PD centre models: context, mission, structure and activities.
A review of models, challenges and success factors to lead improvements in
STEM teacher professional development

IO 5
Information about the report/IO
IO N° 5
Publication date: 25/06/2018

Project Information
Grant no. 2016-1-DE03-KA201-023103
Project title: European Network of STEM Professional Development Centres
Project acronym: STEM PD Net
Start date of project: 01/09/2016
Duration: 36 months
Program: Erasmus+, Key Action 2 (KA2) – Strategic Partnerships

Contact Information
Coordinating Institution: University of Education Freiburg, International Centre for STEM Education (ICSE)
Coordinator: Prof. Dr. Katja Maaß
Project Manager: Elena Schäfer
Lead partner for this report/IO: Prof. Dr. Günter Törner, Joyce Peters-Dasdemir
Website: http://stem-pd-net.eu/

© STEM PD Net project (grant no. 2016-1-DE03-KA201-023103) 2016-2019, lead contributions by University Duisburg-Essen. CC-NC-SA 4.0 license granted.

This document is based on the work within the project European Network of STEM Professional Development Centres (STEM PD Net). Coordination: Prof. Dr. Katja Maaß, International Centre for STEM Education (ICSE) at the University of Education, Freiburg. Partners: University Klagenfurt, Austria; University of Innsbruck, Austria; Institute of Mathematics & Informatics at the Bulgarian Academy of Sciences, Bulgaria; Ljuben Karavelov School, Bulgaria; Texas Instruments Education Technology GmbH, Germany; University of Duisburg-Essen, Germany; Ministry of Education, Culture & Sport, Spain; Education Development Centre, Lithuania; Gymnasium of the President Valdas Adamkus, Lithuania; Linköping University, Sweden; University of Gothenburg, Sweden; Turkish Ministry of National Education, Turkey; Hacettepe University, Turkey.

The project European Network of STEM Professional Development Centres (STEM PD Net) has received co-funding by the Erasmus+ programme of the European Union.

The creation of these resources has been co-funded by the Erasmus+ programme of the European Union under grant no. 2016-1-DE03-KA201-023103. Neither the European Union/European Commission nor the project’s national funding agency PAD are responsible for the content or liable for any losses or damage resulting of the use of these resources.
Contents

Executive Summary .................................................................................................................................. 2
1. Main report .......................................................................................................................................... 3
  1.1 PD CENTRES .............................................................................................................................. 3
  The different types of centres .......................................................................................................... 3
  To summarize our observations ....................................................................................................... 4
  1.2 CASE STUDIES ........................................................................................................................... 5
  GERMAN CENTRE FOR MATHEMATICS TEACHER EDUCATION (DZLM) ........................................... 6
  NATIONAL CENTRE FOR MATHEMATICS EDUCATION (NCM) .......................................................... 13
  T3 EUROPE – Teachers Teaching with Technology ........................................................................ 19
  LEHRERINNENBILDUNG WEST ....................................................................................................... 22
  EDUCATION DEVELOPMENT CENTRE (EDC) ................................................................................... 26
  1.3 MISSION & CHALLENGES ........................................................................................................ 31
  Change processes ........................................................................................................................... 31
  The dilemma of STEM .................................................................................................................... 31
  Success Factors .............................................................................................................................. 31
  Further missions & activities .......................................................................................................... 34
2. Conclusions & Recommendations ................................................................................................. 35
3. Appendices ..................................................................................................................................... 37
  3.1 Appendix 1: Questionnaire 1 ................................................................................................... 37
  3.2 Appendix 2: Questionnaire 2 ................................................................................................... 41
Executive Summary

As part of the ERASMUS project European STEM Professional Development (PD) Centre Network (STEM PD Net), we have been working on PD centre models. The main aspects that we have focused on were a review of models, challenges and success factors to lead improvements in STEM teacher professional development. We tried to measure and understand the varieties and commonalities of STEM centres.

All project partners as well as the PD Centres Network partners contributed to a comprehensive information base by completing the questionnaire. The evaluation of the questionnaires brought depth insights into the different PD centre models and approaches in the project partners different countries – any beyond, as members of the PD Centres Network also filled in the questionnaire.

Also, the evaluation impressively illustrated the differences of PD centres exemplary reasons for the establishment of the centres, e.g. improving STEM education, improving professional development of teachers resp. teacher educators resp. teacher training, widening activities and expertizing in research of pedagogies, focusing on instructional and school development, or strengthening coherent teacher education. In completing the questionnaire and considering about the different categories it could also be achieved that the centres became clearer about their own centre model and in this way also support the organizational development of their institution. The whole consortium could also learn a lot from the best-practice examples.

Our compendium is designed to make our results available to you and help you to understand what distinguishes successful STEM PD centres. It is especially important to describe the different possibilities available when setting up a centre for professional development in the STEM area. The compendium will include a structured overview of possibilities of PD centre organization and activities, selected descriptions of PD centres with examples of their activities as well as an analysis of their weaknesses, strengths and challenges, and a review of challenges and recommendations on developing influential PD centres and possibilities to overcome challenges.

To enhance these overviews we added case studies of selected centres which can also be found on the STEM PD Net homepage (http://stem-pd-net.eu/en). These case studies provide us best practice-examples to orientate ourselves for successful centres. These are presented before the missions and challenges, since the five centres exemplify represent the four types and concretize them that the differences have their legitimacy.

When writing the case studies we gained further insights and accordingly another questionnaire. From this we finally gained new insights. At the end of this document, we have placed these new insights and provided them with recommendations.

The Compendium is structured due to the analysis of the questionnaires issued as follows:

- Structure of PD centres and situation in the countries
- 5 Case Studies
- The mission of the centres and major challenges
- Conclusion & Recommendation: New insights on the PD centres
- Appendices: Questionnaires
1. Main report

1.1 PD CENTRES

The different types of centres
Over decades most of the European countries have established governmental PD centres for some school subjects. These centres have to be understood as central educational institutions and their main task was and is to assist and support the official educational politics of the government. In the past, a new curriculum induced a new initiative of in-service training courses for teachers which had to implement the new curriculum. This task was the predominant function of these centres. However, our view was widened by research.

Fortunately, it was understood by the governments in the last twenty years, that continuous professional development of teachers is important issue – independently of an actual change of the curriculum. This development was accompanied by the research side, since ‘teacher change’ and ‘professional development’ gradually turned into new important keywords to which attention has to be devoted. Thus the (new) title ‘Professional Development (PD) centre’ for the traditional centres gradually became in use. Thus, most of the PD centres in our network originate in the old governmental institutions which were responsible for implementation of curriculum.

But there exists also a second type of a PD centre, some of these centres are members and partners in our network. We would like to explain their genesis and their role. In all European countries, teacher education is being held more or less intensively by universities. Sometimes, research focused universities have no faculties of teacher education, but this is not contradicting our assumptions. If a faculty is responsible for teacher education, it is not surprising that the teacher educators are also engaged in research about processes in the classrooms as well as about the role of teachers, e.g. professional development of teachers.

Thus, it is self-evident that these stakeholders at universities are claiming some responsibilities for upgrading teachers at schools. Some of the researchers are handling this task voluntarily, others are bringing in their expertise because of the employment agree within their faculty. We could prove that different models in European countries exist how to deal with this important interface. We don’t know any investigation about the linkages between university research and the implementation into daily practice within schools where ‘teachers’ and ‘students’ are the interesting stakeholders. Thus, it is only a small step to establish a university institution which calls itself a PD centre. Obviously, this type has different characteristics than the PD centres described above.

Finally a third type of a PD centre has been established by initiatives of firms and companies having interest to contribute to the educational system which is seen as a market, e.g. Texas Instrument financed the important PD initiative T3 (teachers teaching technology).

Last no least, non-governmental organizations (NGO) have to be regarded also as a stakeholder. Money is provided in areas where experts are recognizing deficits within the educational framework. The national institute for teacher education within mathematics in Germany, namely German Centre for Mathematics Teacher Education (DZLM), may serve as a classical example. The educational politics in
Germany is fragmented since the sixteen provinces (so called ‘Bundesländer’) own the authority to regulate curriculum. The foundation of Telekom Deutschland was free to establish a national centre which could be designed by a different political stakeholder.

To summarize our observations

In Europe there exist four different types of centres:

Type 1) PD centres run by educational institutions in the charge of the government. The government or related institutions financing the PD centres. Thus, on the other side, the government is determining the various tasks and has the right to appoint persons.

Type 2) Universities are stakeholder of teacher education, thus they are claiming or are imposed to bring in their expertise and to run in-service teacher courses. These continuous duties have lead on to the establishing of university PD centres.

Type 3) Education can also be seen as a market, publication companies, companies producing software or materials have an interest to intervene into this market and they decided to run their own PD centres. T3 of Texas Instruments is a good example.

Type 4) It is not surprising that non-governmental organization have an interest to bring in their expertise, often they are able to act where official institutions have to accept barriers. In Germany, for example, education politics is authorized by the 16 provinces (so-called ‘Bundesländer’). Thus, it is not very easy to establish a national institution which previously finds the consent of 16 partners. A NGO has the capacity to build on such an institution as long as it is paying for his/her endeavor.

In our case studies, we described five institutions in details which are of different type.

- DZLM (Berlin, Germany) – German Centre for Mathematics Teacher Education (Type 4)
- NCM (Gothenburg, Sweden) – National Centre for Mathematics Education (Type 1)
- T3 Europe – Teachers Teaching with Technology (Type 3)
- Verbund LEHRERINNENBILDUNG WEST (Innsbruck, Austria) – RECC Biologie, RECC Mathematik (Type 2)
- UPC (Vilnius, Lithuania) – Education Development Centre (EDC) (Type 1)

It is self-evident, that the four different types are differing enormously with respect to the variables.

- Identity of the centre and the self-conception of its employees
- Basic philosophies of its acting
- Internal flexibility
  - Balancing theory and practice to support teachers’ learning.
  - Addressing many and diverse aspects of teachers’ competencies and experiences.
  - Being contextual and flexible (e.g., addressing the needs of teachers, students, industry and business).
- ‘Reach of action’ towards politics
- Dependency resp. independency with respect to governmental commitments
- Professionality of internal management processes
- Nearness resp. distance to research; the role of research for the work within the centre
- International visibility
- Intensity and type of cooperation with other stakeholders; the importance of interdisciplinarity
Financial resources

The distinction is also due to various motives of the establishing like:

- improving STEM education
- improving professional development of teachers resp. teacher educators resp. teacher training
- supporting physics teaching at all levels
- widening activities and expertizing in research of pedagogies
- focusing on instructional and school development
- implementing educational school subject content, inquiry based mathematics and computer science education, teacher competence development
- strengthening coherent teacher education
- Networking computer science technology

1.2 CASE STUDIES

We added case studies as mentioned above of selected centres. These case studies provide us best practice-examples to orientate ourselves for successful centres and concretize them that the differences have their legitimacy.

The case studies were created separately and are created below in the following order:

First, the DZLM of the type 4 is presented. Then follows an overview of the NCM (type 1) and the T3 (type 3). Afterwards the centre will be shown from Western Austria (type 2) and last but not least the centre EDC (type 1).
We refer to the presentation of DZLM on its website (https://dzlm.de/dzlm/international-visitors). Parts of the following text are cited from an English version of its homepage and modified according to our categories:

I The DZLM as a German Institution

I.I The Starting Point

The DZLM was initiated and is funded by the Deutsche Telekom Stiftung (www.telekom-stiftung.de), a corporate foundation centred on improving STEM-education. On the recommendation of a panel of experts for Mathematics across the Educational Chain, the foundation created the DZLM in 2011 as a nationwide centre aiming at general quality standards for teacher training. The idea of such an institution was mainly influenced by the characteristics of National Centre for Excellence in the Teaching of Mathematics (NCETM) in London which was run by the prominent mathematics educator Celia Hoyles at that time. In a country where each state has its own politically driven philosophy on professional development, this was a totally new approach.

I.II DZLM Embedded into the Heterogeneous Educational System of Germany

Thus, the centre is an institution completely independent within the highly complex framework of the German educational system. It should be annotated that Germany consists of 16 federal states which are responsible for the educational policy in their state. Federal state laws regulate education in general, as well as teacher education in Germany. This autonomy results in a heterogeneity in the systems of further qualification of teachers and educators. The differences between federal states are challenging for DZLM, but DZLM also considers them to be a chance: The great variety of successful formats and rich content in continuous professional development courses is thus bundled by the German Centre for Mathematics Teacher Education. To disseminate the concepts, materials and courses at a large scale and to ensure their practicability for the target group, the DZLM cooperates closely with the education authorities in the different federal states, strengthened by the help of specific local coordinators and federal delegates from education policy. As a consequence, DZLM can draw on the experience of the partners in teaching and research, in the didactics of mathematics and in pedagogy.

Further, the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany (KMK) takes over a coordinating role.

DZLM is successfully in establishing in the landscape of professional development in Germany and it is well-known to all stakeholders. However, DZLM has not reached a permanent status. It is not a trivial question how to anchor and finance an institution like DZLM in the Federal Republic Germany in the future. At the moment, various negations are underway to reach a compromise in 2019. The problems are described in Section 8.
I.III The Constitutive Partners, the Personnel and the Budget

At the moment members of eight universities are involved in the consortium: Humboldt-University Berlin, Free University Berlin, Ruhr-University Bochum, Technical University Dortmund, University Duisburg-Essen, University of Education Freiburg, Paderborn University and University of Potsdam. The main office resides at the Humboldt-University. DZLM succeeded in having contracts with these universities regulating the cooperation.

On the basis of such a construction, DZLM owns a wide panel of various experts in professional development, from primary schools to secondary schools, from mathematics to education theory at the different residences of their universities in Germany with many different research interests. Since the professors are further engaged at their universities on the basis of their regular contracts, the work is divided between them and many young scientists or seconded teachers. Most of them are PhD candidates..., often researching issues of professional development.

Only travel expenses of the professors and the expenses for courses are paid by DZLM, thus round about 60% of 1.2 million euros per year is used for internal financing.

It is self-evident, that DZLM cooperates with further partners in the fields of mathematics, mathematics education and educational research as well as the educational institutes of the different federal states.

Figure 1: The embedding of DZLM
II Philosophy, Mission and Networking

II.I Traditions of PD Centres in Germany

It is easy to provide an answer: There is no tradition of mathematics PD centres: however, over many decades, various cooperation (of different insensitivities) have been developed regionally with institutions of the educational systems, but none has ever reached a global (a country-wide) ‘charisma’.

This maybe explained by the federal structure of the German educational systems with authority in the specific ‘Bundesländer’. Next, we would like to annotate that the learned societies of physics and chemistry have a lot of resources to pay for professional development and they are doing it since companies and firms are existing; this is not true for mathematics since there does not exist a mathematical industry and last not least there was no tradition built up by the German mathematical society. Note that only a small percentage of teachers are members of mathematical society, differently to the situation in the former Eastern bloc.

II.II Philosophy and Mission

It was decisive that a ‘neutral’ stakeholder, namely the Deutsche Telekom foundation affine to mathematics, has taken over the responsibility. And again the Deutsche Telekom Stiftung set the specific well-defined objectives for the centre for which it was willing to pay. Both, the universities and all other partners involved in the German Centre for Mathematics Teacher Education have a common mission:

- To accompany the professional development of mathematics teachers during their whole career.

Since it is impossible to address each mathematics teachers in a country with more than 80 million inhabitants and more than 100.000 mathematics teachers, we have to restrict our mission to teacher instructors (multipliers). DZLM follows a trend that was formerly accentuated by the group of Katja Maas at Freiburg, namely Educating the Educators.

The continuous professional development (CPD) courses, concepts and materials follow a competence framework and design guidelines according to the latest research results in teacher education. Also, comparable concepts for the support and the securing of early education in mathematics are developed. These concepts result in CPD courses for kindergarten and elementary educators.

II.III Networking as a Crucial Issue of a PD Centre

It is an important objective to create networks between many different types of partners: teachers, colleagues, institutions and societies wherever possible. Thus, we network on a national and international scale through conferences, institutional cooperation and the creation of regional branches:

- Cooperation between educational and government institutions or ministries from different German federal states
- Creation of a web portal offering information, material for professional development and interactive teaching environments
- Inclusion of further education offerings from other people, projects or institutions through integration or linking

Research reports in literature prove that isolated initiatives are in general not successful, mathematics educators need various partners in different systems, they need friends. DZLM knows that networking between various levels promotes professionality (see the figure on page 2). These initiatives are indispensable. DZLM does not like to be regarded as a competitor. In a governmental system we would not have a chance to win.
DZLM’s activities are in line with a coherent concept of mathematics education from kindergarten and elementary education to upper secondary level that includes diagnosis and advancement of students' learning processes in mathematics.

The DZLM is interested in being a prominent member of the European Network of STEM Professional Development Centres.

III Activities

The DZLM’s fields of action are:

- topic-specific (mathematics) and practice-oriented;
- research-based, and seek to gain and share insights;
- networked throughout school levels.

The activities of the German Centre for Mathematics Teacher Education can be structured in three main strands:

Certified Qualification Measures:
- Creation of a nationwide master course for teacher educators
- Subject-specific and didactical qualification of teacher educators particularly for professional development
- Further qualification of out-of-field teachers
- Qualification events and courses for teachers and elementary educators

Research in Teacher Education and Professionalization:
- Evaluation of activities of the German Centre for Mathematics Teacher Education and of other agencies
- Research in the effectivity of professional development courses and publication of the results on an international level

- Research-based design of the quality framework (theoretical basis, design guidelines and competence framework)
- Initiation and financial support of professional learning communities (PLC) for peer coaching and competence development

Development of Material and Concepts:
- Development of material used by teacher educators in CPD courses
- Development of material used by teachers and elementary educators for self-teaching
- Development of information material, videos and flyers
- Joint development of concepts with teacher education institutes and ministries in the German federal states

IV The Theoretical Framework

The theoretical framework constitutes the foundation of its activities and builds upon theory and is evidence based.

- A competence model,
- a research and development agenda and design guidelines

have been derived from this and serve as a basis for the actual continuous professional development courses. All activities are monitored for quality with a systematic evaluation by means of transparent criteria. A subdivision within the centres is responsible for coordinating and monitoring design-based research around the courses.

Research on professional development is a central part of the agenda of DZLM, especially the PhD-graduation and qualification of young scientists providing also an international auditorium.
Specific Aspects

V Political Dependency

Since DZLM is actually not a part of the German educational system and is not paid by government, it is of course politically independent. Using a metaphor, DZLM is thus a further provider – and not to be ignored – a further competitor in the market of professional development. Thus, DZLM is free to set up its own norms.

On the one hand, this independence can be seen as an advantage: DZLM may experiment, may generate its own patterns and may follow new tracks.

On the other hand, having no political power behind it, independence is also a disadvantage. So the institution knows that it has to downplay its role and should seek for cooperation. Meanwhile, this role has been practised and accepted. Many courses are run beyond a label DZLM & xy or xy & DZLM.

VI Interdependence of Initial Teacher Education and DZLM Activities

The German Teacher education system consists of three consecutive levels. Firstly, there is the teacher education at university and in the most ‘Bundesländer’ the university curricula are being subordinate to different ministries, the ministry for academic and sciences on one hand, the ministry for education and schools on the opposite side.

After graduating from university the prospectives have to go into a preparatory service for 18 months. Actually, there is almost no cooperation between the persons in these virtual institutions and the faculties at university.

Having obtained a teacher position at school, the (novice) teachers are now in front of their classrooms. That is the first time that DZLM might address these teachers within the complicated role as novice teachers. One may regard this process as new and substantial, whereas in older times professional development has been seen as an upgrade after several years of service.

Thus, DZLM propagate that professional development initiatives should start as early as possible. Next, we would like to make professional development initiatives also as self-evident as possible. Thus cooperation at the moment highly depends on the program offered by DZLM.

VII Quality Assurance

As mentioned before using design-based research, DZLM is trying to influence the design of any course in advance. DZLM-members conduct the courses themselves or work together with experienced partners in the federal states, with whom they develop the courses together or make sure their concepts are in line with DZLM-standards and goals.

Next, after intensive discussions DZLM has set up specific position papers, namely

- a competence model and
- design guidelines.

These documents serve as a basis for the actual continuous professional development courses and are continuously revised according to new research and practice experiences. All activities are monitored for quality with a systematic evaluation by means of transparent criteria.

VIII Interdependence of Research and Practice – a Balance Act

Nevertheless, having accompanied the development of DZLM for many years and being at the same time also involved in the international research domain of professional development, the author has often posed the question of what is really sustainable. We should not ignore: DZLM consists of highly qualified persons from
universities and only partly experienced teacher instructors.

To be honest, it is not easy to guarantee that professional development is successful. Firstly, we should accept that teachers, their classrooms and their students live in a world which is disjoint from our field of experiences, the world of universities, the world of research projects. Next, we should reflect how we can bridge between these two strands. For the author, it is extremely difficult to balance between research and practice and that is an actual (hidden) struggle at DZLM.

To run courses for teachers and teacher instructors is not very deserving in the university world, a professor will not be honoured through such initiatives when he/she applies for a new position. Persons at a university will be measured by the amount of research money which they have achieved in the past. Numbers of publications in referred journals are decisive; however, teachers normally have no access to this literature and no time to study them.

On the other hand, teachers at schools are in most cases reserved towards what is offered as the latest research results by university teachers. They have often experienced that the worldviews of researchers about classroom are far beyond from being adequate. Thus, we need solutions balancing between practice and research while serving for the DZLM.

What was described for the individuals is also valid for the ranking of the whole institution DZLM. Is DZLM an institution for research or for generating materials and course? Yes and no, DZLM has to play both roles, but also sees this as one of its unique characteristics compared to other institutions.

**Miscellaneous**

**IX Conclusions and Recommendations**

**IX.I The Role of Learned Societies**

Since DZLM only addresses mathematics teachers, there are only two learned societies which should cooperate. The centre has strong relations to the

- German Mathematical Society (DMV) as well as to the
- German Mathematics Education Society (GDM) and

DZLM is usually present at their annual conferences and supports in particular any activity which is run on the ‘Teachers’ day’. Some members of DZLM also work within joint commissions.

**IX.II Networking; Informal Education**

Since DZLM does not address the individual teacher, but teacher educators, the link links are not very strong to informal activities of the communities of teachers. However, if there are requests DZLM would not refuse its collaboration, e.g. seeking for experts accompanying professional learning groups (PLG).

**IX.III Diversity of PD Centres: Culture, International Relations**

DZLM is so far not a permanent institution, thus its highest priority is actually given to efforts which guarantee the permanent existence. Thus, the STEM initiative in general plays a minor role since resources are limited.

**IX.IV Visions**

The predominant vision: DZLM will become a permanent institution, financed by a governmental system and will contribute to a development of mathematics all over the German teachers’ culture.
IX.V Publications

Here you can find international publications by DZLM members. A complete list of publications in German and English is available https://dzlm.de/dzlm/international-visitors/publications
We refer to the presentation of NCM within on its website (https://ncm.gu.se/node/203).

Parts of the following text are cited from an English version of its homepage and modified according to our categories. Also by the help of Peter Nyström:

I The NCM as a Swedish Institution

I.I The Beginning

In 1999 the Swedish government decided to establish a National Resource Centre for Mathematics Education at Göteborg University (UGOT) and reserved some funding for that purpose. The centre would coordinate, support, develop and implement the contributions which promote Swedish mathematics education from pre-school to university college.

The centre also utilizes the experiences and the knowledge base evolving within the framework of the Nämnaren project which started as a journal for mathematics education in 1974. After years of planning, the first issue of a second journal, Nordic Journal for Research in Mathematics Education, NOMAD, was launched in the fall of 1993.

Thus, the centre was developed based on a long tradition of in-service training of mathematics teachers in Sweden.

I.II The Embeddedness

NCM is the Swedish National Resource Centre for Mathematics. Its main task is to support the development of Swedish mathematics education. It is one of a number of centres for different school subjects established by the government over the last 15 years. NCM does not come under the auspices of any state authority, but is an independent body at Göteborg University.

University of Göteborg is a large higher education institution in Sweden. One of many profile areas is knowledge formation and learning, where teacher education plays an important part. The university offers the broadest range of teacher education in Sweden in terms of available programmes and subjects.

I.III The Constitutive Partners, the Personal and Budget

UGOT hosts the Swedish National Centre for Mathematics Education. The centre is commissioned and financed by the Swedish government with the mission to coordinate, support, develop, carry out and follow up initiatives promoting Swedish mathematics education in pre-school, school and adult education. NCM is also specifically expected to stimulate and disseminate research in mathematics education in Sweden.

It is self-evident, that NCM cooperates with further partners in the fields of mathematics, mathematics education and educational research as well as the ministry of education.

The most important cooperation and collaboration is with the Swedish Agency of Education (the governmental authority responsible for school
NCM also collaborates with other PD-Centres, including the Norwegian Centre for Mathematics Education. Not to forget with several universities in Sweden, to some extent through their specific centres for in-service training of teachers.

NCM employs six academics as facilitator and one as researcher, three non-academics as well as another employee (75% of full employed). The research is done individual and play a minor role for the NCM.

<table>
<thead>
<tr>
<th>What is the money spend for?</th>
<th>Rough percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staff</td>
<td>60%</td>
</tr>
<tr>
<td>Materials (development)</td>
<td>13%</td>
</tr>
<tr>
<td>Other</td>
<td>27%</td>
</tr>
</tbody>
</table>

Half of the funding comes from the third party funding. The other half comes from the educational ministries as well as centre's intake (publishing, ...).

Thus, the centre has a budget of more than 1 million euros per year.

II Philosophy, Mission and Networking

II.I Target Group of NCM

Nursery school and in-service teacher with a University degree use local and regional conferences as a PD. Those conferences are mostly one day, working in professional learning communities and regular courses. NCM reaches by year about 500 nursery schools and 1000 in-service teachers. However, through the website and materials developed at the centre, they reach a much larger group.

Pre-service training of teachers is not a goal for NCM. The materials are however widely used in pre-service training of teachers and they facilitate a yearly conference for pre-service teacher educators in mathematics. 2017 approximately 60 educators participated in the conference.

Also school-leaders (which need a university-degree and school-leader program) are not a primary target group for the centre. In some development projects school-leaders are included. During the large scale national PD-project for mathematics education 2012-2016, NCM was responsible for a program for school-leaders. Over the whole period they reached almost 3000 school-leaders.

Varying, in-service training is done by universities, but also by a variety of private initiatives. Thus, this group isn't a goal for NCM.

