

**LEARNING FROM
INNOVATION AND
NETWORKING IN
STEM (LINKS)**

EXPERIENCES IN IMPLEMENTING EFFECTIVE

CONTINUOUS PROFESSIONAL DEVELOPMENT

FOR STEM TEACHERS IN FIVE EUROPEAN COUNTRIES





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Foreword

The LINKS project (Learning from Innovation and Networking in STEM - science, technology, engineering and mathematics), funded by the Erasmus + programme of the European Union and coordinated by the Fondation *La main à la pâte* (France) is carried by a partnership composed of 9 institutions involved in STEM Continuing Professional Development (CPD) of teachers and their educators in five countries: Austria (IMST/NEP), Finland (LUMA Centres), France (*Maisons pour la science*), Italy (ANISN) and the United Kingdom (STEM Learning). They belong to (and some of them coordinate) national networks which all together represent 120 local CPD providers.

These national networks share the same convictions:

1. **The challenges of our time require the consideration of the role of broad science and technology education** as a basis for securing the innovation potential and the sustainable social and economic development in Europe. This involves increasing public understanding of science, interest and motivation for innovation, civic competencies as well as the achievements of students in STEM (science, technology, engineering and mathematics).
2. **For the crucial task of preparing young people to live in a complex world marked by rapid change, key players are teachers.** Just like their students, they need to constantly learn and develop their skills.
3. **Continuous Professional Development is the most effective leverage to support teachers** in their task and enhance the quality of STEM teaching.

The principal objective of the LINKS project is therefore to develop a network focused on **systemic change**, in order to propose to their main targets (CPD providers, local and national governments, employers, the scientific community

and the European Commission) long-term strategies to answer this central question: **What should be considered –and thus promoted and supported- as innovative, effective and sustained STEM CPD programmes?**

The partners have collated and shared practices on the design and implementation of impactful CPD in their country, shared experiences on cross-cutting issues conducive to successful CPD programmes with the objective of disseminating the outputs of the project to enhance the mobilisation of the various stakeholders.

The first step of the network's work was to propose **a common framework for STEM CPD based on the experience of the 5 national networks and to draw some recommendations for its implementation.** This took the form of a collective work capitalising on best practices which is the core content of a study that analyses conditions for innovative and successful CPD on the basis of activities and programmes that have been developed within networks and that have proven themselves beneficial in different European countries.

This booklet is a summary of the study. The full version is available online.



https://www.fondation-lamap.org/sites/default/files/upload/media/minisites/international/links_Final_Study.pdf

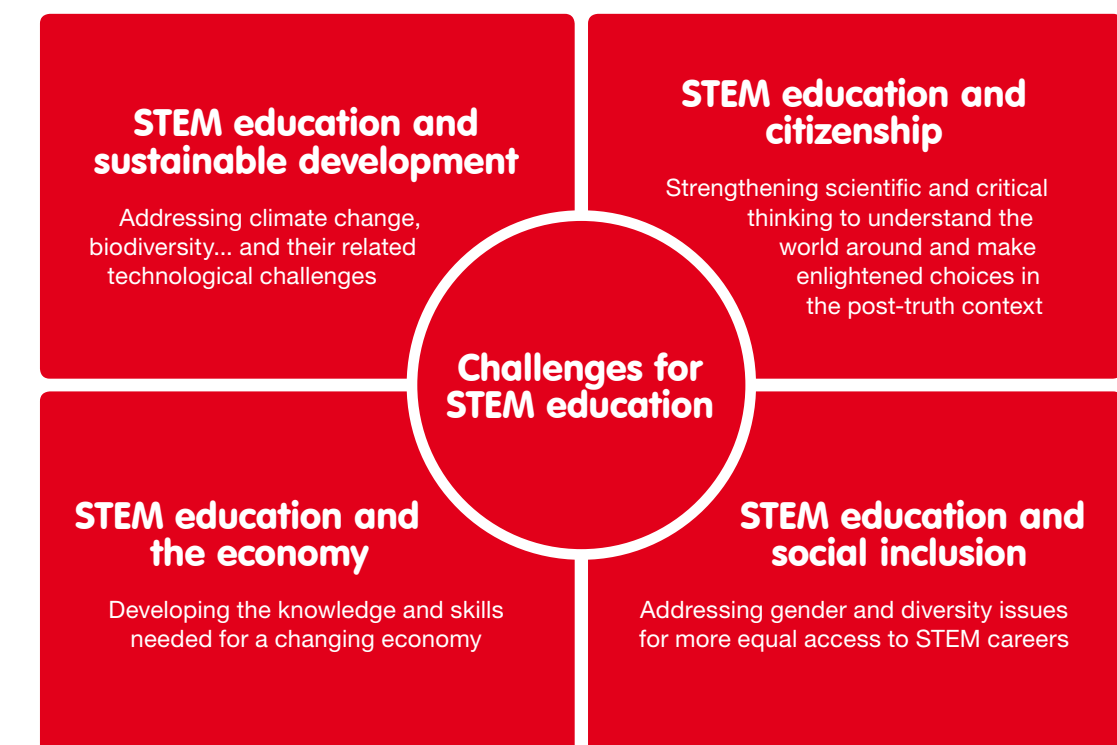
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1. STEM Education in a Changing World

