion and nothing is established or fixed. Ideas that were accepted years ago are no longer today.

IBSE is an approach to teaching and learning science that comes from an understanding of how students learn the science and a focus on basic content to be learned. It is also based on the belief that it is important to ensure that students truly understand what they are learning, and not simply learning how to repeat subjects and information. Rather than a superficial

The NetS-EU project. Knowing

learning process in which motivation is based on the satisfaction of being rewarded, IBSE goes deep and motivation comes from the satisfaction of having learned and understood something.

This kind of methodology is more focused on the use and learning content as a means to develop skills during problem solving. It is an active process where the teacher is a facilitator of the process of learning and students become more involved in the construction of the knowledge itself. Teachers must also help students reflect on the characteristics of the processes in which they are involved. The inquiry-based learning requires special attention to create learning environments and experiences where students can confront new ideas, deepen their understandings, and learn to think logically and critically about the world around. Learning becomes easier when something fascinates students and reflects their interests and goals.

In the framework of the NetS-EU project the research and analysis included two strands:

– desktop research to collect materials to upload in the NetS-EU platform of three different kinds of resources: educational projects, activities and tools and scientific support;

– case studies of teachers to carry out a survey about the work developed by five teachers participating in the NetS-EU workshops in each European partner's country through three questionnaires filled in by teachers at different times till the end of the project.

The aim of the surveys was to follow the work of the teachers until the end of the project to assess the impact of the NetS-EU workshops and website in their daily work. In the overall each teacher represented an individual case study and the main goal is to understand their professional evolution by comparing the results of the three questionnaires. The first questionnaire aimed to get the first perception of the work developed by each teacher before the NetS-EU project in order to know: What do teachers know about some concepts? How do they work? Which practices do they apply in the classroom? How often and confidently they apply them? The second questionnaire wanted to get information about the participation of the teachers in the project: Are teachers using the NetS-EU platform? Are they attending NetS-EU workshops? What else are teachers doing to improve their work? Are they attending other kinds of training courses, conferences...? Have they participated in other related projects? The third and last questionnaire intended to assess the global impact of the NetS-EU project in the teachers' daily work: What do teachers change in their daily work? How are they using the new knowledge in the classroom? Are teachers applying new methodologies in the classroom?[1]

1. Give a look to the results of research and analysis carried out during the NetS-EU project at netseu.ning.com.

6
The Network's Strength Is Our Diversity

by *Sheena Laursen*

6.1
Networking – and how to Network with a Diversity of Institutions

The network's strength is our diversity. It is when we meet up with different partners that unexpected opportunities and the possibility of new solutions arise.

Networking is about working together and helping one another to solve the challenges that each of us face. It is therefore an important part of networking in that we are different and able to mirror ourselves in the different challenges we face and that we help each other share experiences and learn how we can become better at what we do.

The basis for working together in networks is that everyone is different by virtue of being part of different institutions, but all still share some common challenges, and can therefore also set common goals. The first important step in coming together in a network is to define common challenges and goals. When networking partners have agreed on a common purpose and which goals to pursue and what partners hope to achieve, a process of evolution is already initiated – and then you have already committed to developing a solution together.

6.2
Networking in NetS-EU

One of the main objectives of the NetS-EU project has been to support the development of a broad, European network of trainers, experts and institutions working within the area of non-formal science education in Europe. The NetS-EU project has strived to develop a broad network starting with the partner institutions of the project and moving on to include science centres, museums, universities, university colleges and school teachers throughout Europe.

The NetS-EU project. Meeting

6.3
So What Does a Network Look Like?

There is no straight answer to what a network looks like or should look like. There are so many different varieties and the broad spectrum of these can allow each person and each institution to decide what kind might be right. A network can be compared to carbon atoms, which, when bound together one way, form graphite, which is the soft substance we know from pencils. When the atoms on the other hand are attached together in a different manner they may form diamonds, which are the hardest substance known in nature.

There isn't a standard answer to whether or not networks should be homogeneous or heterogeneous as it depends on the objectives of the network. If the objective is for example to find answers to a specific technical complex problem it can make sense to have a homogeneous group. If, on the other hand, the objective is to seek different impulses and experiences to different challenges, this can more readily be achieved in heterogeneous groups.

Nevertheless, networks have two common characteristics that they build on:

– relations between people, that serve as the kit that ties people together;
– meaningful and purposeful objectives for all network members.

Basically, a network ensures that knowledge that otherwise would have been accumulated in individual institutions is allowed to flow freely between participants. There is knowledge sharing and a common knowledge base is created, and this in turn gives participants a significant development of competences. In other words, a good network provides joint survival power. You get something you would not otherwise have earned by participating in the network.

