Identification and Dissemination within Europe of Best Practices in the context of Science Teaching that places Science and Technology into meaningful learning contexts

EXECUTIVE SUMMARY
This Final Report presents the results of the activities carried out in the framework of the Study identified by the contract DG-RTD-C6-2004-2. The Study approach and the developed contents have been very practical and focused on experiences regarding applications of context-based methodologies in science teaching implemented in schools (formal settings) and out-of school (non formal and informal settings, e.g. science parks, science museums, etc.). Based on the mandate stated in the Tender Specifications, the Study has aimed at:

- identifying and disseminating within Europe best practice experiences in the context of science teaching that place science and technology into meaningful learning contexts;
- collecting information in the 25 Member States of the EU, the Associated Countries and the Candidate Countries, on best practice examples, with justification, of particularly effective techniques or experiences for demonstrating the relevance of science and innovation in our daily lives.

In this respect, the purpose of the Study has consisted in identifying:

- the current implementation policy and trends in the 25 Member States of the EU, the Associated Countries and the Candidate Countries, concerning the introduction into schools of context-based teaching techniques for demonstrating the relevance of science, technology and scientific innovation to our daily lives.
- the “best practice” examples, with justification, of particularly effective techniques or experiences.

As detailed in the Tender Specifications, “context-based learning (CBL) is to be interpreted in a broad sense. It covers teaching and demonstration techniques that use examples, experience and issues drawn from every day life in order to illustrate the role that science plays. It emphasises the connection with basic scientific principles as learned elsewhere in the science curriculum in order to enhance students’ appreciation of the relevance of science and how it is applied.”

The Study has been built on a case-based methodology, developed with the aim of identifying successful experiences concerning the application of context-based learning (CBL in the rest of the document) methodologies for science and technology (S&T) teaching. Within the Study a comprehensive and systematic observation and analysis has been carried out focused on current practices in the use of context-based learning methodologies for Science and Technology teaching in thirty-three European countries.

Based on forty-six broadly examined experiences and on sixteen more thoroughly analysed ones, it has been possible to collect a substantial range of data and information allowing then to identify some common implementation patterns and mechanisms, the adopted learning design strategies and didactical approaches to involve students in significant and exhaustive hands-on activities, within meaningful learning contexts. The analysis of the good practice experiences has focused specific ‘clusters’ specifically designed so to better articulate and clarify the relevant trends and the identified key dimensions. The six clusters / dimensions addressed are:

- Teacher training schemes and initiatives
- Resources for learning design and implementation
- Networking and access to external resources
- Stakeholders involvement
Based on the analysis of the above-mentioned clusters, specific ‘enhancing’ and ‘inhibiting’ factors have been identified. The ‘enhancing factors’ refer to concrete and specific conditions which characterise the examined case studies and which have exerted an influence towards their successful implementation. Par contre, the ‘inhibiting factors’ consist in those conditions which hamper the development of an initiative, in the form of bottlenecks, constraints, delays and ‘dead ends’. Between the identified enhancing and inhibiting factors there is – not surprisingly– a sort of ‘symmetry’. In order to highlight such a correspondence, for each cluster a tabular format has been used: the first column refers to the ‘enhancing factors’ and describes the positive and constructive condition, whereas the second column introduces the constraints and the so-called ‘situations to avoid’.

<table>
<thead>
<tr>
<th>ENHANCING FACTORS</th>
<th>INHIBITING FACTORS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Teacher training schemes and initiatives</strong></td>
<td></td>
</tr>
<tr>
<td>Specific Programmes and dedicated funding for teachers training in CBL within S&amp;T subject matters</td>
<td>Lack of focus on CBL in teachers training programmes in S&amp;T</td>
</tr>
<tr>
<td>Widespread ‘culture of innovation’ in the teaching profession</td>
<td>Teachers’ (over)exposition to top-down innovation policies</td>
</tr>
<tr>
<td>Support to teachers in exploring and becoming familiar with the potential of Communities of Practice</td>
<td>Persistence of transmissive teaching models in pre-service and in-service programmes.</td>
</tr>
<tr>
<td><strong>2. Resources for learning design and implementation</strong></td>
<td></td>
</tr>
<tr>
<td>Existence of specific measures to support transferability of good practices</td>
<td>Lack of information and support to facilitate exchange of good practices</td>
</tr>
<tr>
<td>Utilisation of extra-school learning experiences</td>
<td>Reluctance to integrate learning experiences developed in extra-school environments</td>
</tr>
<tr>
<td><strong>3. Integration within the curriculum</strong></td>
<td></td>
</tr>
<tr>
<td>Autonomy of schools, including financial implications</td>
<td>School resources managed by national / regional administration authorities with little or no room for school initiatives</td>
</tr>
<tr>
<td>Recognition of the role of other learning providers and resources – in a perspective of mature Lifelong Learning</td>
<td>Resistance to recognise the existence and role of other learning providers</td>
</tr>
<tr>
<td><strong>4. NETWORKING AND ACCESS TO EXTERNAL RESOURCES</strong></td>
<td></td>
</tr>
<tr>
<td>Existence of Lifelong Learning policies fully in place</td>
<td>Persistence of inflexible institutional borders between formal, non formal and informal learning systems</td>
</tr>
</tbody>
</table>
Following the analysis of good practice experiences the key **conclusive remarks** have focused on a variety of issues:

1. Teachers have a pivotal role. In all analysed good practice experiences, teachers are recognised as the key actors in designing and implementing effective projects and initiatives. The introduction of CBL approaches and the resulting hands-on experiments greatly challenges their professional profile and expertise, bringing about novel and often unexplored working methods and roles.

2. In this respect, targeted teachers training schemes are needed, both as regards pre-service and in-service programmes. The application of CBL methodologies already in these phases allows teachers to ‘learn by doing’, thus better embedding the new approach in their teaching methodology and style.

3. The availability of learning resources and reference materials represents for teachers an opportunity to support their continuous professional development and the exposure to state-of-the-art pedagogical research. The existence of resource centres has proved to be an key asset in this respect.

4. A very useful solution to promote teachers’ awareness of CBL potential and benefits, as well as their continuous learning processes is represented by the set up of spontaneous communities of practices (CoPs). The ‘spontaneous’ nature of CoPs is a fundamental feature which has proved to support teachers’ participation and active contribution.

5. A cultural change is required from teachers. Their idea of the teaching profession as based on the traditional teacher-centric concept is confronted with novel teaching methodologies, built on the learner-centric idea of active and collaborative learning. The analysed good practice experiences propose interesting solutions to address this issue in an effective and transferable way.

6. Cultural changes can only occur if the variety of involved players commit themselves to bring innovation forward. Players from the institutional educational sector, industry, higher education, NGOs, foundations and associations, other learning providers such as museums and libraries, and other ‘non formal and informal’ learning providers, usually activate themselves so to support change and consolidate novel work practices.
The recognition of the role of a variety of learning providers is also a key step that has been taken in order to promote CBL within the school curriculum. Non-formal and informal learning providers are usually more used to applying experiential and experiment-based learning methodologies. By recognising their role as learning providers, the formal education system benefits from the expertise and know-how accumulated in long-term activities.

Particular actions are usually taken in order to support the innovation cycle. Many analysed good practice case studies have developed their own solution to move on from the pilot scale to a broader scale, up to mainstreaming. The development of specific guidelines for teachers, school managers and other players usually contribute to scale a small experience up.

The implementation of successful and meaningful experiences are usually based on the involvement of a varying range of players, since the design phase. So-called ‘participatory governance processes’ greatly help elaborate needed and targeted interventions. These are meant to provide practical and sustainable answers to the demand for sustainable local development and for increased social capital.

The application of gender approaches in CBL methodologies for Science and technology teaching needs to be carefully designed and implemented. The analysed experiences are based on specific concepts taken from psychology and pedagogy, such as the concept of ‘role model’.

The general recommendation which can be drawn on the basis of the outcomes of the analysis of the collected good practice experiences is a kind of exhortation: ‘Build on enhancing factors, minimise inhibiting factors!’.

Aside from such a simplistic and tautological statement, the following recommendations have been elaborated for three key intervention areas:

- Dissemination and capitalisation of existing experiences.
- Integration of CBL and other related innovative learning approaches within Lifelong Learning policies.
- Adaptation and application of what works elsewhere.
- Promotion of sustainable Communities of Practice.

Disseminate and capitalise on existing experiences

1. Stakeholders and the wider community of practitioners and experts should be involved in the design phase and in the implementation process of CBL initiatives. Only in this way is it possible to foster their sense of ‘ownership’ of the action and their commitment to the further development of the experience, in a perspective of capitalisation, promotion of visibility and sustainability.

2. In this respect, the adoption of ‘participatory governance structures’ can be of great help in bringing different interests together and in definition a shared agenda.

3. Promoters of CBL initiatives should make all efforts to create partnerships and/or networks with other players willing to work synergistically so to contribute to the increase of the local social capital.
4. Specific resources centres should be set up, so to provide teachers, other learning providers as well as learners with state-of-the-art reference materials and possibly laboratory facilities. Such resource centres should be created and maintained thanks to the contribution and collaboration of different players, working together in partnership or network.

5. In order to support the visibility, and therefore the sustainability of an initiative, specifically designed events should be organised. Participation and presentations made in conferences, exhibitions, other events held at local and/or at national or international level generally contribute to raise interest on the initiative and to generate constructive feedback.