Global trends of the beginning of the 21st century pose manifold challenges to STEM education that cannot be met by previous means and methods of teacher training and teaching.

In a rapidly changing society characterised by globalisation, technical innovation, digitalisation and social upheaval, classic subject teaching is getting aware of its limits. Furthermore, educational policy makers expect schools to foster a holistic personality development covering cognitive, physical, social and cultural aspects.

The educational systems should prepare the next generation for a life in an increasingly complex world, where knowledge, skills and expertise are key for **economic, social and civic inclusion of all**, taking into account the challenges of **sustainable development**.





Main levers for effective and impactful professional development

2.1 CPD core contents

The content of the activities offered to teachers and educators is a major issue in the review of continuing professional development. This content concerns both the field of knowledge - science in this case - and the teaching methods involved in the transmission of scientific knowledge.

The integration of both subject content knowledge (SCK) and pedagogical content knowledge (PCK) in the same CPD programme is beneficial to the teachers throughout their career, especially in countries where it is difficult to access CPD.

This integration takes different forms across the LINKS countries and partners involved in science CPD design and delivery.

However, the partners share the vision that this integration is more effective in a context where cutting-edge scientific content is addressed by putting teachers in the situation of adult learners. This approach allows teachers to have a learning experience at their level and to gain a better understanding of the difficulties that learners - including their students - may encounter when they face an unknown situation.

Hence the choice of **cutting-edge science** to renew SCK and of **Inquiry-Based Science Education (IBSE)** as an effective approach for the enhancement of PCK, especially when complemented with recent findings in the science of learning and the consideration for diversity issues.

Besides drawing from these two common pillars, LINKS partners also develop CPD innovations to address two major trends in STEM education: the attention to the **Nature of Science** (NoS) and the development of **interdisciplinarity**, both in line with the combination of cutting-edge science and IBSE.



2.2 CPD delivery

The various formats that can be developed to deliver CPD is an issue as critical for the effectiveness of the experience for the teacher as the content itself.

Indeed, finding the appropriate characteristics of CPD in terms of organisation over time and space is crucial from a pragmatic point of view in order to make CPD accessible to the majority of teachers. On a more fundamental point of view the LINKS partners also discuss other challenges: how to support teachers, who are isolated, in their daily teaching practice? How to empower them to take charge of their own professional development and at the same time to form a learning community with their peers and other stakeholders not directly pertaining to the educational system?

LINKS partners do not intend to prescribe a list of recipes that could be implanted everywhere without adaptations. We rather intend to show, like in the previous part related to CPD content, that some major elements, like **the duration**, and strategies, for instance **training trainers**, have been identified as significant in the delivery of impactful CPD.

However, it is important to mention here that delivery will be all the more effective where several forms are combined: **distance-learning** complementing face-to-face CPD, **provision of turnkey resources**, in and outside the classroom... The strength of each CPD activity will be maximised by its proactive association with others. Creating a cohesive system, especially through the support of **learning communities**, rather than providing isolated activities, is the main lesson learnt.