Depending on what is set as challenges and goals, and the variation in the types of institutions that are part of the network, the cooperation may involve different kinds of activities. There are three main questions that should be asked:

– what common challenges and what do we hope to get out of the network?
– what processes and what methods will we use to achieve common objectives?
– how do we get the most out of our networking process?

Networks offer added value through contact with other institutions and organizations and meeting between companies and knowledge institutions can inspire and help step up innovative and creative ideas.

Basically networking supports and plays a major role in lifelong learning which the NetS-EU project has strived to play a part in.

7
Meeting Teachers... at the Workshop!

by *Claire Le Moine* and *Jean-Baptiste Paulin*

Each of the eight countries participating in the NetS-EU project has organized local workshops for education professionals, mainly teachers. These workshops address the science education methodologies using the inquiry process. Were they a good tool to use for the purpose? Here are the details of the workshop organization.

7.1
Preparation of Animation

7.1.1. HAVE A GOOD KNOWLEDGE OF HOW THE SYSTEM WORKS

The organization of workshops for teachers depends a lot on how the national education system works and on the habits of each country. Here, animations can be offered free of charge to teachers, during their professional time or otherwise. There, animations should be integrated into the national training plan and comply with numerous constraints.

It is therefore important to identify contact people in the formal system that provide information about specific operations in each country. Moreover their investment brings an "institutional" security, calculated to reassure teachers, and allows easier monitoring implementation.

7.1.2. IDENTIFY A RELEVANT PROBLEM AND DOCUMENT IT

Inquiry-based science education lies at the heart of an approach to be implemented in the classroom, it is more a means than an end. Therefore it fits perfectly with all kinds of subjects. The choice of the theme presented could be linked to a specific context: national thematic, class project, worldwide year of something. Whatever the choice of the theme, it has to be properly documented: bibliography, sitography, iconography. This information should be easily accessible to teachers.

7.2 Workshop's Content

7.2.1. EUROPEAN CONTEXT

Inquiry-based science education is already included in the programs of the European Union. Some countries have already begun to integrate these concepts in the training of teachers, and the movement is gaining ground. The method has been proven and it is commonly accepted that the investigative approach allows a firm anchoring of knowledge and the development of the critical and argumentative faculties.

7.2.2. IN THEORY...

Inquiry-based science education is based on a phased approach that can be summarized as follows (changes are possible):

1. Observation/manipulation/query.
2. When the problem is identified, I develop possible scenarios.
3. I imagine how to check my assumptions and I elaborate (experience, observation retrieval).
4. I get results, I present.
5. I check the validity of my assumptions.
6. If my assumption is correct, I confirm and I conclude.
7. If my assumption is not true, I start again from step 1.

7.2.3. LET'S PRACTICE!

Teachers have often little or no training in this process, let alone its use in the classroom. It is important to start by setting conditions, making them experience a problem resolution by using an investigative approach.

Change the media to present the issues: observation, experiment, question/riddle.

Feel free to create bridges between disciplines. Teachers of the primary school are not in a specialized field: it will be easier to implement this method if it offers the possibility to create links between the different disciplines taught in the classroom.

Make sure that the content you offer does not require precise prerequisites. It is important that teachers' knowledge is not questioned by what you are offering.

Remember that the primary purpose of the establishment of an investigative approach in the classroom is not to solve problems but to encourage the emergence of a dynamic that arouses interest, curiosity, sharing and communication.

The NetS-EU project. Experimenting

The first tests may seem to take long before they produce results, but this method is in the long term, where each progress is beneficial to the individual and the group.

7.3 Dissemination of Documentation and Support

7.3.1. THE DIGITAL PLATFORM

There are a thousand ways to implement an inquiry-based approach in teaching science. Digital platforms allow exchange and serve as a resource base. The inscription on this type of platform is usually free. Access to the NetS-EU platform: http://netseu.ning.com.

7.3.2. SUPPORT THE TEACHERS

Thereafter it can be effective to create "focus groups" composed of motivated teachers. They should be regularly monitored and supported in their projects (equipment, delivery of content, methodology). The aim is to create a dynamic within the schools to disseminate the science teaching methodologies.

8

Using Web Interactive Tools for Inquiry-Based Learning and Networking

by *Beáta Holá*

Inquiry is seeking knowledge, information, or truth through questioning. Infants use inquiry to build their sense of the world, they turn towards voices, put things in their mouths, grasp things, and observe faces that come near. But also in later life, all people carry on with this process. The inquiry process is mainly the gathering of data and information and applying them to senses like smelling, tasting, touching, hearing and seeing. Inquiry-based learning is not just asking questions, but it is a way of converting data and information into useful knowledge. In this chapter of the handbook, we present a selection of interesting tools for a useful application of inquiry-based learning. Much information and facts are readily available, which needs an understanding of how to make sense out of it and turn it into useful knowledge. You will have to work your way through the list to identify the ones that would be relevant for you and your classroom and how you would embed the tool into your learning program.