II.II Philosophy and Mission

The mission of the centre is to coordinate, support, develop, carry out and follow up initiatives promoting Swedish mathematics education in pre-school, school and adult education. Specifically, NCM is commissioned to stimulate and disseminate research in mathematics education in Sweden.

Specific Aspects

III Characteristics of NCM Activities

III.I Main Ideas

The NCM is working on all sorts of ideas related to teaching and learning mathematics in school, and it is difficult to pinpoint the most important ones. However, trying to list the activities of NCM results in three main strands:

Teaching Number and Problem Solving:

They have over the years had a fairly strong focus on the teaching of number from pre-school all through compulsory school. This is based on the fundamental role of understanding number in order to learn mathematics. Problem solving is another important theme (of course). One example of the efforts in this area is the work with Cangarou sans Frontiers/Kangaroos without
borders, which is an international competition distributing challenging problems to all students. The project has a number of different 'classes' for students of different ages. Approximately 150000 students participate in Sweden each year.

Courses, conferences and other PD activities:

Another important idea is to give teachers concrete suggestions for activities in the classroom, which are based on fundamental goals and principles for mathematics teaching and learning. This idea influences strongly the efforts to produce materials that are published in their books and journals, and the rich material published on the website of NCM. This idea also influences their planning of courses, conferences and other direct PD activities. NCM finds it important that teachers try out activities and that they gain experience using different approaches in the classroom. This is an important key to effective professional development. One particular area which the centre has been promoting is the use of hands-on materials in the teaching and learning of mathematics.

Research in Teacher Education and Professionalization:

A third important idea that highly influences the priorities of the centre is the spreading of relevant research in mathematics education, transformed into a useful form for teachers. But also (and equally important) spreading of best-practice and praxis-related knowledge developed by teachers. Many of NCM-publications are characterized by a mixture of voices, both researchers and practitioners, presenting important and interesting lessons learned about teaching mathematics which are relevant to teachers.

The PD-offers are 100% focused on the pedagogical content knowledge (PCK).

III.II NCM Activities

The typical activities of the Swedish National Centre for Mathematics Education fall into the follow areas:

- Half-day course for teachers about hands-on activities in mathematics: Groups of teachers come to the mathematics workshop and are given an introduction to ideas behind using manipulatives and are offered the opportunity to test some activities.
- Municipalities arranging a series of half-day or whole day meetings for their teachers, asking NCM to contribute in planning and executing.
- Conferences (mostly half day) for teachers explaining, exemplifying and encouraging the use of materials produced by NCM.

IV Quality Assurance

Among those working at NCM, there are people with experience from the national school curriculum, syllabus and test development work, national and international assessment and conference activities, national and local research and competence development projects. Also people with knowledge of Information Communication Technology (ICT) and distance learning, teacher training and supplementary education, text book production for both teachers and students, work in pre-school, pre-school classes, all levels of the nine-year compulsory school, upper secondary school and as remedial teachers. In addition, there are researchers in mathematics and mathematics education.

They are responsible for and participate in various activities and projects such as

- Publication of the magazines Nämnaren and NOMAD
- Publication literature for teacher training
- Participation and organization of seminars, courses and conferences
• Operation and development of several websites.

All activities are monitored for quality with a systematic evaluation by means of transparent criteria.

**V Best-Practice Examples**

Three examples of best-practice that the NCM-Centre has been working with:

**Important aspects of learning numbers:**
They have produced a book together with the Australian researcher Alistair McIntosh which describes important aspects of learning about number in grades 1-10, including diagnostic tests for each year. They also give short courses in how to use the book and how to lead others in using the book. The book is frequently used in many schools in Sweden and has been a huge success.

**Teaching material for pre-school class:**
NCM has also developed a teaching material for pre-school class, i.e. school for six-year old children in Sweden which is a bridge between pre-school and school. For this they have material met with many teachers to introduce the ideas in the material and also leading a network of teachers who use the material and who lead colleagues in using the material.

The pre-school project they are working with was thoroughly investigated in the developmental phase and they are currently working on a book describing the project more deeply. This book will only be published in Swedish. There is however one publication in English about this project (http://ncm.egu.se/media/smdf/Published/No10_Madif9/159168-Sterner_Helenius.pdf).

**The boost for mathematics:**
The centre has been deeply involved in the large-scale national professional development project for all teachers of mathematics ('The boost for mathematics'), which reached a majority of Swedish mathematics teachers in 2012-2016. The project continues and new modules are developed and publish on a web-portal run by the Swedish National Agency of Education.

The 'Boost for mathematics' project has been extensively evaluated and there seem to be a lot of positive effects so far. The long-term effects remain to be investigated. The publications are in Swedish, and there is very little published in other languages. One of the Swedish publications (https://www.skolverket.se/publikationer?id=3706) is an evaluation made by researchers in mathematics education at Ume University.

A more local study of the effects of the project (and another local project) on student learning was recently published:


Currently NCM is developing modules for Coding and mathematics and Special education and mathematics.

**VI Interdependence of Research**

Research has had an important role in the centre as individual projects and as a foundation for activities and projects at the centre, but not so much as a commitment for the centre as a whole. Reviews of research have of course played a significant role, but not so much empirical research first hand. However, recently the centre has been engaged in developmental projects with a clear research agenda.

**VII Conclusions and Recommendations**

**VII.I Major Challenges**

There are different ways of looking at challenges. One type of challenge concerns factors that limit our possibilities to make a difference for the
teaching and learning of mathematics. One such factor concerns the often short-term character of projects. NCM wish to engage in more long-term, sustainable efforts of professional development. Another factor is the financial situation, which makes it difficult to initiate and run the kind of projects that could make a difference.

Another type of challenges concern the areas where professional development is most needed and perhaps most hard to achieve. NCM is currently involved in planning for a project that will address two of these challenges: developing the confidence and knowledge in mathematics for teachers in primary school (which is a pre-requisite for doing a lot of the teaching that we know can make a difference) and developing structures where teachers efforts of developing mathematics education is supported by school-leaders and policy makers in a sustainable way.

**VII.II Diversity of PD Centres in Sweden**

In Sweden are further STEM Centres next to NCM. But not with the specific focus for mathematics education. To name but a few: (We refer to the presentation of the Centres within on their website.)

*The National Resource Centre for Chemistry Teachers (KRC)*


In June 1994 Kemilärarnas Resurscentrum, KRC got an assignment from the Swedish government to start a Centre supporting activities of chemistry teachers in Swedish compulsory and upper-secondary schools. The general aim of the Centre is to promote and stimulate interesting and up-to-date teaching of chemistry in Swedish schools. The Centre is supported by Stockholm University.

*Centre for School Technology Education (CETIS)*

[https://liu.se/cetis/english/index_eng.shtml](https://liu.se/cetis/english/index_eng.shtml)

The Swedish National Centre for School Technology Education, CETIS, at Linköping University started in 1993. In 1996, the government made CETIS a national centre. The main aim of the Centre is, in collaboration with teachers, teacher-trainers, and representatives for industry etc., to develop technology education in schools.


The National Resource Centre for Physics Education located at Lund university is aimed at being a resource for teachers from preschool to upper secondary school (high school). The aim is to inspire and stimulate the development of physics education and to give teachers the opportunity to further studies of physics.

*National Centre for Science and Technology’s Didactic (NATDID)*

[https://liu.se/forskning/natdid](https://liu.se/forskning/natdid)

One of the new Centres is the national Centre for science and technology didactic. The aim of this is that teachers should be able to translate subject didactic research into practice and thereby let the school rest on a scientific basis. NATDID was established after a government decision in February 2014 and is located at Linköping University.

As can be seen, the founding is usually associated with the decision of the Swedish government. But it suggets itself that there is a need for networking and exchange.

**VII.III Publications**

Some highlighted publications are


- *Förstå och använda tal* [Understand and use numbers]. A guide through teaching about number throughout compulsory
school, including diagnostic tests intended for formative use in each school year.

- *Blå strävor* [Blue aspirations]. A collection of activities specifically designed for use in mathematics education for students with learning disabilities.

Here you can find publications by NCM members [http://ncm.gu.se/publikationer](http://ncm.gu.se/publikationer)
This case study has been written in collaboration with Oliver Wagener and Ian Galloway.

I Philosophy

Frank Demanna and Bert Waits started T3, Teachers Teaching with Technology, in 1986. The T3 philosophy is exemplified by a quote from Bert Waits in 2000,

- Some Knowledge and Skills become more important because technology requires it.
- Some Knowledge and Skills become less important because technology replaces it.
- Some Knowledge and Skills become possible because technology allows it.

II Traditions of STEM PD centres

T3 has arisen from a grass roots drive to find better ways to teach mathematics. Its vision statement being:

Technology has changed the mathematics and science classroom, and its impact will continue to grow. Technology provides the opportunity for all students to be active learners as they are afforded the chance to explore and investigate what they have learned in the classroom. When used effectively by a well-trained teacher, technology supports the learning of mathematics and science students, enhancing rather than degrading their skills. Technology provides value as an efficient means of analysing data and instantly seeing the results. It provides opportunities for further exploration.

These activities allow insight and understanding which is not available without the use of technology.

T3 refers to this bridge to learning and understanding as The Power of Visualisation. This has evolved to encompass science as well as mathematics. T3 today regularly brings mathematics and science teachers to discuss content and pedagogy. T3 Europe is part of this tradition.

III A survey of STEM PD centres

T3 Europe is composed of 12 countries each with its own website and all linked to the umbrella site of T3 Europe. Funding for all the activities is derived from Texas Instruments (TI) who as owns the T3 logo.

The result is a symbiotic relationship between T3 and TI in which TI consults T3 to better understand how to reach policy makers and T3 consults TI during product development. The common language when meeting as T3 Europe is English. Each country is self-regulated and devises its own programme of activity. Every two years T3 Europe organises a conference by invitation, Sharing Inspiration, held in a European capital city.

IV Foci and activities of STEM PD centres: consultancy, PD provision, curriculum and content development.

Sharing Inspiration is about

- providing quality professional development that enables the mathematics and science educator to
be successful in the classroom through the appropriate use of technology;
• developing state-of-the-art classroom pedagogy or didactics and sharing it with our peers both nationally, within our $T^3$ country organization and internationally as $T^3$ Europe
• sharing expertise in training, educational curricula and exam development;
• sharing this expertise with Ministries of Education, curriculum development and exam bodies, public and private pre- and in-service professional development organisations, pedagogical research institutions, textbook publishers and other content providers

we seek
• to identify common elements across European STEM curricula and teaching methodologies.
• to promote inquiry-based learning through the use of real-world applications and data collection devices for students aged 10-19.
• to encourage a balanced approach combining the use of graphing and other technologies along with mental skills and paper and pencil skills to support STEM curricula.
• to influence the content of STEM curricula and students' skills through demonstrating the power of technology to accelerate student cognition.

Each national $T^3$ organisation supports these aims but will use its own networks and methods of working to achieve them.

Specific Aspects

V Political dependency

$T^3$ Europe is politically independent but seeks the ability to cooperate with political administrations. By its very nature the use of technology within the classroom and the examination system is often rejected, not only by politicians but by society at large. By sharing expertise with Ministries of Education, curriculum development and exam bodies, public and private pre- and in-service professional development organisations, pedagogical research institutions, textbook publishers and other content providers, $T^3$ Europe is working towards a more equitable landscape.

VI Interdependence of initial Teacher Education and STEM centre PD activity

Activity is frequently integrated into ITE programmes, and in some institutions this is systematic. In general there is no interdependence and any activity only serves to make trainee teachers aware that such technology exists and has the potential to be useful in the classroom.

VII Quality assurance

$T^3$ Europe has no formal process of assuring quality. This does not mean that it is ignored, quite the contrary, the organisation is always examining its own protocols and content with a view to improving.

All website content for example is peer-reviewed, PD providers themselves have undergone extensive peer observation and this information is fed back to organisers and website managers.

$T^3$ trainers do use evaluation sheets and the whole network of $T^3$ members is looking at impact back in the classroom on an ongoing basis. This never stops and is formally recorded through the use of focus groups conducted by Texas Instruments developers at international conferences. In this way the hardware, firmware and software is continually updated through teacher feedback ensuring that it is of the highest possible quality and efficacy for teaching and learning.

VIII Interdependence of research and practice

There is cooperation within $T^3$ between researchers and practitioners who are both using the technology to improve learning. Researchers and practitioners meet with each other at conferences, particularly Sharing Inspiration, and exchange views and ideas.
As well as funding T³ activities, Texas Instruments also funds research and some university teaching. The interdependence is then a triangular one!

IX Conclusions and recommendations

IX.I The role of learned societies

Many T³ Instructors belong to learned societies, and this helps to connect the pedagogical use of technology to committees and working parties within these groups who may be working on educational projects.

IX.II Networking; informal education

Networking is a principle aim of the T3 organisation. Sharing Inspiration is the highlight of the T3 Europe calendar and brings together teachers from many countries including the USA and Australia. Considerable effort is made to include educational administrators and researchers to ensure that networking is vertical as well as horizontal.

IX.III Diversity of PD centres: culture, international relations

Composed of 12 different countries T³ Europe is already very diverse in terms of culture and language.

Networking is supporting other countries wishing to become a partner of T³ Europe. Members themselves are engaged with many different examination systems, Germany alone has 16 different federal states. Not only are our exam systems different but curricula vary widely. The one feature we have in common is how best to use technology for the learning of students. In identifying common elements across European STEM curricula and teaching methodologies we are helping to improve international relations.
The cluster LEHRERiNNENBILDUNG WEST (LB-West) was launched by the cooperation agreement „Sekundarstufe (Allgemeinbildung)“ between five institutions in 2016. In 2014 already, the subjects „Mathematik & Geometrie“, „Physik“ and „Biologie“ were accredited with the RECC-label (regional educational competence centre). In 2015, „Geographie & Wirtschaftskunde“ and „Deutsch & Mehrsprachigkeit“ were also accredited with the same label [3].

I.II LB-West embedded into the Heterogeneous Educational System of Austria

In 2012, after the approval of a new law [2] concerning the teacher's education system, four cluster across Austria were installed in order to design the new teacher education programme. As a consequence of the new law, the pedagogical colleges and the universities have to collaborate and are responsible for the whole teacher education. The collaboration may also offer a stronger involvement of the universities regarding the PD courses, especially in the STEM subjects. In Western Austria this clusters has been renamed to LB-West.

I.III The Constitutive Partners, the „Personnel“ . . . and the Budget

The LB-West comprises two universities (University of Innsbruck and University Mozarteum) and three pedagogical colleges (PH Tirol, PH Vorarlberg and KPH Edith Stein). Two regional competence centres (RECC Biologie, RECC Mathematik & Geometrie) – collaborations within the LB-West – are partner of the STEM PD Net-Project. The universities are mostly autonomous and related to the Federal Ministry of Science, Research and Economy; the pedagogical colleges are under the supervision of the Federal Ministry of Education. The LB-West is run by the heads of the participating institutions and has not an own budget.

II Philosophy, Mission and Networking

II.I Traditions of PD centres in Austria

In Austria, the so called pedagogical institutes (Pädagogische Institute) were responsible for teachers' PD courses till the foundation of the pedagogical colleges (Pädagogischen Hochschulen) in 2007. In 2004/5, the Federal Ministry of Education set up six Austrian Educational Competence Centres (AECC) to support the teacher education (pre-service and in-service). Five centres for the subjects biology, chemistry, physics, german, mathematics, and the institute of instructional and school development.
II.II Philosophy and Mission

The main aim of LB-West is to implement the „PädagogInnenbildung Neu“ [1] in Western Austria, but it offers also the chance to reshape the PD courses especially in the STEM subjects under the RECC labels.

II.III Networking as a Crucial Issue of a PD Centre

Since the LB-West comprises several institutions and collaborates intensively with the school authorities in Tirol, Vorarlberg and Südtirol, networking is a core mission of the LB-West.

III Activities

The main focus at the moment is to implement (we are starting the third year) the new teacher education programme. Especially in science education and mathematics education new courses were designed.

IV Specific Aspects

IV.I Political dependency

The origin of LB-West was in 2013 when a new law was released in order to reform the teacher education in Austria [2] Part of the new law was that pedagogical colleges and universities plan and implement the new teacher education in a close cooperation. From a political point of view, the pedagogical colleagues are depended of the Federal Ministry of Education meanwhile the universities are in the competence of the Federal Ministry of Science, Research and Economy, but act autonomously. Before the new law in 2013, only the pedagogical colleges were allowed to offer PD courses, although many researchers from the university gave the courses. With the new law, this restriction was softened and therefore it is reasonable that at least the subjects under the RECC-label will plan and offer PD courses together.

IV.II Interdependence of initial Teacher Education and STEM PD activities

The new structure of the teacher education in Western Austria allows a close connection between the initial teacher education and future PD courses in the LB-West. In the new teacher education programme all secondary teachers (upper and lower, academic and vocational) graduate from the same study. Before the new teacher education programme, the pedagogical colleges only educated the teachers for the lower secondary (part of it), but offered PD courses for all teachers. In the pedagogical colleges, we have now the chance to employ the same teacher educators for the initial teacher education and the PD courses, especially in the subjects under the RECC label.

IV.III Quality assurance

Quality assurance with respect to PD courses is still an open topic within the LB-West. In 2015/16, the RECC Mathematik & Geometrie under the lead of the pedagogical college Tyrol tested a new PD format, with face-to-face meetings and an implementation phase between those meetings. A modest monitoring showed that the acceptance by the teachers was quite low. Therefore, new PD course structures are recently discussed. An alternative approach may arise from the initial teacher education itself. The curricula of the new teacher education foresees a closer collaboration with in-service teachers and emphasises the exchange between researchers and practitioners in specially designed courses. We hope to extend such collaborations also for the PD courses in a few years.

At the moment, no certificate is needed for a successful graduation of a PD courses, only the attendance counts.
IV.IV Interdependence of research and practice

Subject-specific education in Western Austria got only recently – within the context of the new law concerning the teacher education – an institutional framework. At the University of Innsbruck a new institute – at the new faculty School of Education – was founded and at the pedagogical college Tirol the „Fachdidaktikzentrum“ was initiated. In biology, research on conceptual change with focus on learning outside the classroom is implemented directly in PD courses already for several years. In mathematics, subject-specific education is at the very beginning, but gathered some experiences in the field of inquiry-based learning within the EU-project mascil and conducts actual a survey on the natural number bias. For the next year, we plan PD courses together with practitioners with a focus on topics from pedagogical content knowledge.

V Conclusions and recommendations

V.I The role of learned societies

Due to the early stage of the LB-West, the relations to learned societies in Austria are in still in an initial phase.

V.II Networking; informal education

Due to the early stage of the LB-West, there not yet links to informal activities of the communities of teachers.

V.III Diversity of PD centres: culture, international relations

Due to the early stage of the LB-West, international collaborations in the field of PD are not yet established. The RECC Biologie and RECC Mathematik & Geometrie are partner in the STEM PD Net project.

V.IV Visions

LB-West is going to be responsible for the teacher education in Western Austria.

V.V Publications

The LB-Wes WEST exists since 2016, publication within the cluster are in preparation but not yet published [1].


Figure 2: Map of the political dependencies of LB-West [https://www.upc.smm.lt/projektai/stempdnet/naujienos/diskusija/3-LEHRERINNENBILDUNG-WEST-LB-West-klasterio-kurimas.pdf; p. 7]
We refer to the presentation of UPC on its website. Parts of the following text are cited from an English version of its homepage and modified according to our categories, the rest is collected internally. This case study has been written by Ruta Mazgelytė & Vytautas Andrėkus.

I EDC as a Lithuanian Institution

I.1 The Founding

The Education Development Centre (EDC) was established on the 1st September, 2009 after the reorganization of Teacher Professional Development Centre (TPDC), Education Development Centre (EDC), Teacher Competence Centre (TCC), Lithuanian Adult Education and Information Centre (LAEIC) and it is the largest institution under the direct authority of the Ministry of Education and Science.

In 1945 the Republican Pedagogical Cabinet at the Ministry of Education was founded. In 1950 the cabinet was transformed into Republican Teacher Qualification Improvement Institute which had the main function of teacher qualification improvement and teacher training. In 1990, after the independence of our country had been restored, the institute was rearranged into the Lithuanian In-Service Teacher Training Institute. In 1999, the institute was reorganized into Teacher Professional Development Centre (TPDC). The main goals of this institute were: dissemination of education reform ideas and innovations, implementation of strategic in-service training projects and programmes, preparation of consultants for regions, organization and coordination of methodological activity, preparation of methodological tools for teachers.

In 1958 the Scientific School Research Institute was established; it was reorganized into the Pedagogical Scientific Research Institute and later into Institute of Pedagogy. In 1991, the Education Development Centre was established after the restructuring of the Institute of Pedagogy. The main EDC tasks were: the preparation and introduction of the documents which determine the curriculum and methodological material for teachers, organization and implementation of education system monitoring, preparation of education development models.

In 2003, the Teacher Competence Centre (TCC) was established. This institution organized the supervision of in-service teacher training quality, accreditation of in-service teacher training institutions and their programmes, and provision of methodological support. TCC has been coordinating the attestation of pedagogues and school administrators, implementing expert in-service teacher training evaluation and participating in expertise of teacher training programmes.

In 2005 after the reorganization of Distance (Extramural) Education Centre, Lithuanian Adult Education and Information Centre (LAEIC) started its activity. The Centre had been providing support for continuing adult education, gathering and
storing data on adult education possibilities, on employs 65 persons with pedagogical degrees and institutions which provide adult education and their programmes, disseminating information, testing adult education status and needs, implementing different projects on adult education development.

I.II The Embeddedness and Institutional Dependencies

The Education Development Centre (EDC) is a national level institution affiliate to the Ministry of Education and Science of the Republic of Lithuania. It provides educational support in the field of pre-school, primary and general education. Due to centre establishment peculiarities, the centre carries various tasks, which require close cooperation and collaboration with other institutions – and particularly in the field of in-service teacher training.

In the field of in-service teacher training EDC cooperates with 5 institutions affiliate to the Ministry of Education and Science of the Republic of Lithuania (Lithuanian Centre of Non-formal Youth Education, National Agency for School Evaluation, The Lithuanian Children and Youth Centre, Special Pedagogy and Psychology Centre, Centre for the Development of Qualifications and Vocational Training), professional development centres in 8 institutions of continuing education at universities and 62 regional teacher training centres, 63 subject associations. The institutional dependencies by financial and accreditation aspects are shown in the graph ‘Lithuanian teacher professional development system and institutional dependencies’.

EDC has 5 divisions: Education Content Division, In-Service Training Division, School Performance Development Division, Education Content Quality Assurance Division, Information and Communication Division and 3 supporting departments: Law, Human Resources and Public procurement department, Accounting department, Administration and Maintenance department. EDC

In addition to allocated budget, EDC has got additional funding from international projects 0.3 mln. Euro, EU structural funds project 1.4 mln. Euro.

II Philosophy, Mission and Networking

II.I Traditions of PD Centres in Lithuania

PD centres in Lithuania can be classified into two categories according to their scope:

- national level and
- regional level PD centres.

National level centres focus on CPD, which corresponds to national in-service teacher training needs and key-education policy trends.

These institutions are the Education Development Centre, institutions of continuing education at universities, the Lithuanian Centre of Non-formal Youth Education and the Lithuanian Children and Youth Centre. Their operational activities are funded by Ministry of Education and Science and Teacher PD voucher. The slight exceptions are institutions of continuing education at universities – they are funded by universities (but again: universities get funding from the Ministry of Education and Science).

<table>
<thead>
<tr>
<th>What is the money spend for?</th>
<th>Rough percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staff</td>
<td>50 %</td>
</tr>
<tr>
<td>PD Initiatives</td>
<td>24 %</td>
</tr>
<tr>
<td>Materials development</td>
<td>1,06 %</td>
</tr>
<tr>
<td>Other:</td>
<td>25,94 %</td>
</tr>
</tbody>
</table>

Rough percentage

<table>
<thead>
<tr>
<th>Staff</th>
<th>50 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD Initiatives</td>
<td>24 %</td>
</tr>
<tr>
<td>Materials development</td>
<td>1,06 %</td>
</tr>
<tr>
<td>Other:</td>
<td>25,94 %</td>
</tr>
</tbody>
</table>

22
Regional level PD providers – regional teacher training centres and private PD providers usually focus their CPD on the needs of the teachers in the region they operate in. Their operational activities are funded by the Municipality and Teacher PD voucher. Being a nationwide public institution, EDC cooperates with regional PD centres by sharing practices, taking part in discussion or working groups.

Consequently, EDC operates in a very classical CPD institutions’ environment.

II.II Philosophy and Mission

Due to teacher CPD institutional transformations and EDC emergence as an institution of structural reforms, the centre has a wide mission. The purpose of EDC is to implement national professional development and general education programmes and policies; to provide methodological materials for schools and pre-school, primary and general education teachers; to accredit professional development programmes and monitor their implementation and teachers’ professional growth; to coordinate activities of education advisors (consultants) in the field of ICT, programme evaluation; to provide professional development and other support for specialists, who work with special needs students.

II.III Networking as a Crucial Issue of a PD Centre

As a national level PD provider, which is closely linked to education policy implementation, EDC joins and participates in various international
cooperation initiatives coordinated by European SchoolNet, STEM PD Network and others. These initiatives EDC is involved in are take a shape of international project activities. For example in 2016 EDC was partner or coordinator of 8 international projects:

- 'STEM capacity building',
- 'European Network of STEM Professional Development Centres',
- 'Scientix 3',
- 'Media and information literacy education',
- 'MENTEP - MENtoring Technology Enhanced Pedagogy',
- 'Innovative Teacher - Motivated Student: Collaborative Problem Solving',
- 'Teachers Professional Competences Common framework' and
- 'M.A.R.C.H. – 'Make Science Real in Schools'.

Joining international colleagues is an important source of new ideas and a channel to transmit experience and insights to partners abroad.

III Activities

The activities of the Education Development Centre fall into five areas:

- Development and implementation of pre-school, primary, general education content;
- Methodological support for teachers, professional development and coordination of education advisors' (consultants) activities;
- In-service teacher training and quality assurance (evaluation and accreditation of teacher professional development programmes);
- Organization and coordination of expert evaluation of textbooks and other teaching/learning tools;
- Initiation and implementation of education innovations during national and international projects.