6. In order to support the visibility, the promoter and partners of an initiative should exploit the opportunities offered by existing initiatives, journals, portals, permanent discussion fora (physical events as well as virtual fora). The more a project/experience is presented, showed and discussed, the greater the attention will be on its outcomes and potential for further development.

7. In this respect, a targeted use of media should be made. A specific ‘communication strategy’ should be developed for each initiative, defining the addressed target publics and the coherent communication and dissemination actions to be implemented. In the ‘Knowledge Society’ the use of information and communication media represents a decisive step to be taken.

**Integrate innovative learning approaches within Lifelong Learning policies**

1. The widespread implementation of Lifelong Learning policies across European countries should be coupled with particular actions aimed at recognising a variety of learning providers, apart from the formal ones (e.g. schools). Only the integration of different learning and training systems can generate real and effective synergies between different policy areas and implementation domains. In this respect, in the framework of the Education & Training 2010 Work Programme, recommendations addressed to decision-makers in the area of Mathematics, Science and Technology (MST) point out the need to modernise teaching methods and to promote extra-curricular activities, as well as to connect MST to real-life contexts and experiences\(^1\). Suggestions also focus on the opportunity to move from ‘content’ to ‘activity’-based teaching.

2. The shift from ‘knowledge-based’ learning approaches to ‘competence-based’ ones should be backed by specific policy actions. This shift goes hand in hand with the recognition of out-of-school learning providers and with the need to value the learning outcomes also emerging from non formal and informal learning processes. Furthermore, the recently adopted Recommendation on European Reference

---


Framework on Key Competences for Lifelong Learning defines ‘competences’ rather than 'knowledge' as part of the national reforms and strategies for Lifelong Learning. Mathematical competence and basic competences in science and technology are actually one out of eight areas addressed by this Recommendation².

3. Teachers should be supported in the challenging process of becoming aware of and grasping a holistic view of innovation including topics, concepts, approaches and working methods. The risk is that the whole picture appears fragmented into small, unrelated and meaningless pieces. In this respect, the identification and exchange of good practices and the promotion of peer learning activities in MST are at the heart of the work being carried out by the EU Member States (the so-called ‘EU27) with the support of the European Commission. A specific Cluster of countries is launching initiatives in the field of science education. The information network on education in Europe, EURYDICE, published a comparative study on Science Teaching in Schools presenting a detailed overview of school curriculum, teacher training and pupils' assessment in Europe³.

Learn, adapt and apply what works elsewhere

1. An ‘observatory capacity’ should be fostered at local, national and transnational level. Good practice experiences should be collected and explained to the broad interested public. As a matter of fact, it often happens that newly designed experiences start almost from scratch, without knowing what has been going on in a nearby school or organisation. Collecting information and making it available through a public space (possibly a web portal or other easy-to-update and to access supports) would greatly contribute to the capitalisation of past experiences, to their visibility and to the aggregation of expert organisations in further activities.

2. Strategies for horizontal transferability should be developed and implemented. *Horizontal transferability* refers to the opportunity to apply the developed CBL model and the processes behind it to other similar contexts. Support to horizontal transferability aims at broadening the borders of the initiative and stretching it out so to reach larger numbers of users. Actions for horizontal transferability should imply efforts aimed at increasing either the group of partners, or the addressed stakeholders, or both.

3. Strategies for vertical transferability. *Vertical transferability* refers to the extent to which a CBL model and processes can be transferred to all levels of the system (namely the formal education system).

4. Collaboration processes should be nurtured, involving teachers and other involved learning practitioners. This should be based on stable and easy-to-access organised structures, such as dissemination events, coordination committees, communities of practice.

---

Promote sustainable Communities of Practice

1. Communities of Practice (CoPs) should be fostered and nurtured. It is important to stress that CoPs should be set up spontaneously by interested players and not imposed in a top-down way. The set up of CoPs supports teachers and other learning practitioners in developing a professional culture and a sense of belonging to a professional community. When teachers have a strong sense of professional community their morale is better and teacher commitment is higher. Professional communities help support teaching practices, and help teachers address the uncertainty that accompanies non-routine teaching of the sort brought about by CBL.

2. In order to acquire the know-how needed for the successful adoption of innovations, teachers need to be supported in becoming well aware of why the innovations are proposed. Discussion and informal exchange of experiences and ideas which take place in a CoP should be directed to this end.

3. Ad hoc training actions should aim at creating clusters of teachers in each school in order to diffuse expertise among fellow teachers and potentially greatly increase the take-up of innovations based on IT.

4. Spontaneous participation in CoPs should be recognised as an informal opportunity to develop professionally, within the planned in-service training and continuous professional development schemes.