It is crucial to recognize that inquiry-based teaching should not be viewed as a technique or instructional practice or method used to teach a subject. Rather, inquiry starts with teachers as engaged learners and researchers with the foundational belief that the topics they teach are rich, living and generous places for wonder and exploration. Under these aspects, the following Internet tools may contribute to a successful teaching.

Our selection has been checked for availability in July 2013.

Spiderscribe	Online mind mapping and brainstorming tool	http://www.spiderscribe.net
TED-Ed	Education talks that can be used as a stimulus to engage students in the inquiry process	http://ed.ted.com
Text2MindMap	Creates a mind map using text	http://www.text2mindmap.com
GoGooligans.com	A safe search tool for “kids & teens” – educational / academic search engine	http://www.gogooligans.com

The NetS-EU project. Presenting

InstaGrok	Presents your topic in an interactive visual display – interactive concept map format	http://www.instagrok.com
Simple Wikipedia	Online encyclopaedia in simple English – great to help students with other mother tongue develop background knowledge	http://simple.wikipedia.org/wiki/Main_Page
WikiSummarizer	Presents search results as a visual map, a list or word cloud	http://www.wikisummarizer.com
Diigo	Collect and organize anything – capture, store, tag, recall and share	http://www.diigo.com
Pics4Learning	A safe, free image library for education. Teachers and students can use the copyright-friendly photos and images for classrooms, multimedia projects, web sites, videos, portfolios, or any other project in an educational setting	http://www.pics4learning.com
Polldaddy	Create surveys, polls, quizzes and collect the responses	http://polldaddy.com

Survey Monkey	Design your surveys, collect the responses and analyse the results	http://www.surveymonkey.com
Animoto	Create simple video slide shows – add pictures, text, select music and create	http://animoto.com
Audacity	Audio recording and editing program that lets you mix, record and edit sounds. Multilingual tutorials	http://audacity.sourceforge.net
AudioBoo	Allows you to record and share audio	http://audioboo.fm
Blogger	A Google tool for creating blogs	http://www.blogger.com
Bookbuilder	Use this site to create, share, publish, and read digital books that engage and support diverse learners according to their individual needs, interests, and skills	http://bookbuilder.cast.org
Glogster	Create interactive posters – online multimedia posters with text, photos, videos, graphics, sound, drawings and more	http://edu.glogster.com
infogr.am	Create interactive charts and infographics	http://www.infogr.am
Jing	Create images and videos of what you see on your computer screen and then share	http://www.techsmith.com/jing.html
Photo Peach	Create an audio slideshow	http://photopeach.com
Piktochart	Create engaging presentations from data and information – infographic tool	http://piktochart.com
Pixorial	Rather than spending time learning a complicated video editing program, you and your students can now get straight to the project. You can film your lectures, create exciting presentations, or encourage your students' creativity by having them shoot, edit and share their own videos	http://www.pixorial.com
Prezi	A dynamic presentation tool that helps you organise, present and share your ideas – zoom out for the overview and zoom in for the detail	http://prezi.com

Scribd	Store documents – doc, ppt, pdf, xls etc. and share them with others	http://www.scribd.com
Vimeo	Share your videos	http://vimeo.com
Voki	A talking voice character, either computer-generated or your own voice. Voki also has a lesson plan database	http://www.voki.com
Weebly for education	An easy way to create a website	http://education.weebly.com
Wikispaces	A space where you can share work and ideas, pictures and links, videos and media. Can save building a web site	http://www.wikispaces.com
Wordle	Create word visuals using the text you enter – suggested as a form of infographic	http://www.wordle.net
WordPress	Blogging platform	https://wordpress.com
xtranormal	Animated, narrated movie maker	http://www.xtranormal.com
Edmodo	Secure social network for classroom and teacher use. Collaborate and share content and ideas	http://www.edmodo.com

9
Organizing Conferences for Teachers and More: Tips and Tricks

by *Halinka De Visscher*

9.1 Background

We live in a world that is constantly changing, and we believe that it is not possible to understand this constantly evolving world without any technical and scientific knowledge. For generating interests to acquire scientific insight or for encouraging young people to study science or mathematics with the aim to gain insight in a world where we are faced with a rapidly changing technical offer, understanding science cannot start early enough. This is the basic objective of all activities addressed to science education, of the NetS-EU project in general and of the three International Comenius Conferences organized during the project[1]: sharing knowledge about methods that can improve non-formal science learning to increase the participation of children and youngsters in a society that is getting more and more complex. The school is the place where all this can start and inquiry-based science education should have a permanent place in the curriculum.