IV The Foundation of EDC Activities

The foundation of CPD activities provided by EDC consists of three ideas: development and implementation of curriculum innovation, according to the learning needs of society; development of effective and teacher-oriented PD; development of strategic partnerships and sustainable collaboration networks for innovative, up-to-date CPD. As a result, the most typical CPD offers focus on pedagogical content knowledge transmission for in-service teachers.

Specific Aspects

V Political Dependency

The political dependency of EDC stems directly from the fact that it is affiliate to the Ministry of Education and Science of the Republic of Lithuania. However, it does not necessarily mean that CPD provision solely takes into consideration national education policy guidelines. EDC is independent to design CPD according to teacher community needs, too.

VI Interdependence of Initial Teacher Education and Activities

The main target group of CPD provided by EDC are in-service teachers. Not being a university EDC does not provide courses specifically designed for the future teachers (i.e. students at universities). However, for the last three years EDC has been cooperating with the Ministry of Education and Science in order to provide professional development opportunities and support for young teachers' recent graduates, who started working in schools and who have been working there up to five years.
VII Quality Assurance

All CPD programmes run by EDC are accredited according to professional development programmes’ procedure description approved by the Minister of Education and Science. The description defines quality criteria for professional development programmes. Among these are: PD priorities set by the Ministry and developed or acquired competences defined in teacher competence descriptions.

VIII Interdependence of Research and Practice

EDC has formalized cooperation with few universities by signing long-term cooperation agreements; however, in most cases it is a common interest in specific or actual themes and problems that determines the need for short-term cooperation.

Miscellaneous

IX Conclusions and Recommendations

EDC is settled in the PD-providers system as a unique institution, which has undergone a wide organizational consolidation. Being interdependent with the Ministry of Education and Science it is exposed to education policy changes, new initiatives or changing priorities. Main challenges for EDC in the field of professional development are:

- Renewal of a general education curriculum, dissemination and activities related to teacher competence development;
- Implementation of IT in primary education;
- STEM implementation and national STEM network coordination;
- Media and information literacy improvement in schools;
- Integration of financial literacy in schools;
- Professional development related to health, sexuality and preparation to family life education;
- Competences’ development for inclusive education;
- Implementation of training courses devoted to updated pre-school curriculum.
1.3 MISSION & CHALLENGES

Change processes
We have to accept that traditions (of these centres in European countries) are very persistent. Of course, the members of the project team have some dreams and recommendations (on the basis of their experiences and scientific insights), but we should be realistic and first of all, thankful, for what is in existence and working. We know that is not possible to find resources in order to establish a new institution as we would like to dream of.

Especially, PD centres of Type 1 are very persistent since – last not least – the government has the authority and right to regulate all the processes. It is much easier to convince colleagues in university centres (Type 2) to adopt one’s ideas, to run some experiments. Also, centres of Type 3 and 4 appear more flexible.

Next we have to state that what should be understood by a PD centre is anchored as beliefs in the mind of many stakeholders. To describe it with other words: It is not easy to change the relevant issues within the centres in our network. We have to tolerate a slow process of adoption.

The dilemma of STEM
A further problem which we had to agree on, is the fact that the landscape with respect to our subject – STEM – is very heterogeneous. There does not exist a single and unique school subject which is called STEM. STEM teaching at schools is often realized by presenting a bundle of different aspects from four independent subjects. We don’t know anything about a stringent STEM education at university.

Nevertheless, all the project partners are very open to STEM. Choosing any subset of the letters S,T,E and M, you will find a centre which is working in the area of the school subjects represented by these letters.

Success Factors
PD centre quality criteria refer to the levels of philosophy, learning organization, resources, networking, and evaluation. These quality criteria are important success factors of these different PD centres and are also found in the Ready-to-use-Guide of O1. These are summarized below.

Philosophy
High quality PD centres are able to influence the professionalization and practice of STEM teaching. Thus, high quality PD centres explicitly provide their philosophy.

A clear and transparent philosophy statement takes core issues into account, for example:

- What is the PD centres’ STEM identity? For example: interdisciplinarity, scientific inquiry and connection with real life.
- What does the PD centre want to achieve in teacher PD? For example: teachers becoming experts in their everyday teaching.
- What educational standards and requirements does the PD centre follow? For example, going in line with national teacher training standards.
- What kind of teachers’ professionalization is aimed at? For example: teachers need to improve their competencies in STEM education, by changing their attitudes, improving their skills and broaden their knowledge.
High quality PD centres’ philosophy is reflected by their respective STEM PD curriculum. By developing each curriculum, PD centres highlight and prioritize their respective philosophy.

This includes for example:

- Balancing theory and practice to support teachers’ learning.
- Addressing many and diverse aspects of teachers’ competencies and experiences.
- Being contextual and flexible (e.g., addressing the needs of teachers, students, industry and business).
- Providing structured and progressive content.
- Meeting different expectations of stakeholder (e.g. students, teachers, PD providers).
- Having a research-based background.
- Using different learning strategies (e.g., learning from experience, learning from experts).

**Learning Organization**

High quality PD centres constantly reflect and enhance the way they work; they act as learning organizations, which are open to innovations, continuous learning and improvement. PD centres aim at good balance between being providers of relevant knowledge and being open and flexible learners themselves. In this way, PD centres ensure two-way communication: developing knowledge as well as integrating experiences and ideas from outside. As learning organisations, PD centres analyse and react on STEM teachers’ and schools’ needs and challenges. They adapt themselves according to constantly changing contexts.

Developments of high quality PD centres are evidence-based and informed by national and international developments and practices. Communication and cooperation with relevant environments are crucial to ensure high quality STEM PD.

As a learning organization, PD centres in particular provide the following features:

- providing resources for critically reflect on PD centres’ development
- solving problems (e.g., regarding content or organisational issues) systematically;
- experimenting with new approaches;
- learning from experience;
- learning from others (partners and target groups);
- transferring and communicating knowledge.

**Resources**

For high quality PD centres, it is crucial to have relevant resources. In particular, professional teacher educators demonstrate positive attitudes towards their work, have social-emotional skills and high standards of professional ethics. Expertise in STEM field and didactics, as well as adult education is of great importance. Teacher educators have a clear vision of their work, and use it as a benchmark to reflect on the outcomes of their work and identify the needs for further professional development. PD centres support such culture of reflective learning.

High quality PD centres are able to provide STEM specific materials like

- guidelines (e.g., general information about the structure, content and aims of PD offers; or specific information about the structure, content and aims of certain materials)
• learning environments (e.g., for teachers, including information concerning added value, target group, didactical comments, aso; or for PD providers, including information concerning theoretical models, empirical background, aso.)
• tools and equipment (e.g. technical equipment, rooms, software, aso.)

Cooperation
High quality PD centres ensure cooperation and learning possibilities both within and beyond the centre. They cooperate with partners (university, industry, business, NGO, etc.) to raise awareness regarding STEM issues and knowledge, in particular in connection with real life situations and applications. Networking with other STEM PD centres (internationally or nationally) testifies the centres’ openness to different perspectives and innovations; in particular, the exchange of knowledge and experiences between PD centres creates learning opportunities for each PD centre and fosters further development.

High quality PD centres stimulate and foster cooperation between participants (e.g., teachers, principals, aso.). Moreover, they support and encourage participants’ professional networking with relevant environments. By providing rich opportunities for collaborative reflection and discussion (e.g., of teachers’ practice, students’ work, or other artefacts), high quality STEM PD empowers and encourages participants to collaborate in learning, which represents a core feature of effective learning and development processes.

High quality PD centres create opportunities where relevant stakeholders (e.g. schools, policy, teachers, academia, aso.) can meet and exchange knowledge and expertise.

Evaluation
Evaluation is connected to processes of improvement. High quality PD centres systematically assess their outcomes and impact, using by evaluation tools and differentiating various levels

• Specific feedback: PD centres get detailed feedback regarding specific PD offers by using practical instruments and methods (e.g. surveys or interviews). Evaluation’s findings and insights inform further development and improvement of specific PD offers.
• General feedback: PD centre get sophisticated feedback regarding their general offers. Typically, these evaluations include both qualitative and quantitative methods as well as triangulation (e.g. during conferences or fairs) to get reliable and valid data.

To support evaluation processes, high quality PD centres develop and offer various ready-to-use instruments and methods that focus on different aspects. Since high quality PD centres are interested in further developing their practice, they come with an intrinsic motivation to evaluate their work.

Next to the quality criteria there are further aspects for a successful centre:
• Present on international conferences; lighthouse within the international scene
• Support by the education administration within a country
• Prominent research papers
• Attractive for teachers, teacher educators
• Guarantee quality criteria and constant review
• Innovation and applicability
Further missions & activities
Policy-making also play an enormous role for PD centres. On the basis of the questionnaires we could make out different directions, depending on the location and financier of these centres. Roughly we could divide three ranges, which are to be extended however still further.

1. Material strategy: press, newspaper, publishing companies
2. Personal strategy: cooperation with multiplier and qualifiers, professional learning communities (PLC), various societies of teachers
3. Systemic strategy: learned bodies (learned societies), labour unions, education administration

We have also been able to identify various goals of our policy-making, such as being continuously perceived not only by the educational administration in the country, but also for industry and business, having a representative within central boards or having competent EU perspectives.
2. Conclusions & Recommendations

NEW INSIGHTS ON THE PD CENTRES

Since the ERASMUS-Project STEM PD Net leads to a deeper continuous cooperation, we automatically received detailed insights about the various activities in all PD-centres. New variables which were previously not visible in our inspection are becoming gradually obvious.

Thus, we decided to add some more questions in an additional questionnaire and sent it to the interior circle of cooperating PD-centres. We add this questionnaire as an appendix of this document.

Since the answers are partly fragmentary, a numerical evaluation seems not to be illustrative. In addition, it is not productive to lay one’s cards on the table.

1. Cooperation with learned societies: As a researcher, we know that learned societies (Fachgesellschaften) are important stakeholders in our discourse. They are in direct contact with many researchers and educators. Learned societies represent important views on the virtual landscape of the researchers, of the development of the discipline, and on major new international developments.

For example, in the United States the American Mathematical Society (AMS) or the London Mathematical Society (LMS) in Great Britain are very influential and no debate could be finished without these learned societies’ extensive comments on the relevant issue. The assemblies of the learned societies are meeting annually and edit newsletter or informal journals.

To be honest, not all learned societies are in direct contact with the players in our scene. It should not be ignored that so far there doesn’t exist a learned society devoted to the subject ‘STEM’. Fortunately, in Germany we have an association of teachers – MNU – which is close to a learned society and reflects the needs of schools, teachers, students and classrooms. This body is cooperating with stakeholders of the research side.

RECOMMENDATION: One should start to resp. intensify the cooperation of the centres with these bodies; both sides will profit.

2. Professional management of a PD centre: Of course, many of the PD centres are gradually grown structures run by individuals from the STEM scene and have their personal characteristics. Nearly none of the engaged colleagues have been instructed how to run and organize the management of a centre professionally. We don’t know an example where experts counselled the administration of a centre.

We don’t disregard the engagement of many co-workers, but we have to emphasize, that there are large differences with respect to the effectivity of a centre. Of course, you need personal resources to continuously and successfully organize:

- press work for the public
- looking for further promoters and sponsors
- annual plans of events
- talks
- contacts on the international level
- …
RECOMMENDATION: We recommend starting a discussion with organizational consultants.

3. How to identify the actual need for PD-courses? Reflecting the processes on how the titles of PD-courses are established, we realize a large variety of different procedures. Sometimes courses are predetermined by the educational administration, some courses are proposed by influential educators, in few cases there might be an initiative by teachers asking for offering special courses.

We believe that the success of a PD-course is partly influenced by this procedure.

Again, the answers depend heavily on the type of the centre. centres, which are governmentally driven, are mostly acting top-down, whereas in the virtual centres the demand of the classrooms and schools, e.g. thinking bottom up, is the dominant feature.

RECOMMENDATION: We recommend reflecting in a centre that the list of titles is balanced and not primarily decided by a top-down procedure.
3. Appendices

3.1 Appendix 1: Questionnaire 1

STEM PD Net Questionnaire

General information
Information for data usage
Your information will be used for research purposes in the course of the project only. The data will be matched to the various centres and will not be passed on to third parties.

Structure of the questionnaire
Dear members of the network of PD-centres,
we developed this questionnaire to identify and show the differences and similarities of the centres in our network. Therefore, the questionnaire is structured in five parts:

1. Contact information: We need your contact information
2. Structure of the centre: We are interested in the structure of your centre (how did your organization evolve, how does your financial situation look like and which subjects do you focus on).
3. Situation in your country: We would like to connect this knowledge to the educational system of your country.
4. Mission of your centre and your activities: We want to hear more about your activities and missions.
5. Major challenges and best practice-examples: We want to learn from your major challenges and best-practice examples.

The questionnaire includes questions you answer by ticking the brackets or by adding a number. Additionally, you will find the opportunity for open answers in a chart or a cell. You can expand all cells and charts – there is no limit of characters.

Contact information
- Name of the centre:
- Address of the centre:
- Homepage (if existing, also English website):
- Contact person for queries:

Structure of the centre
S1: We would like to know which school subjects are addressed by your centre.
- Which school-subjects are addressed by your centre (please mark with a cross)?
  ( )Science ( )Technologies ( )Engineering ( )Mathematics ( )other:

S2: We would like to know more about the presence, history and future of your centre. Please tell us the date of the establishment of your centre and since when it exists in this form.
1. Since when does the centre exist?
2. Since about when does it exist in this form?

3. Please mark the expected duration of your centre with a cross:
   ( ) permanently ( ) temporarily, for a certain period of time ( ) unclear
   - If temporary: is an extension possible? ( ) yes ( ) no
   - If temporary: how long is the duration of the centre planned?

4. Is the centre still in a phase of development? ( ) yes ( ) no
5. In which context was the centre developed?

6. Is the centre part of a university? ( ) yes ( ) no
   - If no: please continue with S3
7. Is the centre fully integrated in the university? ( ) yes ( ) no

S3: We would like to know more about the cooperation / collaborations of your centre and how they look like.
1. Are there any additional cooperation / collaborations (actual stable/permanent) with other institutions (e.g. universities, companies, foundations, research institutions, PD-centres, educational authorities etc.)? ( ) yes ( ) no
   - If no: please continue with S4
2. Please mark with whom you cooperate / collaborate:
   ( ) National universities ( ) International universities ( ) Companies ( ) Foundations
   ( ) Research institutions ( ) PD-centre ( ) Educational authorities ( ) other:
3. Please describe briefly up to three cooperation / collaborations which you regard as most important:

S4: We would like to know more roughly about the budget of your centre.
1. Do you have your own budget? ( ) yes ( ) no
   - If no: please continue with S5
2. How much budget (in euro) do you roughly have per year?
   ( ) less than 100 000 ( ) up to 500 000 ( ) up to 1 000 000 ( ) more than 1 000 000
3. Please fill out the chart:

<table>
<thead>
<tr>
<th>Sources of the money</th>
<th>Rough percentage of the whole sum</th>
<th>What is the money spend on?</th>
<th>Rough percentage of the whole sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>University</td>
<td>%</td>
<td>Staff</td>
<td>%</td>
</tr>
<tr>
<td>Educational ministries</td>
<td>%</td>
<td>PD initiatives</td>
<td>%</td>
</tr>
<tr>
<td>Third party funds from the economy</td>
<td>%</td>
<td>Materials (development)</td>
<td>%</td>
</tr>
<tr>
<td>Centre’s intake (participant fees, publishing, …)</td>
<td>%</td>
<td>Other:</td>
<td>%</td>
</tr>
</tbody>
</table>
S5: We would like to know more about the number of your staff.
1. Who works for your centre? Please fill out the chart:

<table>
<thead>
<tr>
<th>Staff of your centre</th>
<th>Number of full time equivalent staff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academics as researcher</td>
<td></td>
</tr>
<tr>
<td>Academics as facilitator</td>
<td></td>
</tr>
<tr>
<td>Non academics</td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
</tr>
</tbody>
</table>

S6: We would like to know more about the role research plays in your centre.
1. Does your centre do research? ( )yes ( )no
   • If no: please continue with S7.
2. Does research play a minor role, an equal or a major role in your centre? ( )minor ( )equal ( )major
3. Is research done by individuals or by groups? ( )individuals ( )groups
4. Please describe how research influences the work of your centre:
5. Please list some references of typical publications of your centre (if they are neither English or German please add keyword about the content of the publications)

S7: We would like to know more about the role PhD-programs play for your centre.
1. Does your centre offer a PhD-program? ( )yes ( )no
   • If no: please continue with Si1.
2. Please give a brief description of your PhD-program.

Situation in your country
Si1: We would like to know more about the existence of Professional Development Centres in your country.
1. Are there further STEM-centres in your country? ( )yes ( )no
   • If no: please continue with Si2.
   • If yes: please list exemplary other centres:

<table>
<thead>
<tr>
<th>Name of other centres</th>
<th>Homepage (in English or German) or short description of the centre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Si2: We would like to know more about the professional development and education in your country.

1. Please fill out the chart:

<table>
<thead>
<tr>
<th>Profession</th>
<th>Typical education (university degree, vocational training, nothing, ...)</th>
<th>Typically used professional development (regular courses, working in Professional Learning Communities, nothing, ...)</th>
<th>How many of these people do you reach per year (give an estimation) by offering what kind of PD format (e.g. courses, professional learning communities, conferences, materials for lessons, ...)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nursery school teacher</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-service-teacher</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Facilitator for in-service-teacher</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Facilitator for pre-service-teacher</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School-leaders</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Mission of your centre and your activities**

M1: We would like to know more about the mission of your centre.

1. Please tell us about the main goals of your centre:

M2: We would like to know more about the characteristics of your activities.

1. Please describe briefly what main ideas your institution pursues in its offers. (list the three most important ones)

2. In how far are the following types of knowledge covered in your Professional Development-offers (please mark the applicable with a cross and try to give an estimation of their frequency)?

<table>
<thead>
<tr>
<th>Types of knowledge</th>
<th>Percentages of your offers that focus on this type of knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>( ) CK (content knowledge)</td>
<td></td>
</tr>
<tr>
<td>( ) PCK (pedagogical content knowledge)</td>
<td></td>
</tr>
<tr>
<td>( ) PK (pedagogical knowledge)</td>
<td></td>
</tr>
</tbody>
</table>

3. Please list typical activities (e.g. a 3-day long course about chance; a conference for teachers about the teaching of climate, ...):

4. Are the offers always designed by your centre? ( )yes ( )no
   - If yes: please continue with MC1.
   - If no: Please describe who designs your offers (e.g. teachers in cooperation with the centre, ...):
Major challenges and best-practice examples
MC1: We would like to know more about your challenges.
1. Please list major challenges your centre faces:

MC2: We would like to know more about your success.
2. Please list best-practice examples of your centre:

3. Are they documented? ( )yes ( )no
   If yes: Please list where we can find them:

3.2 Appendix 2: Questionnaire 2

QUESTIONNAIRE: The Profiles of the PD-centres
Questionnaire to all project partners to get more details on the top 4 main categories of the first questionnaire.

The questions which answers we would like to know are the following:

- Is there an annual job calendar with regularly upcoming and discussed task?
- What are the standard tasks in your centres?
  - Preparing and running CP courses?
    - What are the precise steps?
    - Who is responsible? Who is the initiator?
    - Who is checking quality standards?
    - What is done in advance for a ‘job’?
    - What is done after the measure resp. job?
  - Reviewing and evaluating jobs for other institutions?
- Is your centre integrated into curriculum discussions and developments?
- Does there exist some private communication between your centre and individuals? Does individual counselling is happening? Often?

- Addressees:
  - Are you addressing students (pupils)?
  - Are you responsible for math resp. science fairs and exhibition?

- Cooperation with learned societies:
  - Are you asked to be present at annual conferences of the learned societies?
  - How intensive is the cooperation with the learned society in your country?

- Support for the employees by the centre its own:
  - ... for the scientific development of the employees?
  - ... to visit international conferences?
  - ... to publish in research papers
  - Is there an internal public discussion of joint scientific papers? Jour fixe?
• Facilities:
  o Do you have internal access to educational journals within your centre? Or do you have to use the library of a university?
  o Business cards of your institution

• Public relations work
  o Chance to introduce yourself and your work
  o Is there an annual report to the outside world of your centre?
  o Invitation to other events
PD centre models: context, mission, structure and activities.
A review of models, challenges and success factors to lead improvements in
STEM teacher professional development
IO 5
Information about the report/IO
IO N° 5
Publication date: 25/06/2018

Project Information
Grant no. 2016-1-DE03-KA201-023103
Project title: European Network of STEM Professional Development Centres
Project acronym: STEM PD Net
Start date of project: 01/09/2016
Duration: 36 months
Program: Erasmus+, Key Action 2 (KA2) – Strategic Partnerships

Contact Information
Coordinating Institution: University of Education Freiburg, International Centre for STEM Education (ICSE)
Coordinator: Prof. Dr. Katja Maaß
Project Manager: Elena Schäfer
Lead partner for this report/IO: Prof. Dr. Günter Törner, Joyce Peters-Dasdemir
Website: [http://stem-pd-net.eu/](http://stem-pd-net.eu/)

© STEM PD Net project (grant no. 2016-1-DE03-KA201-023103) 2016-2019, lead contributions by University Duisburg-Essen. CC-NC-SA 4.0 license granted.

This document is based on the work within the project European Network of STEM Professional Development Centres (STEM PD Net). Coordination: Prof. Dr. Katja Maaß, International Centre for STEM Education (ICSE) at the University of Education, Freiburg. Partners: University Klagenfurt, Austria; University of Innsbruck, Austria; Institute of Mathematics & Informatics at the Bulgarian Academy of Sciences, Bulgaria; Ljuben Karavelov School, Bulgaria; Texas Instruments Education Technology GmbH, Germany; University of Duisburg-Essen, Germany; Ministry of Education, Culture & Sport, Spain; Education Development Centre, Lithuania; Gymnasium of the President Valdas Adamkus, Lithuania; Linköping University, Sweden; University of Gothenburg, Sweden; Turkish Ministry of National Education, Turkey; Hacettepe University, Turkey.

The project European Network of STEM Professional Development Centres (STEM PD Net) has received co-funding by the Erasmus+ programme of the European Union.

The creation of these resources has been co-funded by the Erasmus+ programme of the European Union under grant no. 2016-1-DE03-KA201-023103. Neither the European Union/European Commission nor the project’s national funding agency PAD are responsible for the content or liable for any losses or damage resulting of the use of these resources.
## Contents

Executive Summary ............................................................................................................... 2

1. Main report ...................................................................................................................... 3

   1.1 PD CENTRES ................................................................................................................. 3

   The different types of centres ......................................................................................... 3

   To summarize our observations ...................................................................................... 4

   1.2 CASE STUDIES ............................................................................................................ 5

   GERMAN CENTRE FOR MATHEMATICS TEACHER EDUCATION (DZLM) ...................... 6

   NATIONAL CENTRE FOR MATHEMATICS EDUCATION (NCM) .................................... 13

   T3 EUROPE – Teachers Teaching with Technology ......................................................... 19

   LEHRERINNENBILDUNG WEST ....................................................................................... 22

   EDUCATION DEVELOPMENT CENTRE (EDC) ............................................................... 26

   1.3 MISSION & CHALLENGES ......................................................................................... 31

   Change processes ............................................................................................................ 31

   The dilemma of STEM ..................................................................................................... 31

   Success Factors ................................................................................................................ 31

   Further missions & activities ......................................................................................... 34

2. Conclusions & Recommendations ................................................................................. 35

3. Appendices ...................................................................................................................... 37

   3.1 Appendix 1: Questionnaire 1 ...................................................................................... 37

   3.2 Appendix 2: Questionnaire 2 ...................................................................................... 41
Executive Summary

As part of the ERASMUS project European STEM Professional Development (PD) Centre Network (STEM PD Net), we have been working on PD centre models. The main aspects that we have focused on were a review of models, challenges and success factors to lead improvements in STEM teacher professional development. We tried to measure and understand the varieties and commonalities of STEM centres.

All project partners as well as the PD Centres Network partners contributed to a comprehensive information base by completing the questionnaire. The evaluation of the questionnaires brought depth insights into the different PD centre models and approaches in the project partners different countries – any beyond, as members of the PD Centres Network also filled in the questionnaire.

Also, the evaluation impressively illustrated the differences of PD centres exemplary reasons for the establishment of the centres, e.g. improving STEM education, improving professional development of teachers resp. teacher educators resp. teacher training, widening activities and expertizing in research of pedagogies, focusing on instructional and school development, or strengthening coherent teacher education. In completing the questionnaire and considering about the different categories it could also be achieved that the centres became clearer about their own centre model and in this way also support the organizational development of their institution. The whole consortium could also learn a lot from the best-practice examples.

Our compendium is designed to make our results available to you and help you to understand what distinguishes successful STEM PD centres. It is especially important to describe the different possibilities available when setting up a centre for professional development in the STEM area. The compendium will include a structured overview of possibilities of PD centre organization and activities, selected descriptions of PD centres with examples of their activities as well as an analysis of their weaknesses, strengths and challenges, and a review of challenges and recommendations on developing influential PD centres and possibilities to overcome challenges.

To enhance these overviews we added case studies of selected centres which can also be found on the STEM PD Net homepage (http://stem-pd-net.eu/en). These case studies provide us best practice-examples to orientate ourselves for successful centres. These are presented before the missions and challenges, since the five centres exemplify represent the four types and concretize them that the differences have their legitimacy.

When writing the case studies we gained further insights and accordingly another questionnaire. From this we finally gained new insights. At the end of this document, we have placed these new insights and provided them with recommendations.

The Compendium is structured due to the analysis of the questionnaires issued as follows:

- Structure of PD centres and situation in the countries
- 5 Case Studies
- The mission of the centres and major challenges
- Conclusion & Recommendation: New insights on the PD centres
- Appendices: Questionnaires
1. Main report

1.1 PD CENTRES

The different types of centres
Over decades most of the European countries have established governmental PD centres for some school subjects. These centres have to be understood as central educational institutions and their main task was and is to assist and support the official educational politics of the government. In the past, a new curriculum induced a new initiative of in-service training courses for teachers which had to implement the new curriculum. This task was the predominant function of these centres. However, our view was widened by research.

Fortunately, it was understood by the governments in the last twenty years, that continuous professional development of teachers is important issue – independently of an actual change of the curriculum. This development was accompanied by the research side, since ‘teacher change’ and ‘professional development’ gradually turned into new important keywords to which attention has to be devoted. Thus the (new) title ‘Professional Development (PD) centre’ for the traditional centres gradually became in use. Thus, most of the PD centres in our network originate in the old governmental institutions which were responsible for implementation of curriculum.