Sustainable improvement requires long-term CPD investment

- Adopting IBSE requires deep professional changes regarding the attitude, and to consider student learning in a new light
- Helping teachers to change their practices in a sustainable way supposes to engage them in many new ways: working in collaboration with their colleagues, in a spirit of interdisciplinarity, but also working with their management, the parents and the scientific community
- The evolution of professional practices cannot be effective without going back and forth between moments of reflection outside the classroom and moments of implementation with students
- That is why LINKS partners agree with the general recommendation of a total of 80 hours of professional development to achieve significant change

...But long-term CPD also requires specific dissemination strategies and activities to be accessible for all teachers

- Training of trainers is important to generate a multiplying effect and support teachers more effectively
- Distance learning & use of digital tools help to complement and deepen face-to-face professional development
- Turnkey resources and activities facilitate the implementation in the classroom
- Learning communities where teachers can work with their peers and other stakeholders
- LINKS partners consider these strategies as complementary activities, of equal importance and which -as such- should be given equal consideration and support

2.3 CPD targets and CPD providers

All CPD providers work for teachers –and ultimately for the benefit of children – and mobilise dedicated expert staff to this purpose, whatever their status and name: trainer, educator, tutor, instructor...

The focus on teachers, though obvious, does not say anything about the way we engage them in CPD. Indeed, **we do not address only individuals but also groups**; this involves ensuring the way we organise CPD makes the most of collective synergy, considering the various categories teachers are more or less assigned to: primary vs secondary, pre-service vs in-service etc...

However, teachers are not only life-long learners; they are also knowledgeable and experienced actors within their educational settings as they daily modulate between top-down requirements and bottom up needs experienced in sites of learning.

In the same logic, involving people not only to deliver traditional CPD courses but to support a whole learning journey throughout teachers' careers, supposes to associate **a diversity of players who can give useful inputs** and create a relationship with teachers where mutual learning is central. LINKS partners have especially developed cooperation with two categories of players in order to complement the work of more traditional teacher educators: tertiary students and scientists (researchers, engineers, technicians...). Valuable support for teacher development could also be contributed by other sources.

It is also key to consider that teachers themselves, as individuals and together with their peers, are masters of their own professional development.



Going beyond traditional boundaries in CPD

- ▶ **Common CPD for primary and secondary teachers**
 - Favouring interdegree sharing of good practices between teachers
 - Fostering local peer communities
 - Contributing to a smoother transition from primary to secondary school for students
- ▶ **Strong link between pre-service and in-service PD**
 - Promoting a professional development continuum that starts during pre-service studies and continues for the entire career
 - Benefiting from facing people with alternating background but similar interests

Involving new groups of educators in CPD

- ▶ **The possible role of students**
 - Science students provide useful content-orientated support targeted at primary teachers who are uncomfortable with science knowledge
 - Students in education can be mobilised to support teachers in the field, especially through specific small-scale projects to test innovative approaches
- ▶ **The growing role of scientists**
 - Promoting scientific subjects and careers, acting as role models for students
 - Providing scientific support during training or in the class
 - Contributing to the design and delivery of training sessions, pedagogical resources, etc.

Empowering STEM educators

- ▶ **Addressing educators as actors**
 - Forming communities of learning within peers
 - Fostering reflective-practitioners
- ▶ **Using knowledge for systemic change**
 - Modulating between top-down and bottom-up requirements
 - Identifying themselves as management from the middle and seek contact and exchange with scientists, local CPD providers, the industry and educational stakeholders

2.4 What are the conditions for successful CPD programmes?

LINKS partners are part of an organisational environment made of the educational system itself with all its political, administrative and operational components, and of other institutions, both public and private. Although their strategies and expectations may differ the enhancement of STEM

education through CPD is a shared aim for all of these players. To ensure greater cohesiveness and efficacy it is important to produce a common framework.

LINKS partners are very committed to contributing to the design of such a **common strategic framework to a systemic approach in CPD** in their respective countries. They have identified some conditions that should be met in every country and which may be completed and detailed.

Some strategic conditions to build a systemic approach to STEM CPD



The future of STEM CPD: the vision of LINKS partners

3.1 The proposed strategy

There are many possible models and strategies to enhance professional development, depending on the educational context of the country.