9.2 Conferences

Organizing the Comenius conferences is also an important way of raising the profile of our work and to engage with stakeholders (science teachers,

1. The first conference was organized by Città della Scienza, Naples (Italy) on the 13th and the 14th of October 2011. The conference was focused on *European Cooperation in Non-Formal Science Education*. The second conference was organized by Ciência Viva, Lisbon (Portugal) on the 14th and the 15th of September 2012. The conference was focused on *Developing Inquiry Skills in Formal and Non-Formal Environments*. The third one was organized by Technopolis®, Mechelen (Belgium) on the 7th and 8th of October 2013. The conference was focused on *Inquiry-Based Science Education in Formal and Non-Formal Science Learning*.

The NetS-EU project. Listening

stakeholders in formal and non-formal science education). The conferences are a good opportunity to present the results of NetS-EU work and outcomes as well as to attract attention to the NetS-EU project and other similar activities and initiatives.

The Comenius program aims to boost the quality of school education in Europe and helps young people acquire the basic life skills and competences necessary for their personal development and future employment. The Comenius program gives school educational staff, pupils and policy makers in Europe concrete opportunities to learn and work together on issues relevant for school education. It does this by supporting transnational mobility, partnerships and projects, as well as education networks and school twinning. The model of NetS-EU international conferences is a two-day conference of institutions, associations and people involved in the different Comenius projects and initiatives in Europe on non-formal science education.

The conferences are organized in initial plenary sessions followed by workshops and discussions. Each Comenius conference has a clear topic and the organizer knows exactly what he wants to achieve. The nature of the conferences is intended to be multidisciplinary and interactive in several aspects. It includes international speakers and participants, bringing together science teachers, institutions, associations, artists and stakeholders in non-formal science education.

Following our model, the program of the conferences is set up along established lines:

- introduction of Comenius projects and other initiatives devoted to improve non-formal science education in Europe;
- presentations of international speakers with a thorough knowledge of the IBSE method in formal and non-formal education. It is important to choose appropriate speakers for your conference. It goes without saying that anybody who is speaking is comfortable standing up and presenting to people, knows what is expected of them and how long they have to speak. As the organizer you should have a very good idea of what each speaker will talk about and how their input will contribute to the flow of the event. Try to decide how you want the event to be structured and then identify the best people to speak for each element;
- testimonials from science teachers. The more personal and precise a testimonial is, the more it helps capture the attention of your audience;
- workshops on IBSE and non-formal science education. Teachers from primary and secondary education were trained in the new techniques about the IBSE pedagogic and formal and non-formal science learning. Attention in the workshops is also paid to gender imbalance. The best workshops are the ones that not only introduce new ideas but reassure the teacher about current practices. Allow some time at the end for participants to reflect on their own practices. Great workshops are the ones that feel more like a conversation than a lecture. Participants often bring good ideas with them and sharing those ideas with the rest of the group is an important part of the workshop.

The key to a good conference is having the right people at the event and a good number of them. Teachers will more likely attend your conference if they can see what is in it for them, so mention in your invitation what they can gain by attending your conference. Give the teachers an attendance certificate at the end of the conference. In some countries you also need approval from the government to organize an official workshop for science teachers, so the advice is: make sure you get it.

10

For an Efficient Dissemination of Networking Activity Results

by *Wolfgang Eisenreich*

One of the most important tasks for Europe is to strengthen science education. Science helps to promote developments in scientific research and industrial technology, and ultimately leads to a more diverse, robust economy.

The NetS-EU project's main aim is to collect, elaborate, diffuse and exploit ways of applying non-formal methods and inquiry-based learning approaches to science education in schools by establishing a network of different organizations. To ensure that other teachers may benefit from these findings, we consider it important to allocate enough priority time and resources to reach out to people that can take advantage of our results.

Transferring knowledge and information into the teaching practice (and also to other stakeholders) can be a slow and sometimes difficult process. Planning effective dissemination strategies and knowing one's stakeholders habits and preferences is necessary. Based upon the experience acquired during the NetS-EU project, this chapter will provide some guidelines for structured dissemination planning.

Dissemination plays a crucial role within a project and has to be reviewed regularly as the results emerge with the progress of the project. This will help reach the dissemination objectives and eventually contribute to changes in attitude or practices and the upgrade of teachers' skills.

10.1 Dissemination Strategy

A successful dissemination strategy should already be considered during the development of the proposal. This will ensure a sufficient number of allocated tasks, budget and time from an early stage.

It is recommended to involve teachers in the project: this ensures that the project results are geared towards the needs of the teachers. Teachers can also take an active part and provide assistance with the project dissemination.

By having teachers reach out to other teachers with the projects' outcomes one can reach local levels more effectively: teachers often know and have access to local communication channels and communities specifically designed for teachers.