But there exists also a second type of a PD centre, some of these centres are members and partners in our network. We would like to explain their genesis and their role. In all European countries, teacher education is being held more or less intensively by universities. Sometimes, research focused universities have no faculties of teacher education, but this is not contradicting our assumptions. If a faculty is responsible for teacher education, it is not surprising that the teacher educators are also engaged in research about processes in the classrooms as well as about the role of teachers, e.g. professional development of teachers.

Thus, it is self-evident that these stakeholders at universities are claiming some responsibilities for upgrading teachers at schools. Some of the researchers are handling this task voluntarily, others are bringing in their expertise because of the employment agree within their faculty. We could prove that different models in European countries exist how to deal with this important interface. We don’t know any investigation about the linkages between university research and the implementation into daily practice within schools where ‘teachers’ and ‘students’ are the interesting stakeholders. Thus, it is only a small step to establish a university institution which calls itself a PD centre. Obviously, this type has different characteristics than the PD centres described above.

Finally a third type of a PD centre has been established by initiatives of firms and companies having interest to contribute to the educational system which is seen as a market, e.g. Texas Instrument financed the important PD initiative T3 (teachers teaching technology).

Last no least, non-governmental organizations (NGO) have to be regarded also as a stakeholder. Money is provided in areas where experts are recognizing deficits within the educational framework. The national institute for teacher education within mathematics in Germany, namely German Centre for Mathematics Teacher Education (DZLM), may serve as a classical example. The educational politics
Germany is fragmented since the sixteen provinces (so called ‘Bundesländer’) own the authority to regulate curriculum. The foundation of Telekom Deutschland was free to establish a national centre which could be designed by a different political stakeholder.

To summarize our observations

In Europe there exist four different types of centres:

Type 1) PD centres run by educational institutions in the charge of the government. The government or related institutions financing the PD centres. Thus, on the other side, the government is determining the various tasks and has the right to appoint persons.

Type 2) Universities are stakeholder of teacher education, thus they are claiming or are imposed to bring in their expertise and to run in-service teacher courses. These continuous duties have lead on to the establishing of university PD centres.

Type 3) Education can also be seen as a market, publication companies, companies producing software or materials have an interest to intervene into this market and they decided to run their own PD centres. T3 of Texas Instruments is a good example.

Type 4) It is not surprising that non-governmental organization have an interest to bring in their expertise, often they are able to act where official institutions have to accept barriers. In Germany, for example, education politics is authorized by the 16 provinces (so-called ‘Bundesländer’). Thus, it is not very easy to establish a national institution which previously finds the consent of 16 partners. A NGO has the capacity to build on such an institution as long as it is paying for his/her endeavor.

In our case studies, we described five institutions in details which are of different type.

- DZLM (Berlin, Germany) – German Centre for Mathematics Teacher Education (Type 4)
- NCM (Gothenburg, Sweden) – National Centre for Mathematics Education (Type 1)
- T3 Europe – Teachers Teaching with Technology (Type 3)
- Verbund LEHRERINNENBILDUNG WEST (Innsbruck, Austria) – RECC Biologie, RECC Mathematik (Type 2)
- UPC (Vilnius, Lithuania) – Education Development Centre (EDC) (Type 1)

It is self-evident, that the four different types are differing enormously with respect to the variables.

- Identity of the centre and the self-conception of its employees
- Basic philosophies of its acting
- Internal flexibility
  - Balancing theory and practice to support teachers’ learning.
  - Addressing many and diverse aspects of teachers’ competencies and experiences.
  - Being contextual and flexible (e.g., addressing the needs of teachers, students, industry and business).
- ‘Reach of action’ towards politics
- Dependency resp. independency with respect to governmental commitments
- Professionality of internal management processes
- Nearness resp. distance to research; the role of research for the work within the centre
- International visibility
- Intensity and type of cooperation with other stakeholders; the importance of interdisciplinarity
• Financial resources

The distinction is also due to various motives of the establishing like

• improving STEM education
• improving professional development of teachers resp. teacher educators resp. teacher training
• supporting physics teaching at all levels
• widening activities and expertizing in research of pedagogies
• focusing on instructional and school development
• implementing educational school subject content, inquiry based mathematics and computer science education, teacher competence development
• strengthening coherent teacher education
• Networking computer science technology

1.2 CASE STUDIES

We added case studies as mentioned above of selected centres. These case studies provide us best practice-examples to orientate ourselves for successful centres and concretize them that the differences have their legitimacy.

The case studies were created separately and are created below in the following order:

First, the DZLM of the type 4 is presented. Then follows an overview of the NCM (type 1) and the T3 (type 3). Afterwards the centre will be shown from Western Austria (type 2) and last but not least the centre EDC (type 1).
The DZLM was initiated and is funded by the Deutsche Telekom Stiftung (www.telekom-stiftung.de), a corporate foundation centred on improving STEM-education. On the recommendation of a panel of experts for Mathematics across the Educational Chain, the foundation created the DZLM in 2011 as a nationwide centre aiming at general quality standards for teacher training. The idea of such an institution was mainly influenced by the characteristics of National Centre for Excellence in the Teaching of Mathematics (NCETM) in London which was run by the prominent mathematics educator Celia Hoyles at that time. In a country where each state has its own politically driven philosophy on professional development, this was a totally new approach.

DZLM is successfully in establishing in the landscape of professional development in Germany and it is well-known to all stakeholders. However, DZLM has not reached a permanent status. It is not a trivial question how to anchor and finance an institution like DZLM in the Federal Republic Germany in the future. At the moment, various negations are underway to reach a compromise in 2019. The problems are described in Section 8.
I.III The Constitutive Partners, the Personnel and the Budget

At the moment members of eight universities are involved in the consortium: Humboldt-University Berlin, Free University Berlin, Ruhr-University Bochum, Technical University Dortmund, University Duisburg-Essen, University of Education Freiburg, Paderborn University and University of Potsdam. The main office resides at the Humboldt-University. DZLM succeeded in having contracts with these universities regulating the cooperation.

On the basis of such a construction, DZLM owns a wide panel of various experts in professional development, from primary schools to secondary schools, from mathematics to education theory at the different residences of their universities in Germany with many different research interests. Since the professors are further engaged at their universities on the basis of their regular contracts, the work is divided between them and many young scientists or seconded teachers. Most of them are PhD candidates..., often researching issues of professional development.

Only travel expenses of the professors and the expenses for courses are paid by DZLM, thus round about 60 % of 1.2 million euros per year is used for internal financing.

It is self-evident, that DZLM cooperates with further partners in the fields of mathematics, mathematics education and educational research as well as the educational institutes of the different federal states.

Figure 1: The embedding of DZLM
II Philosophy, Mission and Networking

II.I Traditions of PD Centres in Germany

It is easy to provide an answer: There is no tradition of mathematics PD centres: however, over many decades, various cooperation (of different insensitivities) have been developed regionally with institutions of the educational systems, but none has ever reached a global (a country-wide) 'charisma'.

This maybe explained by the federal structure of the German educational systems with authority in the specific 'Bundesländer'. Next, we would like to annotate that the learned societies of physics and chemistry have a lot of resources to pay for professional development and they are doing it since companies and firms are existing; this is not true for mathematics since there does not exist a mathematical industry and last not least there was no tradition built up by the German mathematical society. Note that only a small percentage of teachers are members of mathematical society, differently to the situation in the former Eastern bloc.

II.II Philosophy and Mission

It was decisive that a 'neutral' stakeholder, namely the Deutsche Telekom foundation affine to mathematics, has taken over the responsibility. And again the Deutsche Telekom Stiftung set the specific well-defined objectives for the centre for which it was willing to pay. Both, the universities and all other partners involved in the German Centre for Mathematics Teacher Education have a common mission:

- To accompany the professional development of mathematics teachers during their whole career.

Since it is impossible to address each mathematics teachers in a country with more than 80 million inhabitants and more than 100.000 mathematics teachers, we have to restrict our mission to teacher instructors (multipliers). DZLM follows a trend that was formerly accentuated by the group of Katja Maas at Freiburg, namely Educating the Educators.

The continuous professional development (CPD) courses, concepts and materials follow a competence framework and design guidelines according to the latest research results in teacher education. Also, comparable concepts for the support and the securing of early education in mathematics are developed. These concepts result in CPD courses for kindergarten and elementary educators.

II.III Networking as a Crucial Issue of a PD Centre

It is an important objective to create networks between many different types of partners: teachers, colleagues, institutions and societies wherever possible. Thus, we network on a national and international scale through conferences, institutional cooperation and the creation of regional branches:

- Cooperation between educational and government institutions or ministries from different German federal states
- Creation of a web portal offering information, material for professional development and interactive teaching environments
- Inclusion of further education offerings from other people, projects or institutions through integration or linking

Research reports in literature prove that isolated initiatives are in general not successful, mathematics educators need various partners in different systems, they need friends. DZLM knows that networking between various levels promotes professionality (see the figure on page 2). These initiatives are indispensable. DZLM does not like to be regarded as a competitor. In a governmental system we would not have a chance to win.
DZLM's activities are in line with a coherent concept of mathematics education from kindergarten and elementary education to upper secondary level that includes diagnosis and advancement of students' learning processes in mathematics.

The DZLM is interested in being a prominent member of the European Network of STEM Professional Development Centres.

III Activities

The DZLM's fields of action are:

- topic-specific (mathematics) and practice-oriented;
- research-based, and seek to gain and share insights;
- networked throughout school levels.

The activities of the German Centre for Mathematics Teacher Education can be structured in three main strands:

Certified Qualification Measures:
- Creation of a nationwide master course for teacher educators
- Subject-specific and didactical qualification of teacher educators particularly for professional development
- Further qualification of out-of-field teachers
- Qualification events and courses for teachers and elementary educators

Research in Teacher Education and Professionalization:
- Evaluation of activities of the German Centre for Mathematics Teacher Education and of other agencies
- Research in the effectivity of professional development courses and publication of the results on an international level
- Research-based design of the quality framework (theoretical basis, design guidelines and competence framework)
- Initiation and financial support of professional learning communities (PLC) for peer coaching and competence development

Development of Material and Concepts:
- Development of material used by teacher educators in CPD courses
- Development of material used by teachers and elementary educators for self-teaching
- Development of information material, videos and flyers
- Joint development of concepts with teacher education institutes and ministries in the German federal states

IV The Theoretical Framework

The theoretical framework constitutes the foundation of its activities and builds upon theory and is evidence based.

- A competence model,
- a research and development agenda and
- design guidelines

have been derived from this and serve as a basis for the actual continuous professional development courses. All activities are monitored for quality with a systematic evaluation by means of transparent criteria. A subdivision within the centres is responsible for coordinating and monitoring design-based research around the courses.

Research on professional development is a central part of the agenda of DZLM, especially the PhD-graduation and qualification of young scientists providing also an international auditorium.
Specific Aspects

V Political Dependency

Since DZLM is actually not a part of the German educational system and is not paid by government, it is of course politically independent. Using a metaphor, DZLM is thus a further provider — and not to be ignored — a further competitor in the market of professional development. Thus, DZLM is free to set up its own norms.

On the one hand, this independence can be seen as an advantage: DZLM may experiment, may generate its own patterns and may follow new tracks.

On the other hand, having no political power behind it, independence is also a disadvantage. So the institution knows that it has to downplay its role and should seek for cooperation. Meanwhile, this role has been practised and accepted. Many courses are run beyond a label DZLM & xy or xy & DZLM.

VI Interdependence of Initial Teacher Education and DZLM Activities

The German Teacher education system consists of three consecutive levels. Firstly, there is the teacher education at university and in the most ‘Bundesländer’ the university curricula are being subordinate to different ministries, the ministry for academic and sciences on one hand, the ministry for education and schools on the opposite side.

After graduating from university the prospectives have to go into a preparatory service for 18 months. Actually, there is almost no cooperation between the persons in these virtual institutions and the faculties at university.

Having obtained a teacher position at school, the (novice) teachers are now in front of their classrooms. That is the first time that DZLM might address these teachers within the complicated role as novice teachers. One may regard this process as new and substantial, whereas in older times professional development has been seen as an upgrade after several years of service.

Thus, DZLM propagate that professional development initiatives should start as early as possible. Next, we would like to make professional development initiatives also as self-evident as possible. Thus cooperation at the moment highly depends on the program offered by DZLM.

VII Quality Assurance

As mentioned before using design-based research, DZLM is trying to influence the design of any course in advance. DZLM-members conduct the courses themselves or work together with experienced partners in the federal states, with whom they develop the courses together or make sure their concepts are in line with DZLM-standards and goals.

Next, after intensive discussions DZLM has set up specific position papers, namely

- a competence model and
- design guidelines.

These documents serve as a basis for the actual continuous professional development courses and are continuously revised according to new research and practice experiences. All activities are monitored for quality with a systematic evaluation by means of transparent criteria.

VIII Interdependence of Research and Practice – a Balance Act

Nevertheless, having accompanied the development of DZLM for many years and being at the same time also involved in the international research domain of professional development, the author has often posed the question of what is really sustainable. We should not ignore: DZLM consists of highly qualified persons from
universities and only partly experienced teacher instructors.

To be honest, it is not easy to guarantee that professional development is successful. Firstly, we should accept that teachers, their classrooms and their students live in a world which is disjoint from our field of experiences, the world of universities, the world of research projects. Next, we should reflect how we can bridge between these two strands. For the author, it is extremely difficult to balance between research and practice and that is an actual (hidden) struggle at DZLM.

To run courses for teachers and teacher instructors is not very deserving in the university world, a professor will not be honoured through such initiatives when he/she applies for a new position. Persons at a university will be measured by the amount of research money which they have achieved in the past. Numbers of publications in referred journals are decisive; however, teachers normally have no access to this literature and no time to study them.

On the other hand, teachers at schools are in most cases reserved towards what is offered as the latest research results by university teachers. They have often experienced that the worldviews of researchers about classroom are far beyond from being adequate. Thus, we need solutions balancing between practice and research while serving for the DZLM.

What was described for the individuals is also valid for the ranking of the whole institution DZLM. Is DZLM an institution for research or for generating materials and course? Yes and no, DZLM has to play both roles, but also sees this as one of its unique characteristics compared to other institutions.

Miscellaneous

IX Conclusions and Recommendations

IX.I The Role of Learned Societies

Since DZLM only addresses mathematics teachers, there are only two learned societies which should cooperate. The centre has strong relations to the

- German Mathematical Society (DMV) as well as to the
- German Mathematics Education Society (GDM) and

DZLM is usually present at their annual conferences and supports in particular any activity which is run on the ‘Teachers’ day’. Some members of DZLM also work within joint commissions.

IX.II Networking; Informal Education

Since DZLM does not address the individual teacher, but teacher educators, the link links are not very strong to informal activities of the communities of teachers. However, if there are requests DZLM would not refuse its collaboration, e.g. seeking for experts accompanying professional learning groups (PLG).

IX.III Diversity of PD Centres: Culture, International Relations

DZLM is so far not a permanent institution, thus its highest priority is actually given to efforts which guarantee the permanent existence. Thus, the STEM initiative in general plays a minor role since resources are limited.

IX.IV Visions

The predominant vision: DZLM will become a permanent institution, financed by a governmental system and will contribute to a development of mathematics all over the German teachers’ culture.
IX.V Publications

Here you can find international publications by DZLM members. A complete list of publications in German and English is available https://dzlm.de/dzlm/international-visitors/publications
We refer to the presentation of NCM within on its website (https://http://ncm.gu.se/node/203).

Parts of the following text are cited from an English version of its homepage and modified according to our categories. Also by the help of Peter Nyström:

I The NCM as a Swedish Institution

I.I The Beginning

In 1999 the Swedish government decided to establish a National Resource Centre for Mathematics Education at Göteborg University (UGOT) and reserved some funding for that purpose. The centre would coordinate, support, develop and implement the contributions which promote Swedish mathematics education from pre-school to university college.

The centre also utilizes the experiences and the knowledge base evolving within the framework of the Nämnaren project which started as a journal for mathematics education in 1974. After years of planning, the first issue of a second journal, Nordic Journal for Research in Mathematics Education, NOMAD, was launched in the fall of 1993.

Thus, the centre was developed based on a long tradition of in-service training of mathematics teachers in Sweden.

I.II The Embeddedness

NCM is the Swedish National Resource Centre for Mathematics. Its main task is to support the development of Swedish mathematics education. It is one of a number of centres for different school subjects established by the government over the last 15 years. NCM does not come under the auspices of any state authority, but is an independent body at Göteborg University.

University of Göteborg is a large higher education institution in Sweden. One of many profile areas is knowledge formation and learning, where teacher education plays an important part. The university offers the broadest range of teacher education in Sweden in terms of available programmes and subjects.

I.III The Constitutive Partners, the Personal and Budget

UGOT hosts the Swedish National Centre for Mathematics Education. The centre is commissioned and financed by the Swedish government with the mission to coordinate, support, develop, carry out and follow up initiatives promoting Swedish mathematics education in pre-school, school and adult education. NCM is also specifically expected to stimulate and disseminate research in mathematics education in Sweden.

It is self-evident, that NCM cooperates with further partners in the fields of mathematics, mathematics education and educational research as well as the ministry of education.

The most important cooperation and collaboration is with the Swedish Agency of Education (the governmental authority responsible for school
development, curricula etc. in Sweden.) NCM also collaborates with other PD-Centres, including the Norwegian Centre for Mathematics Education. Not to forget with several universities in Sweden, to some extent through their specific centres for in-service training of teachers.

NCM employs six academics as facilitator and one as researcher, three non-academics as well as another employee (75% of full employed). The research is done individual and play a minor role for the NCM.

<table>
<thead>
<tr>
<th>What is the money spend for?</th>
<th>Rough percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staff</td>
<td>60%</td>
</tr>
<tr>
<td>Materials (development)</td>
<td>13%</td>
</tr>
<tr>
<td>Other</td>
<td>27%</td>
</tr>
</tbody>
</table>

Half of the funding comes from the third party funding. The other half comes from the educational ministries as well as centre's intake (publishing, ...).

Thus, the centre has a budget of more than 1 million euros per year.

II Philosophy, Mission and Networking

II.I Target Group of NCM

Nursery school and in-service teacher with a University degree use local and regional conferences as a PD. Those conferences are mostly one day, working in professional learning communities and regular courses. NCM reaches by year about 500 nursery schools and 1000 in-service teachers. However, through the website and materials developed at the centre, they reach a much larger group.

Pre-service training of teachers is not a goal for NCM. The materials are however widely used in pre-service training of teachers and they facilitate a yearly conference for pre-service teacher educators in mathematics. 2017 approximately 60 educators participated in the conference.

Also school-leaders (which need a university-degree and school-leader program) are not a primary target group for the centre. In some development projects school-leaders are included. During the large scale national PD-project for mathematics education 2012-2016, NCM was responsible for a program for school-leaders. Over the whole period they reached almost 3000 school-leaders.

Varying, in-service training is done by universities, but also by a variety of private initiatives. Thus, this group isn't a goal for NCM.

II.II Philosophy and Mission

The mission of the centre is to coordinate, support, develop, carry out and follow up initiatives promoting Swedish mathematics education in pre-school, school and adult education. Specifically, NCM is commissioned to stimulate and disseminate research in mathematics education in Sweden.

Specific Aspects

III Characteristics of NCM Activities

III.I Main Ideas

The NCM is working on all sorts of ideas related to teaching and learning mathematics in school, and it is difficult to pinpoint the most important ones. However, trying to list the activities of NCM results in three main strands:

Teaching Number and Problem Solving:

They have over the years had a fairly strong focus on the teaching of number from pre-school all through compulsory school. This is based on the fundamental role of understanding number in order to learn mathematics. Problem solving is another important theme (of course). One example of the efforts in this area is the work with Cangarou sans Frontiers/Kangaroos without
borders, which is an international competition distributing challenging problems to all students. The project has a number of different 'classes' for students of different ages. Approximately 150000 students participate in Sweden each year.

**Courses, conferences and other PD activities:**

Another important idea is to give teachers concrete suggestions for activities in the classroom, which are based on fundamental goals and principles for mathematics teaching and learning. This idea influences strongly the efforts to produce materials that are published in their books and journals, and the rich material published on the website of NCM. This idea also influences their planning of courses, conferences and other direct PD activities. NCM finds it important that teacher try out activities and that they gain experience using different approaches in the classroom. This is an important key to effective professional development. One particular area which the centre has been promoting is the use of hands-on materials in the teaching and learning of mathematics.

**Research in Teacher Education and Professionalization:**

A third important idea that highly influences the priorities of the centre is the spreading of relevant research in mathematics education, transformed into a useful form for teachers. But also (and equally important) spreading of best-practice and praxis-related knowledge developed by teachers. Many of NCM-publications are characterized by a mixture of voices, both researchers and practitioners, presenting important and interesting lessons learned about teaching mathematics which are relevant to teachers.

The PD-offers are 100% focused on the pedagogical content knowledge (PCK).

**III.2 NCM Activities**

The typical activities of the Swedish National Centre for Mathematics Education fall into the follow areas:

- **Half-day course for teachers about hands-on activities in mathematics:** Groups of teachers come to the mathematics workshop and are given an introduction to ideas behind using manipulatives and are offered the opportunity to test some activities.
- **Municipalities arranging a series of half-day or whole day meetings for their teachers, asking NCM to contribute in planning and executing.**
- **Conferences (mostly half day) for teachers explaining, exemplifying and encouraging the use of materials produced by NCM.**

**IV Quality Assurance**

Among those working at NCM, there are people with experience from the national school curriculum, syllabus and test development work, national and international assessment and conference activities, national and local research and competence development projects. Also people with knowledge of Information Communication Technology (ICT) and distance learning, teacher training and supplementary education, text book production for both teachers and students, work in pre-school, pre-school classes, all levels of the nine-year compulsory school, upper secondary school and as remedial teachers. In addition, there are researchers in mathematics and mathematics education.

They are responsible for and participate in various activities and projects such as

- **Publication of the magazines Nämnaren and NOMAD**
- **Publication literature for teacher training**
- **Participation and organization of seminars, courses and conferences**
• Operation and development of several websites.

All activities are monitored for quality with a systematic evaluation by means of transparent criteria.

V Best-Practice Examples

Three examples of best-practice that the NCM-Centre has been working with:

Important aspects of learning numbers:
They have produced a book together with the Australian researcher Alistair McIntosh which describes important aspects of learning about number in grades 1-10, including diagnostic tests for each year. They also give short courses in how to use the book and how to lead others in using the book. The book is frequently used in many schools in Sweden and has been a huge success.

Teaching material for pre-school class:
NCM has also developed a teaching material for pre-school class, i.e. school for six-year old children in Sweden which is a bridge between preschool and school. For this they have material met with many teachers to introduce the ideas in the material and also leading a network of teachers who use the material and who lead colleagues in using the material.

The pre-school project they are working with was thoroughly investigated in the developmental phase and they are currently working on a book describing the project more deeply. This book will only be published in Swedish. There is however one publication in English about this project (http://ncm.egu.se/media/smdf/Published/No10_Madif9/159168-Sterner_Helenius.pdf).

The boost for mathematics:
The centre has been deeply involved in the large-scale national professional development project for all teachers of mathematics ('The boost for mathematics'), which reached a majority of Swedish mathematics teachers in 2012-2016. The project continues and new modules are developed and publish on a web-portal run by the Swedish National Agency of Education.

The 'Boost for mathematics' project has been extensively evaluated and there seem to be a lot of positive effects so far. The long-term effects remain to be investigated. The publications are in Swedish, and there is very little published in other languages. One of the Swedish publications (https://www.skolverket.se/publikationer?id=3706) is an evaluation made by researchers in mathematics education at Ume University.

A more local study of the effects of the project (and another local project) on student learning was recently published:


Currently NCM is developing modules for Coding and mathematics and Special education and mathematics.

VI Interdependence of Research

Research has had an important role in the centre as individual projects and as a foundation for activities and projects at the centre, but not so much as a commitment for the centre as a whole. Reviews of research have of course played a significant role, but not so much empirical research first hand. However, recently the centre has been engaged in developmental projects with a clear research agenda.

VII Conclusions and Recommendations

VII.I Major Challenges

There are different ways of looking at challenges. One type of challenge concerns factors that limit our possibilities to make a difference for the
teaching and learning of mathematics. One such factor concerns the often short-term character of projects. NCM wish to engage in more long-term, sustainable efforts of professional development. Another factor is the financial situation, which makes it difficult to initiate and run the kind of projects that could make a difference.

Another type of challenges concern the areas where professional development is most needed and perhaps most hard to achieve. NCM is currently involved in planning for a project that will address two of these challenges: developing the confidence and knowledge in mathematics for teachers in primary school (which is a pre-requisite for doing a lot of the teaching that we know can make a difference) and developing structures where teachers efforts of developing mathematics education is supported by school-leaders and policy makers in a sustainable way.

**VII.II Diversity of PD Centres in Sweden**

In Sweden are further STEM Centres next to NCM. But not with the specific focus for mathematics education. To name but a few: (We refer to the presentation of the Centres within on their website.)

*The National Resource Centre for Chemistry Teachers (KRC)*

In June 1994 Kemilärarnas Resurscentrum, KRC got an assignment from the Swedish government to start a Centre supporting activities of chemistry teachers in Swedish compulsory and upper-secondary schools. The general aim of the Centre is to promote and stimulate interesting and up-to-date teaching of chemistry in Swedish schools. The Centre is supported by Stockholm University.

*Centre for School Technology Education (CETIS)*
[https://liu.se/cetis/english/index_eng.shtml](https://liu.se/cetis/english/index_eng.shtml)

The Swedish National Centre for School Technology Education, CETIS, at Linköping University started in 1993. In 1996, the government made CETIS a national centre. The main aim of the Centre is, in collaboration with teachers, teacher-trainers, and representatives for industry etc., to develop technology education in schools.

*National Resource Centre for Physics Education (NRCF)*

The National Resource Centre for Physics Education located at Lund university is aimed at being a resource for teachers from preschool to upper secondary school (high school). The aim is to inspire and stimulate the development of physics education and to give teachers the opportunity to further studies of physics.

*National Centre for Science and Technology's Didactic (NATDID)*
[https://liu.se/forskning/natdid](https://liu.se/forskning/natdid)

One of the new Centres is the national Centre for science and technology didactic. The aim of this is that teachers should be able to translate subject didactic research into practice and thereby let the school rest on a scientific basis. NATDID was established after a government decision in February 2014 and is located at Linköping University.