Nonetheless **some key elements can be identified as the core added-value of the members of the partnership in their national context.**

- **The capacity to provide consistent and comprehensive CPD programmes**

- **The capacity to progress from innovative pilot actions to larger-scale programmes**

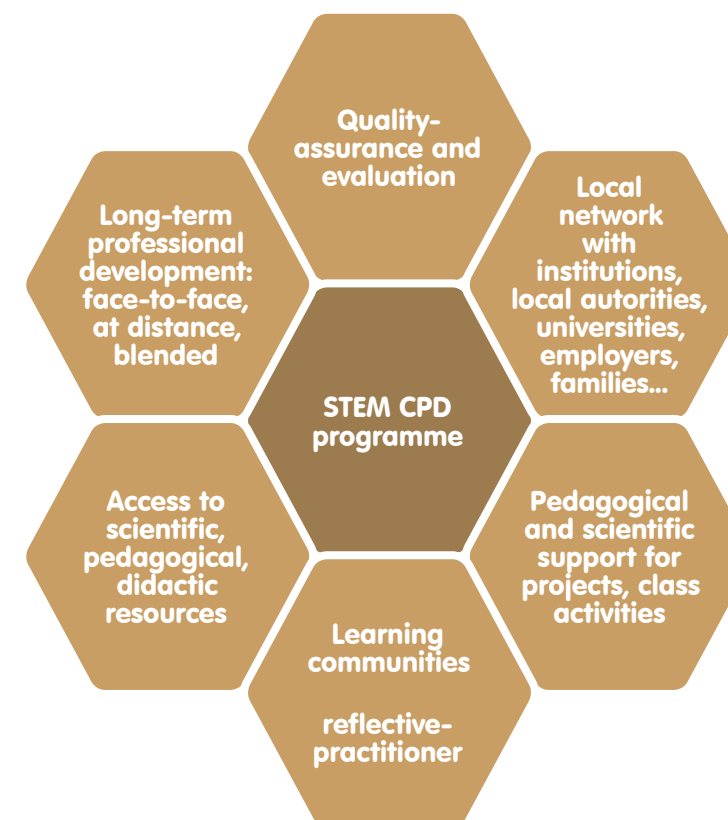
The pilot action can be a project on a local, national or international scale that represents a sort of «craftsman's workshop» where small prototypes are developed, but at the same time wider projects on a progressive scale are on the horizon.

In parallel to this a continuous reflection is needed on how the available resources can be sustained and expanded over time.

All LINKS partners are aware of this double pillar dynamic: to proceed by small operational steps having in mind the steps ahead clearly identified.

The capacity to remain close to local needs and dynamics and to enhance local results through networking

The scaling-up of programmes does not mean that a recipe shall be identified and applied to all teachers. When LINKS partners call for nation-wide mobilisation for CPD, this shall be considered in the sense of an attention to equal treatment for all teachers who all have professional development needs but not necessarily the same. That is why LINKS partners advocate for national strategies which are quite flexible to allow for local adaptations, with a particular focus on the process of involving the whole school itself or small groups of schools in a given area.



CPD design and content should be driven by a relevant needs analysis. While local steering groups may be established to identify the needs of teachers, they are not always involved in further implementation. Where the strategy is locally defined (for instance school led) and based on confidence in the capacities of the teachers to build their own autonomy, teachers inevitably have a greater input into the design and content of resources and the impact of professional development is increased. We perceive teachers not only as receivers of CPD programmes, but as active partners that have the capacity to adapt new knowledge within their educational settings.

Of course, local dynamics need coordination and it is also important to connect them with others at regional and national levels in order to share experiences and highlight the global coherence of all initiatives. To address this purpose, partners have put a strong focus on the development of networks.

► **The capacity to build links between the scientific and educational communities and institutions**

In the field of STEM, there is a profound tradition of school-supporting institutions and programs in all countries that are not embedded directly in formal educational structures but are closely linked to them. They were designed as programme tracks to cooperate with the public school system and other systems like research, regional development, or public institutions.

LINKS partners, even if diverse in status and organisation, are in this intermediary position in their respective school systems.

These intermediary institutions or programmes act as “missing link” providing a repository of scientific knowledge and specialist know-how in order to draw heterogeneous actors and institutions into new relations of co-operation.

LINKS partners are confident that these few trends can provide useful guidance for the implementation of effective and impactful CPD.

However, two main challenges remain at the core of the issue of systemic change.

3.2 The key challenges

► **The challenge of CPD for all teachers**

For a diversity of reasons (geographical, organisational, financial, motivational...) teacher trainings in IBSE are repeatedly attended by the same group of teachers.

Moreover, in-service training is only to some extent mandatory and there is often no replacement system to facilitate the teachers’ coming. As a consequence, professional development is rather attended by teachers on a voluntary basis.