Another advantage of involving teachers in the dissemination activities is that teachers think and speak like teachers: thus, your projects results will be communicated in a simple and understandable manner and contribute to the exploitation of your results.

Teachers generally state that they do not have much time and might sometimes struggle to find their way around an excessive amount of information when searching for new teaching methods and materials. It is therefore essential to identify how to communicate in a relevant and effective way. This can be found out by looking into the national curricula and knowing more about the school systems to integrate new methods and materials.

10.2
The Story

Another crucial point is to define the content and format of the message. Any dissemination is only successful if there is a story to tell. Within every story, key messages are the messages one wants the teachers to remember and react to. Therefore one should start by reflecting about the purpose and the way teachers can use the project results, and to consider their problems, tasks, the results of which can provide a solution.

According to many teachers, it motivates to know that new tools and methods are easy to use and the pedagogical benefits are high. This will encourage teachers to participate in innovative science projects or use their results.

It can be useful to identify and list the added value of certain project outcomes for teachers in a very early phase of the project to structure the dissemination strategy.

10.3
You Must Know the Teacher

Educational systems, science curricula and the teaching methods vary from country to country. A teacher is not just a teacher. A teacher or school teacher is generally someone who provides education for pupils and students. But the role of a teacher may vary among cultures and their professional duties may extend beyond formal teaching. When identifying the target audience, it may be necessary to map the curricula and national practices to ensure that the relevant teachers can actually apply the project results. Targeting young teachers gives you the advantage of reaching teachers without deeply rooted habits with the ability to learn new methods fast. On the other hand, teachers with more stable positions often have a better overview, experience and time to concentrate on the results and they might be good at giving substantial feedback.

10.4 Dissemination Tools

Once the exact profile of the teachers has been defined, one should indicate the most appropriate channels for communicating with them. These might include a newsletter, conference, workshop, leaflet, press release, event – or broader methods such as media and a project website.

It is important to give priority to a local or regional dissemination strategy, and to produce dissemination materials in the national language.

Teachers often know local channels such as science communities or teacher communities. One should be present at conferences and training workshops attended by teachers, even when they are organized by other entities (teacher associations, other museums, festivals ...).

Experience has shown that it is better to allocate resources for face-to-face activities. Mass dissemination of information is perhaps less costly but still requires a lot of time and is often ineffective. Most teachers do not actively seek knowledge; therefore dissemination results are better expressed, communicated, channelled and distributed if one focuses on more interactive channels.

10.5 Timeline

Attention must also be paid to the dissemination timeline. Depending on the project, it might be wise to send out differentiated messages during the timeframe of the project. For example, at the beginning of a project it is better to focus on awareness of the project, and at the end on "selling" achievements. A timeline will help you structure this process.

There are periods in the school year where it can be difficult to reach school staff. One must take into account the special characteristics of teachers in terms of school commitments. For example teachers may not be available during summer holidays or school holidays and exam periods.

Usually a message should be directed at teachers in several ways before it has an impact. Therefore the messages should be spread through various

The NetS-EU project. Discovering

channels and tools. And this often requires more time than what is usually prioritized in most dissemination strategies.

It is also important to create continuity and sustainability, and to think how engaged teachers can benefit from the project after its conclusion. The networks established for the project may be used for other projects and can ensure continuity in dissemination after a finalized project.

10.6 Channels to Reach Teachers

Dissemination channels are the means of making the results of the project accessible for teachers. There are many channels, the costs and time needed vary and should be taken into account to estimate the compatibility of the dissemination activities with the allocated budget.

10.6.1. SOCIAL MEDIA

Social media, virtual communities and networks can help a great deal in order to create, share, and exchange information and ideas with the relevant teachers.

Teachers use social networks, mass media, online conferences, and professional journals in their native language and read newsletters much more frequently than project managers may assume.

Teachers and educators are often under an extreme amount of pressure, having to strike a balance between the official objectives stated by the education department and their day-to-day activities within the classroom. Short overviews and brief updates, by newsletter and mailing lists, are a good system to feed information to them.

10.6.2. WEBSITES

Even if it seems obvious, it is essential to create a project website to help highlight the findings, achievements, publications and ambitions. A website can also be used to give a detailed virtual summary of the project.

If the project has different targets (teachers, policy makers, project managers etc.) as it is often the case, it is recommended to create different sections. Often, project websites adopt a largely corporate approach and are mainly designed to communicate to other project managers and policy makers and do not use an appropriate language.

In order to prevent visitors from getting lost between messages, one should have a few users try the website to make sure it is clear and user-friendly.