As can be seen, the founding is usually associated with the decision of the Swedish government. But it suggets itself that there is a need for networking and exchange.

**VII.III Publications**

Some highlighted publications are


- *Förstå och använda tal* [Understand and use numbers]. A guide through teaching about number throughout compulsory
school, including diagnostic tests intended for formative use in each school year.

- **Blå strävor** [Blue aspirations]. A collection of activities specifically designed for use in mathematics education for students with learning disabilities.

Here you can find publications by NCM members [http://ncm.gu.se/publikationer](http://ncm.gu.se/publikationer)
I Philosophy

Frank Demanna and Bert Waits started T³, Teachers Teaching with Technology, in 1986. The T³ philosophy is exemplified by a quote from Bert Waits in 2000,

- Some Knowledge and Skills become more important because technology requires it.
- Some Knowledge and Skills become less important because technology replaces it.
- Some Knowledge and Skills become possible because technology allows it.

II Traditions of STEM PD centres

T³ has arisen from a grass roots drive to find better ways to teach mathematics. Its vision statement being:

*Technology has changed the mathematics and science classroom, and its impact will continue to grow. Technology provides the opportunity for all students to be active learners as they are afforded the chance to explore and investigate what they have learned in the classroom. When used effectively by a well-trained teacher, technology supports the learning of mathematics and science students, enhancing rather than degrading their skills. Technology provides value as an efficient means of analysing data and instantly seeing the results. It provides opportunities for further exploration.*

These activities allow insight and understanding which is not available without the use of technology.

T³ refers to this bridge to learning and understanding as *The Power of Visualisation*. This has evolved to encompass science as well as mathematics. T³ today regularly brings mathematics and science teachers to discuss content and pedagogy. T³ Europe is part of this tradition.

III A survey of STEM PD centres

T³ Europe is composed of 12 countries each with its own website and all linked to the umbrella site of T³ Europe. Funding for all the activities is derived from Texas Instruments (TI) who as owns the T³ logo.

The result is a symbiotic relationship between T³ and TI in which TI consults T³ to better understand how to reach policy makers and T³ consults TI during product development. The common language when meeting as T³ Europe is English. Each country is self-regulated and devises its own programme of activity. Every two years T³ Europe organises a conference by invitation, Sharing Inspiration, held in a European capital city.

IV Foci and activities of STEM PD centres: consultancy, PD provision, curriculum and content development.

*Sharing Inspiration* is about

- providing quality professional development that enables the mathematics and science educator to
be successful in the classroom through the appropriate use of technology;
• developing state-of-the-art classroom pedagogy or didactics and sharing it with our peers both nationally, within our T³ country organisation and internationally as T³ Europe
• sharing expertise in training, educational curricula and exam development;
• sharing this expertise with Ministries of Education, curriculum development and exam bodies, public and private pre- and in-service professional development organisations, pedagogical research institutions, textbook publishers and other content providers
we seek
• to identify common elements across European STEM curricula and teaching methodologies.
• to promote inquiry-based learning through the use of real-world applications and data collection devices for students aged 10-19.
• to encourage a balanced approach combining the use of graphing and other technologies along with mental skills and paper and pencil skills to support STEM curricula.
• to influence the content of STEM curricula and students’ skills through demonstrating the power of technology to accelerate student cognition.

Each national T³ organisation supports these aims but will use its own networks and methods of working to achieve them.

Specific Aspects

V Political dependency

T³ Europe is politically independent but seeks the ability to cooperate with political administrations. By its very nature the use of technology within the classroom and the examination system is often rejected, not only by politicians but by society at large. By sharing expertise with Ministries of Education, curriculum development and exam bodies, public and private pre- and in-service professional development organisations, pedagogical research institutions, textbook publishers and other content providers, T³ Europe is working towards a more equitable landscape.

VI Interdependence of initial Teacher Education and STEM centre PD activity

Activity is frequently integrated into ITE programmes, and in some institutions this is systematic. In general there is no interdependence and any activity only serves to make trainee teachers aware that such technology exists and has the potential to be useful in the classroom.

VII Quality assurance

T³ Europe has no formal process of assuring quality. This does not mean that it is ignored, quite the contrary, the organisation is always examining its own protocols and content with a view to improving.

All website content for example is peer-reviewed, PD providers themselves have undergone extensive peer observation and this information is fed back to organisers and website managers. T³ trainers do use evaluation sheets and the whole network of T³ members is looking at impact back in the classroom on an ongoing basis. This never stops and is formally recorded through the use of focus groups conducted by Texas Instruments developers at international conferences. In this way the hardware, firmware and software is continually updated through teacher feedback ensuring that it is of the highest possible quality and efficacy for teaching and learning.

VIII Interdependence of research and practice

There is cooperation within T³ between researchers and practitioners who are both using the technology to improve learning. Researchers and practitioners meet with each other at conferences, particularly Sharing Inspiration, and exchange views and ideas.
As well as funding T³ activities, Texas Instruments also funds research and some university teaching. The interdependence is then a triangular one!

IX Conclusions and recommendations

IX.I The role of learned societies

Many T³ Instructors belong to learned societies, and this helps to connect the pedagogical use of technology to committees and working parties within these groups who may be working on educational projects.

IX.II Networking; informal education

Networking is a principle aim of the T³ organisation. Sharing Inspiration is the highlight of the T³ Europe calendar and brings together teachers from many countries including the USA and Australia. Considerable effort is made to include educational administrators and researchers to ensure that networking is vertical as well as horizontal.

IX.III Diversity of PD centres: culture, international relations

Composed of 12 different countries T³ Europe is already very diverse in terms of culture and language.

Networking is supporting other countries wishing to become a partner of T³ Europe. Members themselves are engaged with many different examination systems, Germany alone has 16 different federal states. Not only are our exam systems different but curricula vary widely. The one feature we have in common is how best to use technology for the learning of students. In identifying common elements across European STEM curricula and teaching methodologies we are helping to improve international relations.
LEHRERİNNENBILDUNG WEST

I The cluster LEHRERİNNENBILDUNG WEST

I.I The "Birth" . . .

The cluster LEHRERİNNENBILDUNG WEST (LB-West) was launched by the cooperation agreement „Sekundarstufe (Allgemeinbildung)“ between five institutions in 2016. In 2014 already, the subjects „Mathematik & Geometrie“, „Physik“ and „Biologie“ were accredited with the RECC-label (regional educational competence centre). In 2015, „Geographie & Wirtschaftskunde“ and „Deutsch & Mehrsprachigkeit“ were also accredited with the same label [3].

I.II LB-West embedded into the Heterogeneous Educational System of Austria

In 2012, after the approval of a new law [2] concerning the teacher’s education system, four cluster across Austria were installed in order to design the new teacher education programme. As a consequence of the new law, the pedagogical colleges and the universities have to collaborate and are responsible for the whole teacher education. The collaboration may also offer a stronger involvement of the universities regarding the PD courses, especially in the STEM subjects. In Western Austria this clusters has been renamed to LB-West.

I.III The Constitutive Partners, the „Personnel“ . . . and the Budget

The LB-West comprises two universities (University of Innsbruck and University Mozarteum) and three pedagogical colleges (PH Tirol, PH Vorarlberg and KPH Edith Stein). Two regional competence centres (RECC Biologie, RECC Mathematik & Geometrie) – collaborations within the LB-West – are partner of the STEM PD Net-Project. The universities are mostly autonomous and related to the Federal Ministry of Science, Research and Economy; the pedagogical colleges are under the supervision of the Federal Ministry of Education. The LB-West is run by the heads of the participating institutions and has not an own budget.

II Philosophy, Mission and Networking

II.I Traditions of PD centres in Austria

In Austria, the so called pedagogical institutes (Pädagogische Institute) were responsible for teachers’ PD courses till the foundation of the pedagogical colleges (Pädagogischen Hochschulen) in 2007. In 2004/5, the Federal Ministry of Education set up six Austrian Educational Competence Centres (AECC) to support the teacher education (pre-service and in-service). Five centres for the subjects biology, chemistry, physics, german, mathematics, and the institute of instructional and school development.
II.II Philosophy and Mission

The main aim of LB-West is to implement the „PädagogInnenbildung Neu“ [1] in Western Austria, but it offers also the chance to reshape the PD courses especially in the STEM subjects under the RECC labels.

II.III Networking as a Crucial Issue of a PD Centre

Since the LB-West comprises several institutions and collaborates intensively with the school authorities in Tirol, Vorarlberg and Südtirol, networking is a core mission of the LB-West.

III Activities

The main focus at the moment is to implement (we are starting the third year) the new teacher education programme. Especially in science education and mathematics education new courses were designed.

IV Specific Aspects

IV.I Political dependency

The origin of LB-West was in 2013 when a new law was released in order to reform the teacher education in Austria [2] Part of the new law was that pedagogical colleges and universities plan and implement the new teacher education in a close cooperation. From a political point of view, the pedagogical colleagues are depended of the Federal Ministry of Education meanwhile the universities are in the competence of the Federal Ministry of Science, Research and Economy, but act autonomously. Before the new law in 2013, only the pedagogical colleges were allowed to offer PD courses, although many researchers from the university gave the courses. With the new law, this restriction was softened and therefore it is reasonable that at least the subjects under the RECC-label will plan and offer PD courses together.

IV.II Interdependence of initial Teacher Education and STEM PD activities

The new structure of the teacher education in Western Austria allows a close connection between the initial teacher education and future PD courses in the LB-West. In the new teacher education programme all secondary teachers (upper and lower, academic and vocational) graduate from the same study. Before the new teacher education programme, the pedagogical colleges only educated the teachers for the lower secondary (part of it), but offered PD courses for all teachers. In the pedagogical colleges, we have now the chance to employ the same teacher educators for the initial teacher education and the PD courses, especially in the subjects under the RECC label.

IV.III Quality assurance

Quality assurance with respect to PD courses is still an open topic within the LB-West. In 2015/16, the RECC Mathematik & Geometrie under the lead of the pedagogical college Tyrol tested a new PD format, with face-to-face meetings and an implementation phase between those meetings. A modest monitoring showed that the acceptance by the teachers was quite low. Therefore, new PD course structures are recently discussed. An alternative approach may arise from the initial teacher education itself. The curricula of the new teacher education foresees a closer collaboration with in-service teachers and emphasises the exchange between researchers and practitioners in specially designed courses. We hope to extend such collaborations also for the PD courses in a few years.

At the moment, no certificate is needed for a successful graduation of a PD courses, only the attendance counts.
IV.IV Interdependence of research and practice

Subject-specific education in Western Austria got only recently – within the context of the new law concerning the teacher education – an institutional framework. At the University of Innsbruck a new institute – at the new faculty School of Education – was founded and at the pedagogical college Tirol the „Fachdidaktikzentrum“ was initiated. In biology, research on conceptual change with focus on learning outside the classroom is implemented directly in PD courses already for several years. In mathematics, subject-specific education is at the very beginning, but gathered some experiences in the field of inquiry-based learning within the EU-project mascil and conducts actual a survey on the natural number bias. For the next year, we plan PD courses together with practitioners with a focus on topics from pedagogical content knowledge.

V Conclusions and recommendations

V.I The role of learned societies

Due to the early stage of the LB-West, the relations to learned societies in Austria are in still in an initial phase.

V.II Networking; informal education

Due to the early stage of the LB-West, there not yet links to informal activities of the communities of teachers.

V.III Diversity of PD centres: culture, international relations

Due to the early stage of the LB-West, international collaborations in the field of PD are not yet established. The RECC Biologie and RECC Mathematik & Geometrie are partner in the STEM PD Net project.

V.IV Visions

LB-West is going to be responsible for the teacher education in Western Austria.

V.V Publications

The LB-Wes WEST exists since 2016, publication within the cluster are in preparation but not yet published [1].


Figure 2: Map of the political dependencies of LB-West [https://www.upc.smm.lt/projektai/stempdnet/naujienos/diskusija/3-LEHRERINNENBILDUNG-WEST-LB-West-klasterio-kurimas.pdf; p. 7]
EDUCATION DEVELOPMENT CENTRE (EDC)

We refer to the presentation of UPC on its website. Parts of the following text are cited from an English version of its homepage and modified according to our categories, the rest is collected internally. This case study has been written by Ruta Mazgelytė & Vytautas Andrius.

I EDC as a Lithuanian Institution

I.I The Founding

The Education Development Centre (EDC) was established on the 1st September, 2009 after the reorganization of Teacher Professional Development Centre (TPDC), Education Development Centre (EDC), Teacher Competence Centre (TCC), Lithuanian Adult Education and Information Centre (LAEIC) and it is the largest institution under the direct authority of the Ministry of Education and Science.

In 1945 the Republican Pedagogical Cabinet at the Ministry of Education was founded. In 1950 the cabinet was transformed into Republican Teacher Qualification Improvement Institute which had the main function of teacher qualification improvement and teacher training. In 1990, after the independence of our country had been restored, the institute was rearranged into the Lithuanian In-Service Teacher Training Institute. In 1999, the institute was reorganized into Teacher Professional Development Centre (TPDC). The main goals of this institute were: dissemination of education reform ideas and innovations, implementation of strategic in-service training projects and programmes, preparation of consultants for regions, organization and coordination of methodological activity, preparation of methodological tools for teachers.

In 1958 the Scientific School Research Institute was established; it was reorganized into the Pedagogical Scientific Research Institute and later into Institute of Pedagogy. In 1991, the Education Development Centre was established after the restructuring of the Institute of Pedagogy. The main EDC tasks were: the preparation and introduction of the documents which determine the curriculum and methodological material for teachers, organization and implementation of education system monitoring, preparation of education development models.

In 2003, the Teacher Competence Centre (TCC) was established. This institution organized the supervision of in-service teacher training quality, accreditation of in-service teacher training institutions and their programmes, and provision of methodological support. TCC has been coordinating the attestation of pedagogues and school administrators, implementing expert in-service teacher training evaluation and participating in expertise of teacher training programmes.

In 2005 after the reorganization of Distance (Extramural) Education Centre, Lithuanian Adult Education and Information Centre (LAEIC) started its activity. The Centre had been providing support for continuing adult education, gathering and

1 https://www.upc.smm.lt/veikla/about.php
I.II The Embeddedness and Institutional Dependencies

The Education Development Centre (EDC) is a national level institution affiliate to the Ministry of Education and Science of the Republic of Lithuania. It provides educational support in the field of pre-school, primary and general education. Due to centre establishment peculiarities, the centre carries various tasks, which require close cooperation and collaboration with other institutions – and particularly in the field of in-service teacher training.

In the field of in-service teacher training EDC cooperates with 5 institutions affiliate to the Ministry of Education and Science of the Republic of Lithuania (Lithuanian Centre of Non-formal Youth Education, National Agency for School Evaluation, The Lithuanian Children and Youth Centre, Special Pedagogy and Psychology Centre, Centre for the Development of Qualifications and Vocational Training), professional development centres in 8 institutions of continuing education at universities and 62 regional teacher training centres, 63 subject associations. The institutional dependencies by financial and accreditation aspects are shown in the graph ‘Lithuanian teacher professional development system and institutional dependencies’.

EDC has 5 divisions: Education Content Division, In-Service Training Division, School Performance Development Division, Education Content Quality Assurance Division, Information and Communication Division and 3 supporting departments: Law, Human Resources and Public procurement department, Accounting department, Administration and Maintenance department. EDC employs 65 persons with pedagogical degrees and 39 specialists; thus it makes it a large institution.

<table>
<thead>
<tr>
<th>What is the money spend for?</th>
<th>Rough percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staff</td>
<td>50 %</td>
</tr>
<tr>
<td>PD Initiatives</td>
<td>24 %</td>
</tr>
<tr>
<td>Materials development</td>
<td>1,06 %</td>
</tr>
<tr>
<td>Other:</td>
<td>25,94 %</td>
</tr>
</tbody>
</table>

In addition to allocated budget, EDC has got additional funding from international projects 0.3 mln. Euro, EU structural funds project 1.4 mln. Euro.

II Philosophy, Mission and Networking

II.I Traditions of PD Centres in Lithuania

PD centres in Lithuania can be classified into two categories according to their scope:

- national level
- regional level PD centres.

National level centres focus on CPD, which corresponds to national in-service teacher training needs and key-education policy trends. These institutions are the Education Development Centre, institutions of continuing education at universities, the Lithuanian Centre of Non-formal Youth Education and the Lithuanian Children and Youth Centre. Their operational activities are funded by Ministry of Education and Science and Teacher PD voucher. The slight exceptions are institutions of continuing education at universities – they are funded by universities (but again: universities get funding from the Ministry of Education and Science).
Regional level PD providers – regional teacher training centres and private PD providers usually focus their CPD on the needs of the teachers in the region they operate in. Their operational activities are funded by the Municipality and Teacher PD voucher. Being a nationwide public institution, EDC cooperates with regional PD centres by sharing practices, taking part in discussion or working groups.

Consequently, EDC operates in a very classical CPD institutions’ environment.

**II.II Philosophy and Mission**

Due to teacher CPD institutional transformations and EDC emergence as an institution of structural reforms, the centre has a wide mission. The purpose of EDC is to implement national professional development and general education programmes and policies; to provide methodological materials for schools and pre-school, primary and general education teachers; to accredit professional development programmes and monitor their implementation and teachers’ professional growth; to coordinate activities of education advisors (consultants) in the field of ICT, programme evaluation; to provide professional development and other support for specialists, who work with special needs students.

**II.III Networking as a Crucial Issue of a PD Centre**

As a national level PD provider, which is closely linked to education policy implementation, EDC joins and participates in various international
cooperation initiatives coordinated by European SchoolNet, STEM PD Network and others. These initiatives EDC is involved in are take a shape of international project activities. For example in 2016 EDC was partner or coordinator of 8 international projects:

• `STEM capacity building',
• 'European Network of STEM Professional Development Centres',
• 'Scientix 3',
• 'Media and information literacy education',
• 'MENTEP - MENtoring Technology Enhanced Pedagogy',
• 'Innovative Teacher - Motivated Student: Collaborative Problem Solving',
• 'Teachers Professional Competences Common framework' and
• 'M.A.R.C.H. – Make Science Real in Schools'.

Joining international colleagues is an important source of new ideas and a channel to transmit experience and insights to partners abroad.

III Activities

The activities of the Education Development Centre fall into five areas:

• Development and implementation of pre-school, primary, general education content;
• Methodological support for teachers, professional development and coordination of education advisors' (consultants) activities;
• In-service teacher training and quality assurance (evaluation and accreditation of teacher professional development programmes);
• Organization and coordination of expert evaluation of textbooks and other teaching/learning tools;
• Initiation and implementation of education innovations during national and international projects.

IV The Foundation of EDC Activities

The foundation of CPD activities provided by EDC consists of three ideas: development and implementation of curriculum innovation, according to the learning needs of society; development of effective and teacher-oriented PD; development of strategic partnerships and sustainable collaboration networks for innovative, up-to-date CPD. As a result, the most typical CPD offers focus on pedagogical content knowledge transmission for in-service teachers.

Specific Aspects

V Political Dependency

The political dependency of EDC stems directly from the fact that it is affiliate to the Ministry of Education and Science of the Republic of Lithuania. However, it does not necessarily mean that CPD provision solely takes into consideration national education policy guidelines. EDC is independent to design CPD according to teacher community needs, too.

VI Interdependence of Initial Teacher Education and Activities

The main target group of CPD provided by EDC are in-service teachers. Not being a university EDC does not provide courses specifically designed for the future teachers (i.e. students at universities). However, for the last three years EDC has been cooperating with the Ministry of Education and Science in order to provide professional development opportunities and support for young teachers' recent graduates, who started working in schools and who have been working there up to five years.
VII Quality Assurance

All CPD programmes run by EDC are accredited according to professional development programmes' procedure description approved by the Minister of Education and Science. The description defines quality criteria for professional development programmes. Among these are: PD priorities set by the Ministry and developed or acquired competences defined in teacher competence descriptions.

VIII Interdependence of Research and Practice

EDC has formalized cooperation with few universities by signing long-term cooperation agreements; however, in most cases it is a common interest in specific or actual themes and problems that determines the need for short-term cooperation.

Miscellaneous

IX Conclusions and Recommendations

EDC is settled in the PD-providers system as a unique institution, which has undergone a wide organizational consolidation. Being interdependent with the Ministry of Education and Science it is exposed to education policy changes, new initiatives or changing priorities. Main challenges for EDC in the field of professional development are:

• Renewal of a general education curriculum, dissemination and activities related to teacher competence development;
• Implementation of IT in primary education;
• STEM implementation and national STEM network coordination;
• Media and information literacy improvement in schools;
• Integration of financial literacy in schools;
• Professional development related to health, sexuality and preparation to family life education;
• Competences' development for inclusive education;
• Implementation of training courses devoted to updated pre-school curriculum.
1.3 MISSION & CHALLENGES

Change processes
We have to accept that traditions (of these centres in European countries) are very persistent. Of course, the members of the project team have some dreams and recommendations (on the basis of their experiences and scientific insights), but we should be realistic and first of all, thankful, for what is in existence and working. We know that is not possible to find resources in order to establish a new institution as we would like to dream of.

Especially, PD centres of Type 1 are very persistent since – last not least – the government has the authority and right to regulate all the processes. It is much easier to convince colleagues in university centres (Type 2) to adopt one’s ideas, to run some experiments. Also, centres of Type 3 and 4 appear more flexible.

Next we have to state that what should be understood by a PD centre is anchored as beliefs in the mind of many stakeholders. To describe it with other words: It is not easy to change the relevant issues within the centres in our network. We have to tolerate a slow process of adoption.

The dilemma of STEM
A further problem which we had to agree on, is the fact that the landscape with respect to our subject – STEM – is very heterogeneous. There does not exist a single and unique school subject which is called STEM. STEM teaching at schools is often realized by presenting a bundle of different aspects from four independent subjects. We don’t know anything about a stringent STEM education at university.

Nevertheless, all the project partners are very open to STEM. Choosing any subset of the letters S, T, E and M, you will find a centre which is working in the area of the school subjects represented by these letters.

Success Factors
PD centre quality criteria refer to the levels of philosophy, learning organization, resources, networking, and evaluation. These quality criteria are important success factors of these different PD centres and are also found in the Ready-to-use-Guide of O1. These are summarized below.

Philosophy
High quality PD centres are able to influence the professionalization and practice of STEM teaching. Thus, high quality PD centres explicitly provide their philosophy.

A clear and transparent philosophy statement takes core issues into account, for example:

- What is the PD centres’ STEM identity? For example: interdisciplinarity, scientific inquiry and connection with real life.
- What does the PD centre want to achieve in teacher PD? For example: teachers becoming experts in their everyday teaching.
- What educational standards and requirements does the PD centre follow? For example, going in line with national teacher training standards.
- What kind of teachers’ professionalization is aimed at? For example: teachers need to improve their competencies in STEM education, by changing their attitudes, improving their skills and broaden their knowledge.
High quality PD centres’ philosophy is reflected by their respective STEM PD curriculum. By developing each curriculum, PD centres highlight and prioritize their respective philosophy.

This includes for example:

- Balancing theory and practice to support teachers’ learning.
- Addressing many and diverse aspects of teachers’ competencies and experiences.
- Being contextual and flexible (e.g., addressing the needs of teachers, students, industry and business).
- Providing structured and progressive content.
- Meeting different expectations of stakeholder (e.g. students, teachers, PD providers).
- Having a research-based background.
- Using different learning strategies (e.g., learning from experience, learning from experts).

Learning Organization

High quality PD centres constantly reflect and enhance the way they work; they act as learning organizations, which are open to innovations, continuous learning and improvement. PD centres aim at good balance between being providers of relevant knowledge and being open and flexible learners themselves. In this way, PD centres ensure two-way communication: developing knowledge as well as integrating experiences and ideas from outside. As learning organisations, PD centres analyse and react on STEM teachers’ and schools’ needs and challenges. They adapt themselves according to constantly changing contexts.

Developments of high quality PD centres are evidence-based and informed by national and international developments and practices. Communication and cooperation with relevant environments are crucial to ensure high quality STEM PD.

As a learning organization, PD centres in particular provide the following features:

- providing resources for critically reflect on PD centres’ development
- solving problems (e.g., regarding content or organisational issues) systematically;
- experimenting with new approaches;
- learning from experience;
- learning from others (partners and target groups);
- transferring and communicating knowledge.

Resources

For high quality PD centres, it is crucial to have relevant resources. In particular, professional teacher educators demonstrate positive attitudes towards their work, have social-emotional skills and high standards of professional ethics. Expertise in STEM field and didactics, as well as adult education is of great importance. Teacher educators have a clear vision of their work, and use it as a benchmark to reflect on the outcomes of their work and identify the needs for further professional development. PD centres support such culture of reflective learning.

High quality PD centres are able to provide STEM specific materials like

- guidelines (e.g., general information about the structure, content and aims of PD offers; or specific information about the structure, content and aims of certain materials)
- learning environments (e.g., for teachers, including information concerning added value, target group, didactical comments, aso; or for PD providers, including information concerning theoretical models, empirical background, aso.)
- tools and equipment (e.g. technical equipment, rooms, software, aso.)

**Cooperation**
High quality PD centres ensure cooperation and learning possibilities both within and beyond the centre. They cooperate with partners (university, industry, business, NGO, etc.) to raise awareness regarding STEM issues and knowledge, in particular in connection with real life situations and applications. Networking with other STEM PD centres (internationally or nationally) testifies the centres’ openness to different perspectives and innovations; in particular, the exchange of knowledge and experiences between PD centres creates learning opportunities for each PD centre and fosters further development.

High quality PD centres stimulate and foster cooperation between participants (e.g., teachers, principals, aso.). Moreover, they support and encourage participants’ professional networking with relevant environments. By providing rich opportunities for collaborative reflection and discussion (e.g., of teachers’ practice, students’ work, or other artefacts), high quality STEM PD empowers and encourages participants to collaborate in learning, which represents a core feature of effective learning and development processes.

High quality PD centres create opportunities where relevant stakeholders (e.g. schools, policy, teachers, academia, aso.) can meet and exchange knowledge and expertise.

**Evaluation**
Evaluation is connected to processes of improvement. High quality PD centres systematically assess their outcomes and impact, using by evaluation tools and differentiating various levels

- Specific feedback: PD centres get detailed feedback regarding specific PD offers by using practical instruments and methods (e.g. surveys or interviews). Evaluation’s findings and insights inform further development and improvement of specific PD offers.
- General feedback: PD centre get sophisticated feedback regarding their general offers. Typically, these evaluations include both qualitative and quantitative methods as well as triangulation (e.g. during conferences or fairs) to get reliable and valid data.