Therefore, innovation is limited to a small group of teachers and the involvement of new groups and dissemination are an issue.

To succeed in reaching all teachers and provide them with the diversity of CPD activities that we have developed to address their needs, a second challenge has to be taken up.

► **The challenge of sustainability**

Sustainability is not only a necessity of financial resources. Above all, it is also a matter of the professional development proposal quality and availability, balanced by an adequate sustainability by the teachers with the ability to welcome them in an evolving community where they can then be active participants. The sustainability of the activities starts first from the people and from their shared vision, then from financial resources.

That is why **a central success factor lies in the presence of intermediary network structures**. These mediate between different players to coordinate and disseminate innovative developments. Intermediaries very often conduct their activities through local, national and international projects; although these projects enrich and contribute considerably to the professional development of the involved participants, they are also strongly affected by being time and space limited. Therefore, a very low percentage of available potential is really exploited in a large temporal and spatial dimension. Very often, authorities still favor a clear top-down strategy as their policy approach, no matter how inchoate it proves to be repeatedly. However, intermediary network structures offer a new approach for policy fields that should be utilised more often.

These challenges cannot be taken up only by CPD providers but require a larger mobilisation, especially from educational authorities, at all levels of decision.

3.3 Recommendations to decision-makers

Sustainability and scaling-up of quality STEM CPD are a major concern for LINKS partners, who need other stakeholders, and especially educational authorities, to join efforts for realising systemic change.

To this purpose, three main recommendations are proposed.

► **Educational authorities as well as the European Union should increase their recognition of the role of intermediary structures and their support to their work**

Intermediary structures involved in STEM CPD have developed their capacities to both innovate and demonstrate the value of this innovation at a scale which is large enough to contribute to the prefiguration of public policies.

That is why LINKS partners recommend to educational authorities to increase or maintain their recognition which may take different forms:

- Enable the intermediary structures to work within the educational system to develop innovation with teachers, trainers, schools...
- Cooperate with intermediary structures to implement larger-scale projects that can prefigure tomorrow’s public policies.
- Secure continuous financial support over the years, which is crucial for the sustainable development of the proposed CPD strategy.

LINKS partners strongly advocate the creation of sustainable financing structures at both national and international level to maintain interdisciplinary intermediary education networks and to promote innovation in STEM education. Indeed, apart from national commitment, international projects, in particular those funded by the European Union, are an important source for the maintenance of the innovation capacity of intermediary structures and networks.

► **Educational authorities should lead the change towards a learning system**

To be able to conduct a strategy of change, not only do students and teachers have to learn and change, so do educational research and policy. We see the whole system’s need for learning.

That is why long-term CPD efforts should consider a systemic approach in educational research (providing a basis for teacher educators’ work) as well as in educational policy and related administration (defining the context for teachers’ work).

These assumptions point to a CPD framework that is general enough to be used in different contexts (students, teachers, and teacher educators), leading to the notion of the “learning system” (Krainer & Zehetmaier, 2013) in which four important poles shall be considered:

- Action
- Reflection
- Autonomy
- Networking

Though each of the pairs (“action and reflection” and “autonomy and networking”) are regarded as complementary dimensions that should be kept in a certain balance, traditional teaching and teacher education often underestimate reflection and networking.

That is why **LINKS partners recommend that CPD policies put the stress on the promotion of reflection and networking as key interventions.**

► **Long-term ambitious policy for STEM CPD and STEM education should be adopted and maintained**

Sustaining long term innovative and impactful processes has not always been a priority due to the need for quick results directed through National and European education policies.

However, change and innovation require long term and constant support; continuity appears to be the main characteristic of a successful policy: many different options can be chosen, there is no single model for STEM CPD and STEM education development, but maintaining a strategy over the years and guaranteeing stability in its implementation is essential.

That is why **LINKS partners recommend to educational authorities the adoption of long-term policy and planning, irrespective of political changes.** This policy shall be comprehensive and relate not only to in-service professional development, but to all aspects of the educational system: curricula, pre-service training, assessment of students’ achievements, career management, etc.

Systemic change demands such comprehensive and stable policy. LINKS partners and certainly other CPD providers all across Europe, are keen on supporting this kind of policy in different ways, sharing their most successful innovation and prototypes for further ownership and supporting their scaling-up.



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