10.6.3. PRESENTATION AND FACE-TO-FACE EVENTS

Presentations and face-to-face events are considered quality dissemination. They do not allow you to reach a wide audience but the target is reached effectively, with a certain degree of interactivity among participants. Often the costs are high because of the travelling involved on the part of the project staff members. It is the opposite of quantity dissemination where you are not in direct contact with your teachers.

Teachers find that conferences, seminars and workshops are important and one of the best ways to gain new knowledge and receive information about projects.

10.6.4. OTHER MEDIA

We suggest using already existing contacts with local entities such as newspapers, local TV or radio stations that might not be expensive to use and have a well-established national and local audience.

10.7
Combining Channels

Once the key messages, the target audience and the channels have been identified, the next step is to identify how to combine the channels and interact with other relevant stakeholders in the area.

Using one dissemination channel independently is not effective enough to keep teachers updated on the latest resources, methods and materials that are made available by science education projects. Some teachers involved in the workshops have suggested that they gain more benefits from the innovation resulting from science education projects if online dissemination channels and face-to-face events are combined. The information should be communicated in a simple way and format.

It can also be useful to make connections with other projects and think about how one might maximize resources. It can also avoid confusing and overloading your teacher stakeholders with too much information.

Teachers can be pre-consulted about their used communication channels. They can often mention specific local or national websites and social networks that are commonly used to reach teachers audience at a national and local level.

10.8
Challenges when Working with Teachers

The most important challenge is to involve more teachers at their schools or local communities to participate or gain knowledge provided by EU projects. According to our experience, it is very difficult to involve new teachers in European and national projects because many teachers think that it will increase their work load. However, many teachers highlight the importance of cooperating with other teachers (e.g. English teachers) in order to overcome obstacles, e.g. language barriers, at their school and attract other teachers to participate in European funded projects. The role of the headmasters in supporting teachers to participate in projects is also considered a key element.

Teachers emphasize that incentives exist to engage and encourage them to participate in projects: equipment for the schools, training, social and institutional recognition for the individual teacher, opportunities to participate in workshops, financial support, rewarding systems for active teachers, showing success stories on online portals, as well as international partnerships in funded projects.

Part 3
Projects for Education

11

NetS-eu: A Network to Improve Non-Formal Science Teaching in Europe

by *Silvia Schroeder-Danninger*

11.1
Brief Description of the Project

Young people in Europe are losing contact with science and the number of science students in universities has decreased. This has a strong impact on the amount of students that opt for scientific professional careers and, at the same time, in this context a gender difference exists too: girls appear to be less interested in science and technology than boys are.

The aim of the NetS-eu project is to build a network to share and exchange information, innovative tools and experiences on non-formal learning methods in science, with special emphasis on the inquiry-based learning approach. The project partnership is represented by the science centres, institutions and organizations collaborating with schools for science education, including research and training centres also active in the field of scientific career guidance. Such network focuses on the possible ways to make science and technology studies more attractive to students; to develop and provide information on future scientific and technological studies or careers; to help reduce the gender imbalance in science education and careers.

As already mentioned in the previous chapters, the NetS-eu project has had a duration of three years and has involved eight partners from different countries. The network activities included: the building of a social network, a "web place" where it is possible to connect people interested in non-formal science teaching/learning, to exchange information and discuss project's findings; the production of three annual reports on the state of the art in science education; the organization of three Comenius conferences (2011: Italy, Naples; 2012: Portugal, Lisbon; 2013: Belgium, Brussels) to connect and exchange information among all Comenius activities working in the field of science education; the organization of many school teachers' workshops in each partners' country (more than 500 teachers involved in three years), to encourage the use of the social network and the application of non-formal and inquiry-based learning in their teaching at school.

The results of European research on science perception among young people, as part of the Euro barometer survey 2005 and the ROSE project, show that:

– the reasons for the declining interest in scientific studies and careers are as follows: science classes at school are not sufficiently appealing; scientific subjects are too difficult; the career prospects are not sufficiently appealing;

– the science teaching method in schools certainly influences the interest of students towards scientific disciplines, the S&T school curricula are still too traditional, not attractive and far from having implications on citizens life.

Today this situation is still present as described in the last report *She Figures* 2009. In 2005 the European Commission has appointed a group of experts to examine a cross-section of on-going initiatives, in order to gather elements of know-how and good practice that could bring about a radical change in young people's interest in science studies and to identify the necessary pre-conditions. In this context, the science education community mostly agrees that pedagogical practices based on Inquiry-Based methods are more effective (see also Rocard *et al.*, 2007), but the reality of classroom practice is that in the majority of European countries these methods are simply not being implemented.