To support evaluation processes, high quality PD centres develop and offer various ready-to-use instruments and methods that focus on different aspects. Since high quality PD centres are interested in further developing their practice, they come with an intrinsic motivation to evaluate their work.

Next to the quality criteria there are further aspects for a successful centre:
• Present on international conferences; lighthouse within the international scene
• Support by the education administration within a country
• Prominent research papers
• Attractive for teachers, teacher educators
• Guarantee quality criteria and constant review
• Innovation and applicability
Further missions & activities
Policy-making also play an enormous role for PD centres. On the basis of the questionnaires we could make out different directions, depending on the location and financier of these centres. Roughly we could divide three ranges, which are to be extended however still further.

1. Material strategy: press, newspaper, publishing companies
2. Personal strategy: cooperation with multiplier and qualifiers, professional learning communities (PLC), various societies of teachers
3. Systemic strategy: learned bodies (learned societies), labour unions, education administration

We have also been able to identify various goals of our policy-making, such as being continuously perceived not only by the educational administration in the country, but also for industry and business, having a representative within central boards or having competent EU perspectives.
2. Conclusions & Recommendations

NEW INSIGHTS ON THE PD CENTRES

Since the ERASMUS-Project STEM PD Net leads to a deeper continuous cooperation, we automatically received detailed insights about the various activities in all PD-centres. New variables which were previously not visible in our inspection are becoming gradually obvious.

Thus, we decided to add some more questions in an additional questionnaire and sent it to the interior circle of cooperating PD-centres. We add this questionnaire as an appendix of this document.

Since the answers are partly fragmentary, a numerical evaluation seems not to be illustrative. In addition, it is not productive to lay one’s cards on the table.

1. **Cooperation with learned societies:** As a researcher, we know that learned societies (Fachgesellschaften) are important stakeholders in our discourse. They are in direct contact with many researchers and educators. Learned societies represent important views on the virtual landscape of the researchers, of the development of the discipline, and on major new international developments.

For example, in the United States the American Mathematical Society (AMS) or the London Mathematical Society (LMS) in Great Britain are very influential and no debate could be finished without these learned societies’ extensive comments on the relevant issue. The assemblies of the learned societies are meeting annually and edit newsletter or informal journals.

To be honest, not all learned societies are in direct contact with the players in our scene. It should not be ignored that so far there doesn’t exist a learned society devoted to the subject ‘STEM’. Fortunately, in Germany we have an association of teachers – MNU – which is close to a learned society and reflects the needs of schools, teachers, students and classrooms. This body is cooperating with stakeholders of the research side.

**RECOMMENDATION:** One should start to resp. intensify the cooperation of the centres with these bodies; both sides will profit.

2. **Professional management of a PD centre:** Of course, many of the PD centres are gradually grown structures run by individuals from the STEM scene and have their personal characteristics. Nearly none of the engaged colleagues have been instructed how to run and organize the management of a centre professionally. We don’t know an example where experts counselled the administration of a centre.

We don’t disregard the engagement of many co-workers, but we have to emphasize, that there are large differences with respect to the effectivity of a centre. Of course, you need personal resources to continuously and successfully organize:

- press work for the public
- looking for further promoters and sponsors
- annual plans of events
- talks
- contacts on the international level
- …
RECOMMENDATION: We recommend starting a discussion with organizational consultants.

3. How to identify the actual need for PD-courses? Reflecting the processes on how the titles of PD-courses are established, we realize a large variety of different procedures. Sometimes courses are predetermined by the educational administration, some courses are proposed by influential educators, in few cases there might be an initiative by teachers asking for offering special courses.

We believe that the success of a PD-course is partly influenced by this procedure.

Again, the answers depend heavily on the type of the centre. centres, which are governmentally driven, are mostly acting top-down, whereas in the virtual centres the demand of the classrooms and schools, e.g. thinking bottom up, is the dominant feature.

RECOMMENDATION: We recommend reflecting in a centre that the list of titles is balanced and not primarily decided by a top-down procedure.
Appendices

Appendix 1: Questionnaire 1

STEM PD Net Questionnaire

General information
Information for data usage
Your information will be used for research purposes in the course of the project only. The data will be matched to the various centres and will not be passed on to third parties.

Structure of the questionnaire
Dear members of the network of PD-centres,
we developed this questionnaire to identify and show the differences and similarities of the centres in our network. Therefore, the questionnaire is structured in five parts:

1. Contact information: We need your contact information
2. Structure of the centre: We are interested in the structure of your centre (how did your organization evolve, how does your financial situation look like and which subjects do you focus on).
3. Situation in your country: We would like to connect this knowledge to the educational system of your country.
4. Mission of your centre and your activities: We want to hear more about your activities and missions.
5. Major challenges and best practice-examples: We want to learn from your major challenges and best-practice examples.

The questionnaire includes questions you answer by ticking the brackets or by adding a number. Additionally, you will find the opportunity for open answers in a chart or a cell. You can expand all cells and charts – there is no limit of characters.

Contact information
- Name of the centre:
- Address of the centre:
- Homepage (if existing, also English website):
- Contact person for queries:

Structure of the centre
S1: We would like to know which school subjects are addressed by your centre.
- Which school-subjects are addressed by your centre (please mark with a cross)?
  ( )Science   ( )Technologies   ( )Engineering   ( )Mathematics   ( )other:

S2: We would like to know more about the presence, history and future of your centre. Please tell us the date of the establishment of your centre and since when it exists in this form.
1. Since when does the centre exist?
2. Since about when does it exist in this form?

3. Please mark the expected duration of your centre with a cross:
   ( ) permanently ( ) temporarily, for a certain period of time ( ) unclear
   • If temporary: is an extension possible? ( ) yes ( ) no
   • If temporary: how long is the duration of the centre planned?

4. Is the centre still in a phase of development? ( ) yes ( ) no

5. In which context was the centre developed?

6. Is the centre part of a university? ( ) yes ( ) no
   • If no: please continue with S3

7. Is the centre fully integrated in the university? ( ) yes ( ) no

S3: We would like to know more about the cooperation / collaborations of your centre and how they look like.
1. Are there any additional cooperation / collaborations (actual stable/permanent) with other institutions (e.g. universities, companies, foundations, research institutions, PD-centres, educational authorities etc.)? ( ) yes ( ) no
   • If no: please continue with S4

2. Please mark with whom you cooperate / collaborate:
   ( ) National universities ( ) International universities ( ) Companies ( ) Foundations
   ( ) Research institutions ( ) PD-centres ( ) Educational authorities ( ) other:

3. Please describe briefly up to three cooperation / collaborations which you regard as most important:

S4: We would like to know more roughly about the budget of your centre.
1. Do you have your own budget? ( ) yes ( ) no
   • If no: please continue with S5

2. How much budget (in euro) do you roughly have per year?
   ( ) less than 100,000 ( ) up to 500,000 ( ) up to 1,000,000 ( ) more than 1,000,000

3. Please fill out the chart:

<table>
<thead>
<tr>
<th>Sources of the money</th>
<th>Rough percentage of the whole sum</th>
<th>What is the money spend on?</th>
<th>Rough percentage of the whole sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>University</td>
<td>%</td>
<td>Staff</td>
<td>%</td>
</tr>
<tr>
<td>Educational ministries</td>
<td>%</td>
<td>PD initiatives</td>
<td>%</td>
</tr>
<tr>
<td>Third party funds from the economy</td>
<td>%</td>
<td>Materials (development)</td>
<td>%</td>
</tr>
<tr>
<td>Centre’s intake (participant fees, publishing, …)</td>
<td>%</td>
<td>Other:</td>
<td>%</td>
</tr>
</tbody>
</table>
S5: We would like to know more about the number of your staff.
1. Who works for your centre? Please fill out the chart:

<table>
<thead>
<tr>
<th>Staff of your centre</th>
<th>Number of full time equivalent staff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academics as researcher</td>
<td></td>
</tr>
<tr>
<td>Academics as facilitator</td>
<td></td>
</tr>
<tr>
<td>Non academics</td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
</tr>
</tbody>
</table>

S6: We would like to know more about the role research plays in your centre.
1. Does your centre do research? ( )yes ( )no
   • If no: please continue with S7.
2. Does research play a minor role, an equal or a major role in your centre? ( )minor ( )equal ( )major
3. Is research done by individuals or by groups? ( )individuals ( )groups
4. Please describe how research influences the work of your centre:
5. Please list some references of typical publications of your centre (if they are neither English or German please add keyword about the content of the publications)

S7: We would like to know more about the role PhD-programs play for your centre.
1. Does your centre offer a PhD-program? ( )yes ( )no
   • If no: please continue with Si1.
2. Please give a brief description of your PhD-program.

Situation in your country
Si1: We would like to know more about the existence of Professional Development Centres in your country.
1. Are there further STEM-centres in your country? ( )yes ( )no
   • If no: please continue with Si2
   • If yes: please list exemplary other centres:

<table>
<thead>
<tr>
<th>Name of other centres</th>
<th>Homepage (in English or German) or short description of the centre</th>
</tr>
</thead>
</table>
Si2: We would like to know more about the professional development and education in your country.

1. Please fill out the chart:

<table>
<thead>
<tr>
<th>Profession</th>
<th>Typical education (university degree, vocational training, nothing, ...)</th>
<th>Typically used professional development (regular courses, working in Professional Learning Communities, nothing, ...)</th>
<th>How many of these people do you reach per year (give an estimation) by offering what kind of PD format (e.g. courses, professional learning communities, conferences, materials for lessons, ...)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nursery school teacher</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-service-teacher</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Facilitator for in-service-teacher</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Facilitator for pre-service-teacher</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School-leaders</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Mission of your centre and your activities**

M1: We would like to know more about the mission of your centre.

1. Please tell us about the main goals of your centre:

M2: We would like to know more about the characteristics of your activities.

1. Please describe briefly what main ideas your institution pursues in its offers. (list the three most important ones)

2. In how far are the following types of knowledge covered in your Professional Development-offers (please mark the applicable with a cross and try to give an estimation of their frequency)?

<table>
<thead>
<tr>
<th>Types of knowledge</th>
<th>Percentages of your offers that focus on this type of knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>( ) CK (content knowledge)</td>
<td></td>
</tr>
<tr>
<td>( ) PCK (pedagogical content knowledge)</td>
<td></td>
</tr>
<tr>
<td>( ) PK (pedagogical knowledge)</td>
<td></td>
</tr>
</tbody>
</table>

3. Please list typical activities (e.g. a 3-day long course about chance; a conference for teachers about the teaching of climate, ...):

4. Are the offers always designed by your centre? ( )yes ( )no
   • If yes: please continue with MC1.
   • If no: Please describe who designs your offers (e.g. teachers in cooperation with the centre, ...):
Major challenges and best-practice examples

MC1: We would like to know more about your challenges.
1. Please list major challenges your centre faces:

MC2: We would like to know more about your success.
2. Please list best-practice examples of your centre:
3. Are they documented? ( )yes ( )no
   If yes: Please list where we can find them:

3.2 Appendix 2: Questionnaire 2

QUESTIONNAIRE: The Profiles of the PD-centres
Questionnaire to all project partners to get more details on the top 4 main categories of the first questionnaire.

The questions which answers we would like to know are the following:

- Is there an annual job calendar with regularly upcoming and discussed task?
- What are the standard tasks in your centres?
  - Preparing and running CP courses?
    - What are the precise steps?
    - Who is responsible? Who is the initiator?
    - Who is checking quality standards?
    - What is done in advance for a ‘job’?
    - What is done after the measure resp. job?
  - Reviewing and evaluating jobs for other institutions?
- Is your centre integrated into curriculum discussions and developments?
- Does there exist some private communication between your centre and individuals? Does individual counselling is happening? Often?

- Addressees:
  - Are you addressing students (pupils)?
  - Are you responsible for math resp. science fairs and exhibition?

- Cooperation with learned societies:
  - Are you asked to be present at annual conferences of the learned societies?
  - How intensive is the cooperation with the learned society in your country?

- Support for the employees by the centre its own:
  - ... for the scientific development of the employees?
  - ... to visit international conferences?
  - ... to publish in research papers
  - Is there an internal public discussion of joint scientific papers? Jour fixe?
• Facilities:
  o Do you have internal access to educational journals within your centre? Or do you have to use the library of a university?
  o Business cards of your institution

• Public relations work
  o Chance to introduce yourself and your work
  o Is there an annual report to the outside world of your centre?
  o Invitation to other events
PD centre models: context, mission, structure and activities.
A review of models, challenges and success factors to lead improvements in STEM teacher professional development
IO 5
Information about the report/IO
IO N° 5
Publication date: 25/06/2018

Project Information
Grant no. 2016-1-DE03-KA201-023103
Project title: European Network of STEM Professional Development Centres
Project acronym: STEM PD Net
Start date of project: 01/09/2016
Duration: 36 months
Program: Erasmus+, Key Action 2 (KA2) – Strategic Partnerships

Contact Information
Coordinating Institution: University of Education Freiburg, International Centre for STEM Education (ICSE)
Coordinator: Prof. Dr. Katja Maaß
Project Manager: Elena Schäfer
Lead partner for this report/IO: Prof. Dr. Günter Törner, Joyce Peters-Dasdemir
Website: http://stem-pd-net.eu/

© STEM PD Net project (grant no. 2016-1-DE03-KA201-023103) 2016-2019, lead contributions by University Duisburg-Essen. CC-NC-SA 4.0 license granted.

This document is based on the work within the project European Network of STEM Professional Development Centres (STEM PD Net). Coordination: Prof. Dr. Katja Maaß, International Centre for STEM Education (ICSE) at the University of Education, Freiburg. Partners: University Klagenfurt, Austria; University of Innsbruck, Austria; Institute of Mathematics & Informatics at the Bulgarian Academy of Sciences, Bulgaria; Ljuben Karavelov School, Bulgaria; Texas Instruments Education Technology GmbH, Germany; University of Duisburg-Essen, Germany; Ministry of Education, Culture & Sport, Spain; Education Development Centre, Lithuania; Gymnasium of the President Valdas Adamkus, Lithuania; Linköping University, Sweden; University of Gothenburg, Sweden; Turkish Ministry of National Education, Turkey; Hacettepe University, Turkey.

The project European Network of STEM Professional Development Centres (STEM PD Net) has received co-funding by the Erasmus+ programme of the European Union.

The creation of these resources has been co-funded by the Erasmus+ programme of the European Union under grant no. 2016-1-DE03-KA201-023103. Neither the European Union/European Commission nor the project’s national funding agency PAD are responsible for the content or liable for any losses or damage resulting of the use of these resources.
Contents

Executive Summary .................................................................................................................................. 2

1. Main report .......................................................................................................................................... 3

1.1 PD CENTRES .................................................................................................................................. 3

The different types of centres ........................................................................................................ 3

To summarize our observations ....................................................................................................... 4

1.2 CASE STUDIES ........................................................................................................................ 5

GERMAN CENTRE FOR MATHEMATICS TEACHER EDUCATION (DZLM) ............................................. 6

NATIONAL CENTRE FOR MATHEMATICS EDUCATION (NCM) ............................................................... 13

T3 EUROPE – Teachers Teaching with Technology ........................................................................ 19

LEHRERINNENBILDUNG WEST ........................................................................................................ 22

EDUCATION DEVELOPMENT CENTRE (EDC) .................................................................................. 26

1.3 MISSION & CHALLENGES ........................................................................................................ 31

Change processes ........................................................................................................................... 31

The dilemma of STEM .................................................................................................................... 31

Success Factors .............................................................................................................................. 31

Further missions & activities .......................................................................................................... 34

2. Conclusions & Recommendations ............................................................................................... 35

3. Appendices ..................................................................................................................................... 37

3.1 Appendix 1: Questionnaire 1 ................................................................................................... 37

3.2 Appendix 2: Questionnaire 2 ................................................................................................... 41
Executive Summary

As part of the ERASMUS project European STEM Professional Development (PD) Centre Network (STEM PD Net), we have been working on PD centre models. The main aspects that we have focused on were a review of models, challenges and success factors to lead improvements in STEM teacher professional development. We tried to measure and understand the varieties and commonalities of STEM centres.

All project partners as well as the PD Centres Network partners contributed to a comprehensive information base by completing the questionnaire. The evaluation of the questionnaires brought depth insights into the different PD centre models and approaches in the project partners different countries – any beyond, as members of the PD Centres Network also filled in the questionnaire.

Also, the evaluation impressively illustrated the differences of PD centres exemplary reasons for the establishment of the centres, e.g. improving STEM education, improving professional development of teachers resp. teacher educators resp. teacher training, widening activities and expertizing in research of pedagogies, focusing on instructional and school development, or strengthening coherent teacher education. In completing the questionnaire and considering about the different categories it could also be achieved that the centres became clearer about their own centre model and in this way also support the organizational development of their institution. The whole consortium could also learn a lot from the best-practice examples.

Our compendium is designed to make our results available to you and help you to understand what distinguishes successful STEM PD centres. It is especially important to describe the different possibilities available when setting up a centre for professional development in the STEM area. The compendium will include a structured overview of possibilities of PD centre organization and activities, selected descriptions of PD centres with examples of their activities as well as an analysis of their weaknesses, strengths and challenges, and a review of challenges and recommendations on developing influential PD centres and possibilities to overcome challenges.

To enhance these overviews we added case studies of selected centres which can also be found on the STEM PD Net homepage (http://stem-pd-net.eu/en). These case studies provide us best practice-examples to orientate ourselves for successful centres. These are presented before the missions and challenges, since the five centres exemplify represent the four types and concretize them that the differences have their legitimacy.

When writing the case studies we gained further insights and accordingly another questionnaire. From this we finally gained new insights. At the end of this document, we have placed these new insights and provided them with recommendations.

The Compendium is structured due to the analysis of the questionnaires issued as follows:

- Structure of PD centres and situation in the countries
- 5 Case Studies
- The mission of the centres and major challenges
- Conclusion & Recommendation: New insights on the PD centres
- Appendices: Questionnaires
1. Main report

1.1 PD CENTRES

The different types of centres
Over decades most of the European countries have established governmental PD centres for some school subjects. These centres have to be understood as central educational institutions and their main task was and is to assist and support the official educational politics of the government. In the past, a new curriculum induced a new initiative of in-service training courses for teachers which had to implement the new curriculum. This task was the predominant function of these centres. However, our view was widened by research.

Fortunately, it was understood by the governments in the last twenty years, that continuous professional development of teachers is important issue – independently of an actual change of the curriculum. This development was accompanied by the research side, since ‘teacher change’ and ‘professional development’ gradually turned into new important keywords to which attention has to be devoted. Thus the (new) title ‘Professional Development (PD) centre’ for the traditional centres gradually became in use. Thus, most of the PD centres in our network originate in the old governmental institutions which were responsible for implementation of curriculum.

But there exists also a second type of a PD centre, some of these centres are members and partners in our network. We would like to explain their genesis and their role. In all European countries, teacher education is being held more or less intensively by universities. Sometimes, research focused universities have no faculties of teacher education, but this is not contradicting our assumptions. If a faculty is responsible for teacher education, it is not surprising that the teacher educators are also engaged in research about processes in the classrooms as well as about the role of teachers, e.g. professional development of teachers.

Thus, it is self-evident that these stakeholders at universities are claiming some responsibilities for upgrading teachers at schools. Some of the researchers are handling this task voluntarily, others are bringing in their expertise because of the employment agreement within their faculty. We could prove that different models in European countries exist how to deal with this important interface. We don’t know any investigation about the linkages between university research and the implementation into daily practice within schools where ‘teachers’ and ‘students’ are the interesting stakeholders. Thus, it is only a small step to establish a university institution which calls itself a PD centre. Obviously, this type has different characteristics than the PD centres described above.

Finally a third type of a PD centre has been established by initiatives of firms and companies having interest to contribute to the educational system which is seen as a market, e.g. Texas Instrument financed the important PD initiative T3 (teachers teaching technology).

Last no least, non-governmental organizations (NGO) have to be regarded also as a stakeholder. Money is provided in areas where experts are recognizing deficits within the educational framework. The national institute for teacher education within mathematics in Germany, namely German Centre for Mathematics Teacher Education (DZLM), may serve as a classical example. The educational politics in
Germany is fragmented since the sixteen provinces (so called ‘Bundesländer’) own the authority to regulate curriculum. The foundation of Telekom Deutschland was free to establish a national centre which could be designed by a different political stakeholder.

To summarize our observations

In Europe there exist four different types of centres:

Type 1) PD centres run by educational institutions in the charge of the government. The government or related institutions financing the PD centres. Thus, on the other side, the government is determining the various tasks and has the right to appoint persons.

Type 2) Universities are stakeholder of teacher education, thus they are claiming or are imposed to bring in their expertise and to run in-service teacher courses. These continuous duties have lead on to the establishing of university PD centres.

Type 3) Education can also be be seen as a market, publication companies, companies producing software or materials have an interest to intervene into this market and they decided to run their own PD centres. T3 of Texas Instruments is a good example.

Type 4) It is not surprising that non-governmental organization have an interest to bring in their expertise, often they are able to act where official institutions have to accept barriers. In Germany, for example, education politics is authorized by the 16 provinces (so-called ‘Bundesländer’). Thus, it is not very easy to establish a national institution which previously finds the consent of 16 partners. A NGO has the capacity to build on such an institution as long as it is paying for his/her endeavor.

In our case studies, we described five institutions in details which are of different type.

- DZLM (Berlin, Germany) – German Centre for Mathematics Teacher Education (Type 4)
- NCM (Gothenburg, Sweden) – National Centre for Mathematics Education (Type 1)
- T3 Europe – Teachers Teaching with Technology (Type 3)
- Verbund LEHRERINNENBILDUNG WEST (Innsbruck, Austria) – RECC Biologie, RECC Mathematik (Type 2)
- UPC (Vilnius, Lithuania) – Education Development Centre (EDC) (Type 1)

It is self-evident, that the four different types are differing enormously with respect to the variables.

- Identity of the centre and the self-conception of its employees
- Basic philosophies of its acting
- Internal flexibility
  - Balancing theory and practice to support teachers’ learning.
  - Addressing many and diverse aspects of teachers’ competencies and experiences.
  - Being contextual and flexible (e.g., addressing the needs of teachers, students, industry and business).
- ‘Reach of action’ towards politics
- Dependency resp. independency with respect to governmental commitments
- Professionality of internal management processes
- Nearness resp. distance to research; the role of research for the work within the centre
- International visibility
- Intensity and type of cooperation with other stakeholders; the importance of interdisciplinarity
• Financial resources

The distinction is also due to various motives of the establishing like

• improving STEM education
• improving professional development of teachers resp. teacher educators resp. teacher training
• supporting physics teaching at all levels
• widening activities and expertizing in research of pedagogies
• focusing on instructional and school development
• implementing educational school subject content, inquiry based mathematics and computer science education, teacher competence development
• strengthening coherent teacher education
• Networking computer science technology

1.2 CASE STUDIES

We added case studies as mentioned above of selected centres. These case studies provide us best practice-examples to orientate ourselves for successful centres and concretize them that the differences have their legitimacy.

The case studies were created separately and are created below in the following order:

First, the DZLM of the type 4 is presented. Then follows an overview of the NCM (type 1) and the T3 (type 3). Afterwards the centre will be shown from Western Austria (type 2) and last but not least the centre EDC (type 1).
We refer to the presentation of DZLM on its website (https://dzlm.de/dzlm/international-visitors). Parts of the following text are cited from an English version of its homepage and modified according to our categories:

I The DZLM as a German Institution

I.I The Starting Point

The DZLM was initiated and is funded by the Deutsche Telekom Stiftung (www.telekom-stiftung.de), a corporate foundation centred on improving STEM-education. On the recommendation of a panel of experts for Mathematics across the Educational Chain, the foundation created the DZLM in 2011 as a nationwide centre aiming at general quality standards for teacher training. The idea of such an institution was mainly influenced by the characteristics of National Centre for Excellence in the Teaching of Mathematics (NCETM) in London which was run by the prominent mathematics educator Celia Hoyles at that time. In a country where each state has its own politically driven philosophy on professional development, this was a totally new approach.

I.II DZLM Embedded into the Heterogeneous Educational System of Germany

Thus, the centre is an institution completely independent within the highly complex framework of the German educational system. It should be annotated that Germany consists of 16 federal states which are responsible for the educational policy in their state. Federal state laws regulate education in general, as well as teacher education in Germany. This autonomy results in a heterogeneity in the systems of further qualification of teachers and educators. The differences between federal states are challenging for DZLM, but DZLM also considers them to be a chance: The great variety of successful formats and rich content in continuous professional development courses is thus bundled by the German Centre for Mathematics Teacher Education. To disseminate the concepts, materials and courses at a large scale and to ensure their practicability for the target group, the DZLM cooperates closely with the education authorities in the different federal states, strengthened by the help of specific local coordinators and federal delegates from education policy. As a consequence, DZLM can draw on the experience of the partners in teaching and research, in the didactics of mathematics and in pedagogy.

Further, the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany (KMK) takes over a coordinating role.

DZLM is successfully in establishing in the landscape of professional development in Germany and it is well-known to all stakeholders. However, DZLM has not reached a permanent status. It is not a trivial question how to anchor and finance an institution like DZLM in the Federal Republic Germany in the future. At the moment, various negations are underway to reach a compromise in 2019. The problems are described in Section 8.
I.III The Constitutive Partners, the Personnel and the Budget

At the moment members of eight universities are involved in the consortium: Humboldt-University Berlin, Free University Berlin, Ruhr-University Bochum, Technical University Dortmund, University Duisburg-Essen, University of Education Freiburg, Paderborn University and University of Potsdam. The main office resides at the Humboldt-University. DZLM succeeded in having contracts with these universities regulating the cooperation.

On the basis of such a construction, DZLM owns a wide panel of various experts in professional development, from primary schools to secondary schools, from mathematics to education theory at the different residences of their universities in Germany with many different research interests. Since the professors are further engaged at their universities on the basis of their regular contracts, the work is divided between them and many young scientists or seconded teachers. Most of them are PhD candidates…, often researching issues of professional development.

Only travel expenses of the professors and the expenses for courses are paid by DZLM, thus round about 60 % of 1.2 million euros per year is used for internal financing.