To make this situation more complex, the last Euro barometer surveys show that an important hostility to S&T by women remains, as they feel they can relate less to these topics: only 39.6% of women is interested in S&T, compared to 51.5% of men. The Fondazione IDIS-Città della Scienza, promoter and coordinator of the NetS-EU project, has been working for many years on the theme of gender and science, and recently within the scope of two FP6 European projects (GAPP-Gender Awareness Participation Process, and Pencil-Permanent European Resource Centre for Informal Learning). The results of these projects confirm the lack of women's interest in S&T and contribute to identify the best practices to use in order to address the problem.

II.2
Aims and Objectives

The NetS-EU project comprised the collection, elaboration, distribution and exploitation in Europe of ways of applying non-formal methods and inquiry-based learning approach to science education at school.

Inquiry-based learning provides a range of curricular and pedagogical approaches to teach science in an innovative way. At the same time, this approach is important in teaching students to learn by researching and to provide them with a key to discovering the fascinating nature of scientific activities.

However, inquiry-based learning approaches are not very common in formal and non-formal contexts. For this reason, networking in this field and sharing experiences with other people (through the social networking potential and 2.0 web tools), proved to be very useful for improving school science education. Teachers were actively involved and stimulated through the organization of 72 workshops in all participating countries. In this way teachers play their role not only by learning new methods they can apply to their everyday work at schools but also expressing their opinions on these issues and playing a leading role in the renewal process.

In addition, the organization of three Comenius conferences raised the awareness of the importance of personal competences and made it possible to establish a solid European network in non-formal learning science education.

Thanks to the institutions and the experts involved in the network, non-formal and inquiry-based practices can be shared at European level and exploited as innovative tools for science teaching.

Overall, the strong interest in the projects has created a link between the improvement of science education and the delivery of information on science careers always facing the gender issue.

The specific aim of the project includes:

– the investigation of the way girls and boys perceive science and technology, in order to understand how these differences influence the interest and choice towards S&T higher education and careers;
– the assessment of the experiences shows the different countries involved in the project, in order to deliver common findings and recommendations at European level.

11.3
Tools: Workshops, Conferences, Platform etc.

Other aims of the project were:

– building an effective European Comenius network thanks to the organization of three annual meetings of Comenius projects working in the thematic area of the NetS-EU project;
– producting three detailed annual reports in order to provide an overview on the state of the art of non-formal learning methods in science. This comprises the undertaking of activities, outcomes, experiences and conclusions resulting from organized workshops for teachers, experts and students. Moreover, best practices regarding methods used in the field of non-formal science learning can be found in there as well. Each partner organized them three times a year throughout the whole project duration. In order to complete the results, a questionnaire of interviews conducted

with the teachers involved evaluated information of useful materials on the thematic area of the network;
– spreading the news of non-formal learning methods in science thanks to the organization of workshop in different countries;
– supporting the creation of a wide network of teachers, experts, pilots, working on this thematic area thanks to the implementation of a social network.

II.4 The Partnership

The partners involved consist of members from eight European countries with a wide variety of social, cultural, economic backgrounds, science and technology communication. Therefore, one part of the Consortium consists of five science centres:
– Fondazione IDIS-Città della Scienza, as the project coordinator, science centre; Italy, Naples, http://www.cittadellascienza.it
– Exploradôme, science and multimedia centre; France, Paris, http://www.exploradome.fr
– Technopolis®, science and technology centre; Belgium, Mechelen, http://www.technopolis.be
– Experimentarium, science centre; Denmark, Hellerup, http://www.experimentarium.dk
– Ciência Viva, national agency for scientific and technological culture, Portugal, Lisbon, http://www.cienciaviva.pt

The other three organizations support and implement projects related to guidance in science careers, lifelong learning, in the area of professional qualification and education:
– INTEGRA, human resources development institute; Slovenia, Velenje, http://www.eu-integra.eu
– L4L, learning organization, Czech Republic, Oslavany, http://www.learning4life.eu
– AHAPunkt, institute for experimental training and project consulting, Austria, Vienna, http://www.ahapunkt.at

12

New Projects for Education: An Organismic Perspective of Networking

by *Mario Campanino*

If it is true that the teacher is the heart of the educational action of the school – and indeed the teacher *is* the heart of the educational action of the school[1] – then its body, its legs, its hands, its joints are all the possible worlds in which the school expands, finds support and comparative terms, help or challenges in which to engage, and reasons to define its own task or even reasons to change. These worlds are not always easy to meet (different times and places); it is not always simple to have a dialogue (different linguistic and communication codes) or to share values (inconsistent, in some cases absent, evaluation standards); it is not always simple to obtain help or collaboration (the problem of resources, primarily economic) or provide them. These worlds first require – and demand to the school and the teacher above all – an attitude of openness toward the *other*, the different from oneself, the diversely structured and organized, the differently located on a distinct scale of values that may not fit each other but may be "re-educated" to do so. The researcher does not share language and values or goals with the disseminator, the teacher with the academic, or the volunteer with the employee.