It is self-evident, that DZLM cooperates with further partners in the fields of mathematics, mathematics education and educational research as well as the educational institutes of the different federal states.

Figure 1: The embedding of DZLM
II Philosophy, Mission and Networking

II.I Traditions of PD Centres in Germany

It is easy to provide an answer: There is no tradition of mathematics PD centres: however, over many decades, various cooperation (of different insensitivities) have been developed regionally with institutions of the educational systems, but none has ever reached a global (a country-wide) ‘charisma’.

This maybe explained by the federal structure of the German educational systems with authority in the specific ‘Bundesländer’. Next, we would like to annotate that the learned societies of physics and chemistry have a lot of resources to pay for professional development and they are doing it since companies and firms are existing; this is not true for mathematics since there does not exist a mathematical industry and last not least there was no tradition built up by the German mathematical society. Note that only a small percentage of teachers are members of mathematical society, differently to the situation in the former Eastern bloc.

II.II Philosophy and Mission

It was decisive that a ‘neutral’ stakeholder, namely the Deutsche Telekom foundation affine to mathematics, has taken over the responsibility. And again the Deutsche Telekom Stiftung set the specific well-defined objectives for the centre for which it was willing to pay. Both, the universities and all other partners involved in the German Centre for Mathematics Teacher Education have a common mission:

- To accompany the professional development of mathematics teachers during their whole career.

Since it is impossible to address each mathematics teachers in a country with more than 80 million inhabitants and more than 100.000 mathematics teachers, we have to restrict our mission to teacher instructors (multipliers). DZLM follows a trend that was formerly accentuated by the group of Katja Maas at Freiburg, namely Educating the Educators.

The continuous professional development (CPD) courses, concepts and materials follow a competence framework and design guidelines according to the latest research results in teacher education. Also, comparable concepts for the support and the securing of early education in mathematics are developed. These concepts result in CPD courses for kindergarten and elementary educators.

II.III Networking as a Crucial Issue of a PD Centre

It is an important objective to create networks between many different types of partners: teachers, colleagues, institutions and societies wherever possible. Thus, we network on a national and international scale through conferences, institutional cooperation and the creation of regional branches:

- Cooperation between educational and government institutions or ministries from different German federal states
- Creation of a web portal offering information, material for professional development and interactive teaching environments
- Inclusion of further education offerings from other people, projects or institutions through integration or linking

Research reports in literature prove that isolated initiatives are in general not successful, mathematics educators need various partners in different systems, they need friends. DZLM knows that networking between various levels promotes professionalism (see the figure on page 2). These initiatives are indispensable. DZLM does not like to be regarded as a competitor. In a governmental system we would not have a chance to win.
DZLM's activities are in line with a coherent concept of mathematics education from kindergarten and elementary education to upper secondary level that includes diagnosis and advancement of students' learning processes in mathematics.

The DZLM is interested in being a prominent member of the European Network of STEM Professional Development Centres.

III Activities

The DZLM's fields of action are:

- topic-specific (mathematics) and practice-oriented;
- research-based, and seek to gain and share insights;
- networked throughout school levels.

The activities of the German Centre for Mathematics Teacher Education can be structured in three main strands:

Certified Qualification Measures:
- Creation of a nationwide master course for teacher educators
- Subject-specific and didactical qualification of teacher educators particularly for professional development
- Further qualification of out-of-field teachers
- Qualification events and courses for teachers and elementary educators

Research in Teacher Education and Professionalization:
- Evaluation of activities of the German Centre for Mathematics Teacher Education and of other agencies
- Research in the effectivity of professional development courses and publication of the results on an international level

Research-based design of the quality framework (theoretical basis, design guidelines and competence framework)

- Initiation and financial support of professional learning communities (PLC) for peer coaching and competence development

Development of Material and Concepts:
- Development of material used by teacher educators in CPD courses
- Development of material used by teachers and elementary educators for self-teaching
- Development of information material, videos and flyers
- Joint development of concepts with teacher education institutes and ministries in the German federal states

IV The Theoretical Framework

The theoretical framework constitutes the foundation of its activities and builds upon theory and is evidence based.

- A competence model,
- a research and development agenda and design guidelines

have been derived from this and serve as a basis for the actual continuous professional development courses. All activities are monitored for quality with a systematic evaluation by means of transparent criteria. A subdivision within the centres is responsible for coordinating and monitoring design-based research around the courses.

Research on professional development is a central part of the agenda of DZLM, especially the PhD-graduation and qualification of young scientists providing also an international auditorium.
Specific Aspects

V Political Dependency

Since DZLM is actually not a part of the German educational system and is not paid by government, it is of course politically independent. Using a metaphor, DZLM is thus a further provider – and not to be ignored – a further competitor in the market of professional development. Thus, DZLM is free to set up its own norms.

On the one hand, this independence can be seen as an advantage: DZLM may experiment, may generate its own patterns and may follow new tracks.

On the other hand, having no political power behind it, independence is also a disadvantage. So the institution knows that it has to downplay its role and should seek for cooperation. Meanwhile, this role has been practised and accepted. Many courses are run beyond a label DZLM & xy or xy & DZLM.

VI Interdependence of Initial Teacher Education and DZLM Activities

The German Teacher education system consists of three consecutive levels. Firstly, there is the teacher education at university and in the most 'Bundesländer' the university curricula are being subordinate to different ministries, the ministry for academic and sciences on one hand, the ministry for education and schools on the opposite side.

After graduating from university the prospective have to go into a preparatory service for 18 months.

Actually, there is almost no cooperation between the persons in these virtual institutions and the faculties at university.

Having obtained a teacher position at school, the (novice) teachers are now in front of their classrooms. That is the first time that DZLM might address these teachers within the complicated role as novice teachers. One may regard this process as new and substantial, whereas in older times professional development has been seen as an upgrade after several years of service.

Thus, DZLM propagate that professional development initiatives should start as early as possible. Next, we would like to make professional development initiatives also as self-evident as possible. Thus cooperation at the moment highly depends on the program offered by DZLM.

VII Quality Assurance

As mentioned before using design-based research, DZLM is trying to influence the design of any course in advance. DZLM-members conduct the courses themselves or work together with experienced partners in the federal states, with whom they develop the courses together or make sure their concepts are in line with DZLM-standards and goals.

Next, after intensive discussions DZLM has set up specific position papers, namely

- a competence model and
- design guidelines.

These documents serve as a basis for the actual continuous professional development courses and are continuously revised according to new research and practice experiences. All activities are monitored for quality with a systematic evaluation by means of transparent criteria.

VIII Interdependence of Research and Practice – a Balance Act

Nevertheless, having accompanied the development of DZLM for many years and being at the same time also involved in the international research domain of professional development, the author has often posed the question of what is really sustainable. We should not ignore: DZLM consists of highly qualified persons from
universities and only partly experienced teacher instructors.

To be honest, it is not easy to guarantee that professional development is successful. Firstly, we should accept that teachers, their classrooms and their students live in a world which is disjoint from our field of experiences, the world of universities, the world of research projects. Next, we should reflect how we can bridge between these two strands. For the author, it is extremely difficult to balance between research and practice and that is an actual (hidden) struggle at DZLM.

To run courses for teachers and teacher instructors is not very deserving in the university world, a professor will not be honoured through such initiatives when he/she applies for a new position. Persons at a university will be measured by the amount of research money which they have achieved in the past. Numbers of publications in referred journals are decisive; however, teachers normally have no access to this literature and no time to study them.

On the other hand, teachers at schools are in most cases reserved towards what is offered as the latest research results by university teachers. They have often experienced that the worldviews of researchers about classroom are far beyond from being adequate. Thus, we need solutions balancing between practice and research while serving for the DZLM.

What was described for the individuals is also valid for the ranking of the whole institution DZLM. Is DZLM an institution for research or for generating materials and course? Yes and no, DZLM has to play both roles, but also sees this as one of its unique characteristics compared to other institutions.

Miscellaneous

IX Conclusions and Recommendations

IX.I The Role of Learned Societies

Since DZLM only addresses mathematics teachers, there are only two learned societies which should cooperate. The centre has strong relations to the

- German Mathematical Society (DMV) as well as to the
- German Mathematics Education Society (GDM) and

DZLM is usually present at their annual conferences and supports in particular any activity which is run on the `Teachers’ day’. Some members of DZLM also work within joint commissions.

IX.II Networking; Informal Education

Since DZLM does not address the individual teacher, but teacher educators, the link links are not very strong to informal activities of the communities of teachers. However, if there are requests DZLM would not refuse its collaboration, e.g. seeking for experts accompanying professional learning groups (PLG).

IX.III Diversity of PD Centres: Culture, International Relations

DZLM is so far not a permanent institution, thus its highest priority is actually given to efforts which guarantee the permanent existence. Thus, the STEM initiative in general plays a minor role since resources are limited.

IX.IV Visions

The predominant vision: DZLM will become a permanent institution, financed by a governmental system and will contribute to a development of mathematics all over the German teachers’ culture.
IX.V Publications

Here you can find international publications by DZLM members. A complete list of publications in German and English is available https://dzlm.de/dzlm/international-visitors/publications
I The NCM as a Swedish Institution

I.I The Beginning

In 1999 the Swedish government decided to establish a National Resource Centre for Mathematics Education at Göteborg University (UGOT) and reserved some funding for that purpose. The centre would coordinate, support, develop and implement the contributions which promote Swedish mathematics education from pre-school to university college.

The centre also utilizes the experiences and the knowledge base evolving within the framework of the Nämnaren project which started as a journal for mathematics education in 1974. After years of planning, the first issue of a second journal, Nordic Journal for Research in Mathematics Education, NOMAD, was launched in the fall of 1993.

Thus, the centre was developed based on a long tradition of in-service training of mathematics teachers in Sweden.

I.II The Embeddedness

NCM is the Swedish National Resource Centre for Mathematics. Its main task is to support the development of Swedish mathematics education. It is one of a number of centres for different school subjects established by the government over the last 15 years. NCM does not come under the auspices of any state authority, but is an independent body at Göteborg University.

University of Göteborg is a large higher education institution in Sweden. One of many profile areas is knowledge formation and learning, where teacher education plays an important part. The university offers the broadest range of teacher education in Sweden in terms of available programmes and subjects.

I.III The Constitutive Partners, the Personal and Budget

UGOT hosts the Swedish National Centre for Mathematics Education. The centre is commissioned and financed by the Swedish government with the mission to coordinate, support, develop, carry out and follow up initiatives promoting Swedish mathematics education in pre-school, school and adult education. NCM is also specifically expected to stimulate and disseminate research in mathematics education in Sweden.

It is self-evident, that NCM cooperates with further partners in the fields of mathematics, mathematics education and educational research as well as the ministry of education.

The most important cooperation and collaboration is with the Swedish Agency of Education (the governmental authority responsible for school...
development, curricula etc. in Sweden. NCM also collaborates with other PD-Centres, including the Norwegian Centre for Mathematics Education. Not to forget with several universities in Sweden, to some extent through their specific centres for in-service training of teachers.

NCM employs six academics as facilitator and one as researcher, three non-academics as well as another employee (75% of full employed). The research is done individual and play a minor role for the NCM.

<table>
<thead>
<tr>
<th>What is the money spend for?</th>
<th>Rough percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staff</td>
<td>60%</td>
</tr>
<tr>
<td>Materials (development)</td>
<td>13%</td>
</tr>
<tr>
<td>Other</td>
<td>27%</td>
</tr>
</tbody>
</table>

Half of the funding comes from the third party funding. The other half comes from the educational ministries as well as centre’s intake (publishing, ...).

Thus, the centre has a budget of more than 1 million euros per year.

II Philosophy, Mission and Networking

II.1 Target Group of NCM

Nursery school and in-service teacher with a University degree use local and regional conferences as a PD. Those conferences are mostly one day, working in professional learning communities and regular courses. NCM reaches by year about 500 nursery schools and 1000 in-service teachers. However, through the website and materials developed at the centre, they reach a much larger group.

Pre-service training of teachers is not a goal for NCM. The materials are however widely used in pre-service training of teachers and they facilitate a yearly conference for pre-service teacher educators in mathematics. 2017 approximately 60 educators participated in the conference.

Also school-leaders (which need a university-degree and school-leader program) are not a primary target group for the centre. In some development projects school-leaders are included. During the large scale national PD-project for mathematics education 2012-2016, NCM was responsible for a program for school-leaders. Over the whole period they reached almost 3000 school-leaders.

Varying, in-service training is done by universities, but also by a variety of private initiatives. Thus, this group isn't a goal for NCM.

II.2 Philosophy and Mission

The mission of the centre is to coordinate, support, develop, carry out and follow up initiatives promoting Swedish mathematics education in pre-school, school and adult education. Specifically, NCM is commissioned to stimulate and disseminate research in mathematics education in Sweden.

Specific Aspects

III Characteristics of NCM Activities

III.1 Main Ideas

The NCM is working on all sorts of ideas related to teaching and learning mathematics in school, and it is difficult to pinpoint the most important ones. However, trying to list the activities of NCM results in three main strands:

Teaching Number and Problem Solving:

They have over the years had a fairly strong focus on the teaching of number from pre-school all through compulsory school. This is based on the fundamental role of understanding number in order to learn mathematics. Problem solving is another important theme (of course). One example of the efforts in this area is the work with Cangarou sans Frontiers/Kangaroos without
borders, which is an international competition distributing challenging problems to all students. The project has a number of different 'classes' for students of different ages. Approximately 150000 students participate in Sweden each year.

Courses, conferences and other PD activities:

Another important idea is to give teachers concrete suggestions for activities in the classroom, which are based on fundamental goals and principles for mathematics teaching and learning. This idea influences strongly the efforts to produce materials that are published in their books and journals, and the rich material published on the website of NCM. This idea also influences their planning of courses, conferences and other direct PD activities. NCM finds it important that teacher try out activities and that they gain experience using different approaches in the classroom. This is an important key to effective professional development. One particular area which the centre has been promoting is the use of hands-on materials in the teaching and learning of mathematics.

Research in Teacher Education and Professionalization:

A third important idea that highly influences the priorities of the centre is the spreading of relevant research in mathematics education, transformed into a useful form for teachers. But also (and equally important) spreading of best-practice and praxis-related knowledge developed by teachers. Many of NCM-publications are characterized by a mixture of voices, both researchers and practitioners, presenting important and interesting lessons learned about teaching mathematics which are relevant to teachers.

The PD-offers are 100% focused on the pedagogical content knowledge (PCK).

III.II NCM Activities

The typical activities of the Swedish National Centre for Mathematics Education fall into the follow areas:

- Half-day course for teachers about hands-on activities in mathematics: Groups of teachers come to the mathematics workshop and are given an introduction to ideas behind using manipulatives and are offered the opportunity to test some activities.
- Municipalities arranging a series of half-day or whole day meetings for their teachers, asking NCM to contribute in planning and executing.
- Conferences (mostly half day) for teachers explaining, exemplifying and encouraging the use of materials produced by NCM.

IV Quality Assurance

Among those working at NCM, there are people with experience from the national school curriculum, syllabus and test development work, national and international assessment and conference activities, national and local research and competence development projects. Also people with knowledge of Information Communication Technology (ICT) and distance learning, teacher training and supplementary education, text book production for both teachers and students, work in pre-school, pre-school classes, all levels of the nine-year compulsory school, upper secondary school and as remedial teachers. In addition, there are researchers in mathematics and mathematics education.

They are responsible for and participate in various activities and projects such as

- Publication of the magazines Nämnaren and NOMAD
- Publication literature for teacher training
- Participation and organization of seminars, courses and conferences
• Operation and development of several websites.

All activities are monitored for quality with a systematic evaluation by means of transparent criteria.

V Best-Practice Examples

Three examples of best-practice that the NCM-Centre has been working with:

Important aspects of learning numbers:
They have produced a book together with the Australian researcher Alistair McIntosh which describes important aspects of learning about number in grades 1-10, including diagnostic tests for each year. They also give short courses in how to use the book and how to lead others in using the book. The book is frequently used in many schools in Sweden and has been a huge success.

Teaching material for pre-school class:
NCM has also developed a teaching material for pre-school class, i.e. school for six-year old children in Sweden which is a bridge between pre-school and school. For this they have material met with many teachers to introduce the ideas in the material and also leading a network of teachers who use the material and who lead colleagues in using the material.

The pre-school project they are working with was thoroughly investigated in the developmental phase and they are currently working on a book describing the project more deeply. This book will only be published in Swedish. There is however one publication in English about this project (http://ncm.egu.se/media/smdf/Published/No10_Madif9/159168-Sterner_Helenius.pdf).

The boost for mathematics:
The centre has been deeply involved in the large-scale national professional development project for all teachers of mathematics ('The boost for mathematics'), which reached a majority of Swedish mathematics teachers in 2012-2016. The project continues and new modules are developed and publish on a web-portal run by the Swedish National Agency of Education.

The 'Boost for mathematics' project has been extensively evaluated and there seem to be a lot of positive effects so far. The long-term effects remain to be investigated. The publications are in Swedish, and there is very little published in other languages. One of the Swedish publications (https://www.skolverket.se/publikationer?id=3706) is an evaluation made by researchers in mathematics education at Ume University.

A more local study of the effects of the project (and another local project) on student learning was recently published:


Currently NCM is developing modules for Coding and mathematics and Special education and mathematics.

VI Interdependence of Research

Research has had an important role in the centre as individual projects and as a foundation for activities and projects at the centre, but not so much as a commitment for the centre as a whole. Reviews of research have of course played a significant role, but not so much empirical research first hand. However, recently the centre has been engaged in developmental projects with a clear research agenda.

VII Conclusions and Recommendations

VII.I Major Challenges

There are different ways of looking at challenges. One type of challenge concerns factors that limit our possibilities to make a difference for the
teaching and learning of mathematics. One such factor concerns the often short-term character of projects. NCM wish to engage in more long-term, sustainable efforts of professional development. Another factor is the financial situation, which makes it difficult to initiate and run the kind of projects that could make a difference.

Another type of challenges concern the areas where professional development is most needed and perhaps most hard to achieve. NCM is currently involved in planning for a project that will address two of these challenges: developing the confidence and knowledge in mathematics for teachers in primary school (which is a pre-requisite for doing a lot of the teaching that we know can make a difference) and developing structures where teachers efforts of developing mathematics education is supported by school-leaders and policy makers in a sustainable way.

VII.II Diversity of PD Centres in Sweden

In Sweden are further STEM Centres next to NCM. But not with the specific focus for mathematics education. To name but a few: (We refer to the presentation of the Centres within on their website.)

The National Resource Centre for Chemistry Teachers (KRC) [http://www.krc.su.se/page.php?pid=140]

In June 1994 Kemilärarnas Resurscentrum, KRC got an assignment from the Swedish government to start a Centre supporting activities of chemistry teachers in Swedish compulsory and upper-secondary schools. The general aim of the Centre is to promote and stimulate interesting and up-to-date teaching of chemistry in Swedish schools. The Centre is supported by Stockholm University.

Centre for School Technology Education (CETIS) [https://liu.se/cetis/english/index_eng.shtml]

The Swedish National Centre for School Technology Education, CETIS, at Linköping University started in 1993. In 1996, the government made CETIS a national centre. The main aim of the Centre is, in collaboration with teachers, teacher-trainers, and representatives for industry etc., to develop technology education in schools.

National Resource Centre for Physics Education (NRCF) [http://www.fysik.org/english/]

The National Resource Centre for Physics Education located at Lund university is aimed at being a resource for teachers from preschool to upper secondary school (high school). The aim is to inspire and stimulate the development of physics education and to give teachers the opportunity to further studies of physics.

National Centre for Science and Technology’s Didactic (NAT DID) [https://liu.se/forskning/natdid]

One of the new Centres is the national Centre for science and technology didactic. The aim of this is that teachers should be able to translate subject didactic research into practice and thereby let the school rest on a scientific basis. NATDID was established after a government decision in February 2014 and is located at Linköping University.

As can be seen, the founding is usually associated with the decision of the Swedish government. But it suggets itself that there is a need for networking and exchange.

VII.III Publications

Some highlighted publications are


- *Förstå och använda tal* [Understand and use numbers]. A guide through teaching about number throughout compulsory
school, including diagnostic tests intended for formative use in each school year.

- *Blå strävor* [Blue aspirations]. A collection of activities specifically designed for use in mathematics education for students with learning disabilities.

Here you can find publications by NCM members [http://ncm.gu.se/publikationer](http://ncm.gu.se/publikationer)
This case study has been written in collaboration with Oliver Wagener and Ian Galloway.

I Philosophy

Frank Demanna and Bert Waits started T3, Teachers Teaching with Technology, in 1986. The T3 philosophy is exemplified by a quote from Bert Waits in 2000,

• Some Knowledge and Skills become more important because technology requires it.
• Some Knowledge and Skills become less important because technology replaces it.
• Some Knowledge and Skills become possible because technology allows it.

II Traditions of STEM PD centres

T3 has arisen from a grass roots drive to find better ways to teach mathematics. Its vision statement being:

Technology has changed the mathematics and science classroom, and its impact will continue to grow. Technology provides the opportunity for all students to be active learners as they are afforded the chance to explore and investigate what they have learned in the classroom. When used effectively by a well-trained teacher, technology supports the learning of mathematics and science students, enhancing rather than degrading their skills. Technology provides value as an efficient means of analysing data and instantly seeing the results. It provides opportunities for further exploration.

T3 refers to this bridge to learning and understanding as The Power of Visualisation. This has evolved to encompass science as well as mathematics. T3 today regularly brings mathematics and science teachers to discuss content and pedagogy. T3 Europe is part of this tradition.

III A survey of STEM PD centres

T3 Europe is composed of 12 countries each with its own website and all linked to the umbrella site of T3 Europe. Funding for all the activities is derived from Texas Instruments (TI) who as owns the T3 logo. The result is a symbiotic relationship between T3 and TI in which TI consults T3 to better understand how to reach policy makers and T3 consults TI during product development. The common language when meeting as T3 Europe is English. Each country is self-regulated and devises its own programme of activity. Every two years T3 Europe organises a conference by invitation, Sharing Inspiration, held in a European capital city.

IV Foci and activities of STEM PD centres: consultancy, PD provision, curriculum and content development.

Sharing Inspiration is about

• providing quality professional development that enables the mathematics and science educator to
be successful in the classroom through the appropriate use of technology;
• developing state-of-the-art classroom pedagogy or didactics and sharing it with our peers both nationally, within our T³ country organization and internationally as T³ Europe
• sharing expertise in training, educational curricula and exam development;
• sharing this expertise with Ministries of Education, curriculum development and exam bodies, public and private pre- and in-service professional development organizations, pedagogical research institutions, textbook publishers and other content providers

we seek

• to identify common elements across European STEM curricula and teaching methodologies.
• to promote inquiry-based learning through the use of real-world applications and data collection devices for students aged 10-19.
• to encourage a balanced approach combining the use of graphing and other technologies along with mental skills and paper and pencil skills to support STEM curricula.
• to influence the content of STEM curricula and students' skills through demonstrating the power of technology to accelerate student cognition.

Each national T³ organisation supports these aims but will use its own networks and methods of working to achieve them.

Specific Aspects

V Political dependency

T³ Europe is politically independent but seeks the ability to cooperate with political administrations. By its very nature the use of technology within the classroom and the examination system is often rejected, not only by politicians but by society at large. By sharing expertise with Ministries of Education, curriculum development and exam bodies, public and private pre- and in-service professional development organizations, pedagogical research institutions, textbook publishers and other content providers, T³ Europe is working towards a more equitable landscape.

VI Interdependence of initial Teacher Education and STEM centre PD activity

Activity is frequently integrated into ITE programmes, and in some institutions this is systematic. In general there is no interdependence and any activity only serves to make trainee teachers aware that such technology exists and has the potential to be useful in the classroom.

VII Quality assurance

T³ Europe has no formal process of assuring quality. This does not mean that it is ignored, quite the contrary, the organisation is always examining its own protocols and content with a view to improving.

All website content for example is peer-reviewed, PD providers themselves have undergone extensive peer observation and this information is fed back to organisers and website managers.

T³ trainers do use evaluation sheets and the whole network of T³ members is looking at impact back in the classroom on an ongoing basis. This never stops and is formally recorded through the use of focus groups conducted by Texas Instruments developers at international conferences. In this way the hardware, firmware and software is continually updated through teacher feedback ensuring that it is of the highest possible quality and efficacy for teaching and learning.

VIII Interdependence of research and practice

There is cooperation within T³ between researchers and practitioners who are both using the technology to improve learning. Researchers and practitioners meet with each other at conferences, particularly Sharing Inspiration, and exchange views and ideas.
As well as funding T³ activities, Texas Instruments also funds research and some university teaching. The interdependence is then a triangular one!

IX Conclusions and recommendations

IX.I The role of learned societies

Many T³ Instructors belong to learned societies, and this helps to connect the pedagogical use of technology to committees and working parties within these groups who may be working on educational projects.

IX.II Networking; informal education

Networking is a principle aim of the T3 organisation. Sharing Inspiration is the highlight of the T3 Europe calendar and brings together teachers from many countries including the USA and Australia. Considerable effort is made to include educational administrators and researchers to ensure that networking is vertical as well as horizontal.

IX.III Diversity of PD centres: culture, international relations

Composed of 12 different countries T³ Europe is already very diverse in terms of culture and language.

Networking is supporting other countries wishing to become a partner of T³ Europe. Members themselves are engaged with many different examination systems, Germany alone has 16 different federal states. Not only are our exam systems different but curricula vary widely. The one feature we have in common is how best to use technology for the learning of students. In identifying common elements across European STEM curricula and teaching methodologies we are helping to improve international relations.
LEHRERiNNENBILDUNG WEST

I The cluster LEHRERiNNENBILDUNG WEST

I.I The "Birth" . . .

The cluster LEHRERiNNENBILDUNG WEST (LB-West) was launched by the cooperation agreement „Sekundarstufe (Allgemeinbildung)” between five institutions in 2016. In 2014 already, the subjects „Mathematik & Geometrie”, „Physik” and „Biologie” were accredited with the RECC-label (regional educational competence centre). In 2015, „Geographie & Wirtschaftskunde” and „Deutsch & Mehrsprachigkeit” were also accredited with the same label [3].

I.II LB-West embedded into the Heterogeneous Educational System of Austria

In 2012, after the approval of a new law [2] concerning the teacher’s education system, four cluster across Austria were installed in order to design the new teacher education programme. As a consequence of the new law, the pedagogical colleges and the universities have to collaborate and are responsible for the whole teacher education. The collaboration may also offer a stronger involvement of the universities regarding the PD courses, especially in the STEM subjects. In Western Austria this clusters has been renamed to LB-West.