The new "projects" for education, thus, are projects that would be called pedagogical, above all, but a closer look shows they are, even more, *cultural* projects. They concern, more than anything, the culture of institutions, directed toward a course of re-education that passes through the people but also through the organizational, legislative and economic dictates of

1. The teacher is the first and last pedagogical heart and centre of the school, first as enacting the pedagogical "intention" of the scholastic institution and last as enacting the didactic mediation in which that intention, in fact, is realized. The teacher is a pedagogical centre as reflection of the pedagogical need of the learner, of the learners in their differences, and shares with them and only with them a concentric position – today in fact in many cases partially overlapping, when the teacher goes to the level of the group of peers seeking bargaining for the best learning. The teacher is the pedagogical heart functioning in an organization of times, spaces, material resources, staff organization, flexibility and autonomy that characterize his actions, contain them, but he remains primarily responsible for the act of teaching, in whatever way it takes place.

the institutions themselves. It is impossible to govern the institutional re-education process without keeping in mind at the same time the two aspects that support it: the structural processes for functioning and the people who feed them. Without changes at the level of the first, the people oriented to the change suffer because of the fighting in vain against constrictions in areas "larger than them", that frustrate good individual intentions. Without changes at the level of individual behaviours (orientations, consciousness, and decisions) the structural and organizational "reforms" appear as a new package that still contains *the same things*, and the transformations do not correspond to what in terms of results may be produced on paper. In any case, the division between structure and culture (the human "feeling") is unproductive, and – in contrast – may give rise to reactionary opposition to change.

Despite this inescapable cultural necessity, that is often shown as a difficulty and sometimes – in bad faith – is masked as "wealth" in diversity, it appears clear that the work of the school today is work in the world *in which it expands*, and that the work of the external actors can and must gain their direction from school's directions and needs. It is also evident that, if the networking activity is inescapable, the tools for updating the network should be reconsidered from time to time, according to the goals and opportunities, and the network itself be remodelled dynamically in agreement with the feedback that is returned at various levels and in progressive times.

In this sense an "organismic" dimension is here proposed for the cultural and training work: mono- or multi-polar networks come into contact, are re-modelled according to the goals and opportunities, assume diverse "formation" and centres at the same time, undergoing periodic and even substantial changes that do not necessarily need to be in expansion to be considered "in growth". This same organismic conception seeks the true sense of the energy necessary for doing and undoing networking activities, the harmony and conflicts that are not lacking in an organism, subject to evolutionary phases. It is in this vision that one must work, knowing that seeking the strategies for the development and practicality of the network may also arrive – in case of conflicts and irresolvable dilemmas – at a condition of *paralysis* and *stalemate*, of impossibility to make decisions and confusion: one may speak in this case of a "pathological" condition of the network. This is analogous to what may happen to a human organism – body and psyche. It is loosely knit, for example, with organismic development theories; from this it may arise open but interesting suggestions for study of the organismic opportunities and difficulties of the network. We may also consider pathological concept of Bateson's "double bind", with its effects of behavioural and decision-making paralysis; considering the concept of "group of individuals" as a system of relationships, together with the terms "feedback" and "retroaction" and also the idea of significant relationship (bringing sense). Is the relationship between two organizations not perhaps *significant*? And is the significance of the relationship perhaps inherent in the fact that only through the relationship itself the attainment of a common goal can be guaranteed? In the same way, is the emotionalism of the organism-network – emotionalism that may raise so many difficulties – not perhaps in the tension for attainment of results, individual and common? This is not to forget the corporeal dimension of the network, by which the weakness of one of its limb-functions may-must be compensated by another limb-member, with all the emotive and organizational-economic variable (in terms of more than financial resources) necessary.

It is appropriate for the moment to halt our enthusiasm for analogy, and activate our more mature concerns (organizational and also, I would say, pedagogical). Work within a network needs to be studied and experienced, but especially needs to be *cared for* and *supported*, primarily *understood*. As shown on numerous occasions in the course of this work and in so much of the current literature and that of the recent past, we are perhaps only at the beginning of a vast process of transmigration of knowledge within and outside the school, the institutions and the organizations. The old paradigms of *centre* and *control* of knowledge have already collapsed, but the consequences for the current transformations are all still to be discovered[2]. The problem of the culture and education/training today is strictly linked to the *governance* of knowledge and of its dissemination, and networking (hoped for and encouraged by all the regulatory transformations that in various European countries push schools and academic institutions toward situations of growing autonomy) represents the reference tool: it is toward it that our sensibility, resources and energies have to be best directed.

2. As stated in the first section of the *Manifesto for the Digital Humanities*: «Society's digital turn changes and calls into question the conditions of knowledge production and distribution» (THATCamp, 2010).

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