I.III The Constitutive Partners, the „Personnel” . . . and the Budget

The LB-West comprises two universities (University of Innsbruck and University Mozarteum) and three pedagogical colleges (PH Tirol, PH Vorarlberg and KPH Edith Stein). Two regional competence centres (RECC Biologie, RECC Mathematik & Geometrie) – collaborations within the LB-West – are partner of the STEM PD Net-Project. The universities are mostly autonomous and related to the Federal Ministry of Science, Research and Economy; the pedagogical colleges are under the supervision of the Federal Ministry of Education. The LB-West is run by the heads of the participating institutions and has not an own budget.

II Philosophy, Mission and Networking

II.I Traditions of PD centres in Austria

In Austria, the so called pedagogical institutes (Pädagogische Institute) were responsible for teachers’ PD courses till the foundation of the pedagogical colleges (Pädagogischen Hochschulen) in 2007. In 2004/5, the Federal Ministry of Education set up six Austrian Educational Competence Centres (AECC) to support the teacher education (pre-service and in-service). Five centres for the subjects biology, chemistry, physics, german, mathematics, and the institute of instructional and school development.
II.II Philosophy and Mission

The main aim of LB-West is to implement the „PädagogInnenbildung Neu“ [1] in Western Austria, but it offers also the chance to reshape the PD courses especially in the STEM subjects under the RECC labels.

II.III Networking as a Crucial Issue of a PD Centre

Since the LB-West comprises several institutions and collaborates intensively with the school authorities in Tirol, Vorarlberg and Südtirol, networking is a core mission of the LB-West.

III Activities

The main focus at the moment is to implement (we are starting the third year) the new teacher education programme. Especially in science education and mathematics education new courses were designed.

IV Specific Aspects

IV.I Political dependency

The origin of LB-West was in 2013 when a new law was released in order to reform the teacher education in Austria [2] Part of the new law was that pedagogical colleges and universities plan and implement the new teacher education in a close cooperation. From a political point of view, the pedagogical colleagues are depended of the Federal Ministry of Education meanwhile the universities are in the competence of the Federal Ministry of Science, Research and Economy, but act autonomously. Before the new law in 2013, only the pedagogical colleges were allowed to offer PD courses, although many researchers from the university gave the courses. With the new law, this restriction was softened and therefore it is reasonable that at least the subjects under the RECC-label will plan and offer PD courses together.

IV.II Interdependence of initial Teacher Education and STEM PD activities

The new structure of the teacher education in Western Austria allows a close connection between the initial teacher education and future PD courses in the LB-West. In the new teacher education programme all secondary teachers (upper and lower, academic and vocational) graduate from the same study. Before the new teacher education programme, the pedagogical colleges only educated the teachers for the lower secondary (part of it), but offered PD courses for all teachers. In the pedagogical colleges, we have now the chance to employ the same teacher educators for the initial teacher education and the PD courses, especially in the subjects under the RECC label.

IV.III Quality assurance

Quality assurance with respect to PD courses is still an open topic within the LB-West. In 2015/16, the RECC Mathematik & Geometrie under the lead of the pedagogical college Tyrol tested a new PD format, with face-to-face meetings and an implementation phase between those meetings. A modest monitoring showed that the acceptance by the teachers was quite low. Therefore, new PD course structures are recently discussed. An alternative approach may arise from the initial teacher education itself. The curricula of the new teacher education foresees a closer collaboration with in-service teachers and emphasises the exchange between researchers and practitioners in specially designed courses. We hope to extend such collaborations also for the PD courses in a few years.

At the moment, no certificate is needed for a successful graduation of a PD courses, only the attendance counts.
IV.IV Interdependence of research and practice

Subject-specific education in Western Austria got only recently – within the context of the new law concerning the teacher education – an institutional framework. At the University of Innsbruck a new institute – at the new faculty School of Education – was founded and at the pedagogical college Tirol the „Fachdidaktikzentrum“ was initiated. In biology, research on conceptual change with focus on learning outside the classroom is implemented directly in PD courses already for several years. In mathematics, subject-specific education is at the very beginning, but gathered some experiences in the field of inquiry-based learning within the EU-project mascil and conducts actual a survey on the natural number bias. For the next year, we plan PD courses together with practitioners with a focus on topics from pedagogical content knowledge.

V Conclusions and recommendations

V.I The role of learned societies

Due to the early stage of the LB-West, the relations to learned societies in Austria are in still in an initial phase.

V.II Networking; informal education

Due to the early stage of the LB-West, there not yet links to informal activities of the communities of teachers.

V.III Diversity of PD centres: culture, international relations

Due to the early stage of the LB-West, international collaborations in the field of PD are not yet established. The RECC Biologie and RECC Mathematik & Geometrie are partner in the STEM PD Net project.

V.IV Visions

LB-West is going to be responsible for the teacher education in Western Austria.

V.V Publications

The LB-Wes WEST exists since 2016, publication within the cluster are in preparation but not yet published [1].


Figure 2: Map of the political dependencies of LB-West [https://www.upc.smm.lt/projektai/stempdnet/naujienos/diskusija/3-LEHRERINNENBILDUNG-WEST-LB-West-klasterio-kurimas.pdf; p. 7]
EDUCATION DEVELOPMENT CENTRE (EDC)

We refer to the presentation of UPC on its website. Parts of the following text are cited from an English version of its homepage and modified according to our categories, the rest is collected internally. This case study has been written by Ruta Mazgelytė & Vytautas Andrius.

I EDC as a Lithuanian Institution

I.1 The Founding

The Education Development Centre (EDC) was established on the 1st September, 2009 after the reorganization of Teacher Professional Development Centre (TPDC), Education Development Centre (EDC), Teacher Competence Centre (TCC), Lithuanian Adult Education and Information Centre (LAEIC) and it is the largest institution under the direct authority of the Ministry of Education and Science.

In 1945 the Republican Pedagogical Cabinet at the Ministry of Education was founded. In 1950 the cabinet was transformed into Republican Teacher Qualification Improvement Institute which had the main function of teacher qualification improvement and teacher training. In 1990, after the independence of our country had been restored, the institute was rearranged into the Lithuanian In-Service Teacher Training Institute. In 1999, the institute was reorganized into Teacher Professional Development Centre (TPDC). The main goals of this institute were: dissemination of education reform ideas and innovations, implementation of strategic in-service training projects and programmes, preparation of consultants for regions, organization and coordination of methodological activity, preparation of methodological tools for teachers.

In 1958 the Scientific School Research Institute was established; it was reorganized into the Pedagogical Scientific Research Institute and later into Institute of Pedagogy. In 1991, the Education Development Centre was established after the restructuring of the Institute of Pedagogy. The main EDC tasks were: the preparation and introduction of the documents which determine the curriculum and methodological material for teachers, organization and implementation of education system monitoring, preparation of education development models.

In 2003, the Teacher Competence Centre (TCC) was established. This institution organized the supervision of in-service teacher training quality, accreditation of in-service teacher training institutions and their programmes, and provision of methodological support. TCC has been coordinating the attestation of pedagogues and school administrators, implementing expert in-service teacher training evaluation and participating in expertise of teacher training programmes.

In 2005 after the reorganization of Distance (Extramural) Education Centre, Lithuanian Adult Education and Information Centre (LAEIC) started its activity. The Centre had been providing support for continuing adult education, gathering and

1 https://www.upc.smm.lt/veikla/about.php
storing data on adult education possibilities, on employs 65 persons with pedagogical degrees and institutions which provide adult education and their programmes, disseminating information, testing adult education status and needs, implementing different projects on adult education development.

I.II The Embeddedness and Institutional Dependencies

The Education Development Centre (EDC) is a national level institution affiliate to the Ministry of Education and Science of the Republic of Lithuania. It provides educational support in the field of preschool, primary and general education. Due to centre establishment peculiarities, the centre carries various tasks, which require close cooperation and collaboration with other institutions – and particularly in the field of in-service teacher training.

In the field of in-service teacher training EDC cooperates with 5 institutions affiliate to the Ministry of Education and Science of the Republic of Lithuania (Lithuanian Centre of Non-formal Youth Education, National Agency for School Evaluation, The Lithuanian Children and Youth Centre, Special Pedagogy and Psychology Centre, Centre for the Development of Qualifications and Vocational Training), professional development centres in 8 institutions of continuing education at universities and 62 regional teacher training centres, 63 subject associations. The institutional dependencies by financial and accreditation aspects are shown in the graph ‘Lithuanian teacher professional development system and institutional dependencies’.

EDC has 5 divisions: Education Content Division, In-Service Training Division, School Performance Development Division, Education Content Quality Assurance Division, Information and Communication Division and 3 supporting departments: Law, Human Resources and Public procurement department, Accounting department, Administration and Maintenance department. EDC employs 65 persons with pedagogical degrees and 39 specialists; thus it makes it a large institution.

<table>
<thead>
<tr>
<th>What the money spend for?</th>
<th>Rough percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staff</td>
<td>50 %</td>
</tr>
<tr>
<td>PD Initiatives</td>
<td>24 %</td>
</tr>
<tr>
<td>Materials development</td>
<td>1,06 %</td>
</tr>
<tr>
<td>Other</td>
<td>25,94 %</td>
</tr>
</tbody>
</table>

In addition to allocated budget, EDC has got additional funding from international projects 0.3 mln. Euro, EU structural funds project 1.4 mln. Euro.

II Philosophy, Mission and Networking

II.I Traditions of PD Centres in Lithuania

PD centres in Lithuania can be classified into two categories according to their scope:

- national level and
- regional level PD centres.

National level centres focus on CPD, which corresponds to national in-service teacher training needs and key-education policy trends.

These institutions are the Education Development Centre, institutions of continuing education at universities, the Lithuanian Centre of Non-formal Youth Education and the Lithuanian Children and Youth Centre. Their operational activities are funded by Ministry of Education and Science and Teacher PD voucher. The slight exceptions are institutions of continuing education at universities – they are funded by universities (but again: universities get funding from the Ministry of Education and Science).
Regional level PD providers – regional teacher training centres and private PD providers usually focus their CPD on the needs of the teachers in the region they operate in. Their operational activities are funded by the Municipality and Teacher PD voucher. Being a nationwide public institution, EDC cooperates with regional PD centres by sharing practices, taking part in discussion or working groups.

Consequently, EDC operates in a very classical CPD institutions’ environment.

II.II Philosophy and Mission

Due to teacher CPD institutional transformations and EDC emergence as an institution of structural reforms, the centre has a wide mission. The purpose of EDC is to implement national professional development and general education programmes and policies; to provide methodological materials for schools and pre-school, primary and general education teachers; to accredit professional development programmes and monitor their implementation and teachers’ professional growth; to coordinate activities of education advisors (consultants) in the field of ICT, programme evaluation; to provide professional development and other support for specialists, who work with special needs students.

II.III Networking as a Crucial Issue of a PD Centre

As a national level PD provider, which is closely linked to education policy implementation, EDC joins and participates in various international partnerships.
cooperation initiatives coordinated by European SchoolNet, STEM PD Network and others. These initiatives EDC is involved in are take a shape of international project activities. For example in 2016 EDC was partner or coordinator of 8 international projects:

- 'STEM capacity building',
- 'European Network of STEM Professional Development Centres',
- 'Scientix 3',
- 'Media and information literacy education',
- 'MENTEP - MENtoring Technology Enhanced Pedagogy',
- 'Innovative Teacher - Motivated Student: Collaborative Problem Solving',
- 'Teachers Professional Competences Common framework' and
- 'M.A.R.C.H. – ‘Make Science Real in Schools'.

Joining international colleagues is an important source of new ideas and a channel to transmit experience and insights to partners abroad.

III Activities

The activities of the Education Development Centre fall into five areas:

- Development and implementation of pre-school, primary, general education content;
- Methodological support for teachers, professional development and coordination of education advisors' (consultants) activities;
- In-service teacher training and quality assurance (evaluation and accreditation of teacher professional development programmes);
- Organization and coordination of expert evaluation of textbooks and other teaching/learning tools;
- Initiation and implementation of education innovations during national and international projects.

IV The Foundation of EDC Activities

The foundation of CPD activities provided by EDC consists of three ideas: development and implementation of curriculum innovation, according to the learning needs of society; development of effective and teacher-oriented PD; development of strategic partnerships and sustainable collaboration networks for innovative, up-to-date CPD. As a result, the most typical CPD offers focus on pedagogical content knowledge transmission for in-service teachers.

Specific Aspects

V Political Dependency

The political dependency of EDC stems directly from the fact that it is affiliate to the Ministry of Education and Science of the Republic of Lithuania. However, it does not necessarily mean that CPD provision solely takes into consideration national education policy guidelines. EDC is independent to design CPD according to teacher community needs, too.

VI Interdependence of Initial Teacher Education and Activities

The main target group of CPD provided by EDC are in-service teachers. Not being a university EDC does not provide courses specifically designed for the future teachers (i.e. students at universities). However, for the last three years EDC has been cooperating with the Ministry of Education and Science in order to provide professional development opportunities and support for young teachers' recent graduates, who started working in schools and who have been working there up to five years.
VII Quality Assurance

All CPD programmes run by EDC are accredited according to professional development programmes' procedure description approved by the Minister of Education and Science. The description defines quality criteria for professional development programmes. Among these are: PD priorities set by the Ministry and developed or acquired competences defined in teacher competence descriptions.

VIII Interdependence of Research and Practice

EDC has formalized cooperation with few universities by signing long-term cooperation agreements; however, in most cases it is a common interest in specific or actual themes and problems that determines the need for short-term cooperation.

Miscellaneous

IX Conclusions and Recommendations

EDC is settled in the PD-providers system as a unique institution, which has undergone a wide organizational consolidation. Being interdependent with the Ministry of Education and Science it is exposed to education policy changes, new initiatives or changing priorities. Main challenges for EDC in the field of professional development are:

- Renewal of a general education curriculum, dissemination and activities related to teacher competence development;
- Implementation of IT in primary education;
- STEM implementation and national STEM network coordination;
- Media and information literacy improvement in schools;
- Integration of financial literacy in schools;
- Professional development related to health, sexuality and preparation to family life education;
- Competences' development for inclusive education;
- Implementation of training courses devoted to updated pre-school curriculum.
1.3 MISSION & CHALLENGES

Change processes
We have to accept that traditions (of these centres in European countries) are very persistent. Of course, the members of the project team have some dreams and recommendations (on the basis of their experiences and scientific insights), but we should be realistic and first of all, thankful, for what is in existence and working. We know that is not possible to find resources in order to establish a new institution as we would like to dream of.

Especially, PD centres of Type 1 are very persistent since – last not least – the government has the authority and right to regulate all the processes. It is much easier to convince colleagues in university centres (Type 2) to adopt one’s ideas, to run some experiments. Also, centres of Type 3 and 4 appear more flexible.

Next we have to state that what should be understood by a PD centre is anchored as beliefs in the mind of many stakeholders. To describe it with other words: It is not easy to change the relevant issues within the centres in our network. We have to tolerate a slow process of adoption.

The dilemma of STEM
A further problem which we had to agree on, is the fact that the landscape with respect to our subject – STEM – is very heterogeneous. There does not exist a single and unique school subject which is called STEM. STEM teaching at schools is often realized by presenting a bundle of different aspects from four independent subjects. We don’t know anything about a stringent STEM education at university.

Nevertheless, all the project partners are very open to STEM. Choosing any subset of the letters S,T,E and M, you will find a centre which is working in the area of the school subjects represented by these letters.

Success Factors
PD centre quality criteria refer to the levels of philosophy, learning organization, resources, networking, and evaluation. These quality criteria are important success factors of these different PD centres and are also found in the Ready-to-use-Guide of O1. These are summarized below.

Philosophy
High quality PD centres are able to influence the professionalization and practice of STEM teaching. Thus, high quality PD centres explicitly provide their philosophy.

A clear and transparent philosophy statement takes core issues into account, for example:

- What is the PD centres’ STEM identity? For example: interdisciplinarity, scientific inquiry and connection with real life.
- What does the PD centre want to achieve in teacher PD? For example: teachers becoming experts in their everyday teaching.
- What educational standards and requirements does the PD centre follow? For example, going in line with national teacher training standards.
- What kind of teachers’ professionalization is aimed at? For example: teachers need to improve their competencies in STEM education, by changing their attitudes, improving their skills and broaden their knowledge.
High quality PD centres’ philosophy is reflected by their respective STEM PD curriculum. By developing each curriculum, PD centres highlight and prioritize their respective philosophy.

This includes for example:

- Balancing theory and practice to support teachers’ learning.
- Addressing many and diverse aspects of teachers’ competencies and experiences.
- Being contextual and flexible (e.g., addressing the needs of teachers, students, industry and business).
- Providing structured and progressive content.
- Meeting different expectations of stakeholder (e.g. students, teachers, PD providers).
- Having a research-based background.
- Using different learning strategies (e.g., learning from experience, learning from experts).

**Learning Organization**

High quality PD centres constantly reflect and enhance the way they work; they act as learning organizations, which are open to innovations, continuous learning and improvement. PD centres aim at good balance between being providers of relevant knowledge and being open and flexible learners themselves. In this way, PD centres ensure two-way communication: developing knowledge as well as integrating experiences and ideas from outside. As learning organisations, PD centres analyse and react on STEM teachers’ and schools’ needs and challenges. They adapt themselves according to constantly changing contexts.

Developments of high quality PD centres are evidence-based and informed by national and international developments and practices. Communication and cooperation with relevant environments are crucial to ensure high quality STEM PD.

As a learning organization, PD centres in particular provide the following features:

- providing resources for critically reflect on PD centres’ development
- solving problems (e.g., regarding content or organisational issues) systematically;
- experimenting with new approaches;
- learning from experience;
- learning from others (partners and target groups);
- transferring and communicating knowledge.

**Resources**

For high quality PD centres, it is crucial to have relevant resources. In particular, professional teacher educators demonstrate positive attitudes towards their work, have social-emotional skills and high standards of professional ethics. Expertise in STEM field and didactics, as well as adult education is of great importance. Teacher educators have a clear vision of their work, and use it as a benchmark to reflect on the outcomes of their work and identify the needs for further professional development. PD centres support such culture of reflective learning.

High quality PD centres are able to provide STEM specific materials like

- guidelines (e.g., general information about the structure, content and aims of PD offers; or specific information about the structure, content and aims of certain materials)
• learning environments (e.g., for teachers, including information concerning added value, target group, didactical comments, aso; or for PD providers, including information concerning theoretical models, empirical background, aso.)
• tools and equipment (e.g. technical equipment, rooms, software, aso.)

Cooperation
High quality PD centres ensure cooperation and learning possibilities both within and beyond the centre. They cooperate with partners (university, industry, business, NGO, etc.) to raise awareness regarding STEM issues and knowledge, in particular in connection with real life situations and applications. Networking with other STEM PD centres (internationally or nationally) testifies the centres’ openness to different perspectives and innovations; in particular, the exchange of knowledge and experiences between PD centres creates learning opportunities for each PD centre and fosters further development.

High quality PD centres stimulate and foster cooperation between participants (e.g., teachers, principals, aso.). Moreover, they support and encourage participants’ professional networking with relevant environments. By providing rich opportunities for collaborative reflection and discussion (e.g., of teachers’ practice, students’ work, or other artefacts), high quality STEM PD empowers and encourages participants to collaborate in learning, which represents a core feature of effective learning and development processes.

High quality PD centres create opportunities where relevant stakeholders (e.g. schools, policy, teachers, academia, aso.) can meet and exchange knowledge and expertise.

Evaluation
Evaluation is connected to processes of improvement. High quality PD centres systematically assess their outcomes and impact, using by evaluation tools and differentiating various levels

• Specific feedback: PD centres get detailed feedback regarding specific PD offers by using practical instruments and methods (e.g. surveys or interviews). Evaluation’s findings and insights inform further development and improvement of specific PD offers.
• General feedback: PD centre get sophisticated feedback regarding their general offers. Typically, these evaluations include both qualitative and quantitative methods as well as triangulation (e.g. during conferences or fairs) to get reliable and valid data.

To support evaluation processes, high quality PD centres develop and offer various ready-to-use instruments and methods that focus on different aspects. Since high quality PD centres are interested in further developing their practice, they come with an intrinsic motivation to evaluate their work.

Next to the quality criteria there are further aspects for a successful centre:
• Present on international conferences; lighthouse within the international scene
• Support by the education administration within a country
• Prominent research papers
• Attractive for teachers, teacher educators
• Guarantee quality criteria and constant review
• Innovation and applicability
Further missions & activities
Policy-making also play an enormous role for PD centres. On the basis of the questionnaires we could make out different directions, depending on the location and financier of these centres. Roughly we could divide three ranges, which are to be extended however still further.

1. Material strategy: press, newspaper, publishing companies
2. Personal strategy: cooperation with multiplier and qualifiers, professional learning communities (PLC), various societies of teachers
3. Systemic strategy: learned bodies (learned societies), labour unions, education administration

We have also been able to identify various goals of our policy-making, such as being continuously perceived not only by the educational administration in the country, but also for industry and business, having a representative within central boards or having competent EU perspectives.
2. Conclusions & Recommendations

NEW INSIGHTS ON THE PD CENTRES

Since the ERASMUS-Project STEM PD Net leads to a deeper continuous cooperation, we automatically received detailed insights about the various activities in all PD-centres. New variables which were previously not visible in our inspection are becoming gradually obvious.

Thus, we decided to add some more questions in an additional questionnaire and sent it to the interior circle of cooperating PD-centres. We add this questionnaire as an appendix of this document.

Since the answers are partly fragmentary, a numerical evaluation seems not to be illustrative. In addition, it is not productive to lay one’s cards on the table.

1. Cooperation with learned societies: As a researcher, we know that learned societies (Fachgesellschaften) are important stakeholders in our discourse. They are in direct contact with many researchers and educators. Learned societies represent important views on the virtual landscape of the researchers, of the development of the discipline, and on major new international developments.

For example, in the United States the American Mathematical Society (AMS) or the London Mathematical Society (LMS) in Great Britain are very influential and no debate could be finished without these learned societies’ extensive comments on the relevant issue. The assemblies of the learned societies are meeting annually and edit newsletter or informal journals.

To be honest, not all learned societies are in direct contact with the players in our scene. It should not be ignored that so far there doesn’t exist a learned society devoted to the subject ‘STEM’. Fortunately, in Germany we have an association of teachers – MNU – which is close to a learned society and reflects the needs of schools, teachers, students and classrooms. This body is cooperating with stakeholders of the research side.

RECOMMENDATION: One should start to resp. intensify the cooperation of the centres with these bodies; both sides will profit.

2. Professional management of a PD centre: Of course, many of the PD centres are gradually grown structures run by individuals from the STEM scene and have their personal characteristics. Nearly none of the engaged colleagues have been instructed how to run and organize the management of a centre professionally. We don’t know an example where experts counselled the administration of a centre.

We don’t disregard the engagement of many co-workers, but we have to emphasize, that there are large differences with respect to the effectivity of a centre. Of course, you need personal resources to continuously and successfully organize:

- press work for the public
- looking for further promoters and sponsors
- annual plans of events
- talks
- contacts on the international level
- …
RECOMMENDATION: We recommend starting a discussion with organizational consultants.

3. How to identify the actual need for PD-courses? Reflecting the processes on how the titles of PD-courses are established, we realize a large variety of different procedures. Sometimes courses are predetermined by the educational administration, some courses are proposed by influential educators, in few cases there might be an initiative by teachers asking for offering special courses.

We believe that the success of a PD-course is partly influenced by this procedure.

Again, the answers depend heavily on the type of the centre. centres, which are governmentally driven, are mostly acting top-down, whereas in the virtual centres the demand of the classrooms and schools, e.g. thinking bottom up, is the dominant feature.

RECOMMENDATION: We recommend reflecting in a centre that the list of titles is balanced and not primarily decided by a top-down procedure.
3. Appendices

3.1 Appendix 1: Questionnaire 1

STEM PD Net Questionnaire

General information
Information for data usage
Your information will be used for research purposes in the course of the project only. The data will be
matched to the various centres and will not be passed on to third parties.

Structure of the questionnaire
Dear members of the network of PD-centres,
we developed this questionnaire to identify and show the differences and similarities of the centres in
our network. Therefore, the questionnaire is structured in five parts:
1. **Contact information**: We need your contact information
2. **Structure of the centre**: We are interested in the structure of your centre (how did your
   organization evolve, how does your financial situation look like and which subjects do you focus
   on).
3. **Situation in your country**: We would like to connect this knowledge to the educational system of
   your country.
4. **Mission of your centre and your activities**: We want to hear more about your activities and
   missions.
5. **Major challenges and best practice-examples**: We want to learn from your major challenges and
   best-practice examples.

The questionnaire includes questions you answer by ticking the brackets or by adding a number.
Additionally, you will find the opportunity for open answers in a chart or a cell. You can expand all
cells and charts – there is no limit of characters.

Contact information
- Name of the centre:

Address of the centre:

Homepage (if existing, also English website):

Contact person for queries:

Structure of the centre
S1: We would like to know which school subjects are addressed by your centre.
   ```
   - Which school-subjects are addressed by your centre (please mark with a cross)?
     ( )Science ( )Technologies ( )Engineering ( )Mathematics ( )other:
   ```

S2: We would like to know more about the presence, history and future of your centre. Please tell us the
date of the establishment of your centre and since when it exists in this form.
   1. Since when does the centre exist?
2. Since about when does it exist in this form?

3. Please mark the expected duration of your centre with a cross:
   ( ) permanently ( ) temporarily, for a certain period of time ( ) unclear
   • If temporary: is an extension possible? ( ) yes ( ) no
   • If temporary: how long is the duration of the centre planned?

4. Is the centre still in a phase of development? ( ) yes ( ) no
5. In which context was the centre developed?

6. Is the centre part of a university? ( ) yes ( ) no
   • If no: please continue with S3
7. Is the centre fully integrated in the university? ( ) yes ( ) no

S3: We would like to know more about the cooperation/collaborations of your centre and how they look like.

1. Are there any additional cooperation/collaborations (actual stable/permanent) with other institutions (e.g. universities, companies, foundations, research institutions, PD-centres, educational authorities etc.)? ( ) yes ( ) no
   • If no: please continue with S4
2. Please mark with whom you cooperate/collaborate:
   ( ) National universities ( ) International universities ( ) Companies ( ) Foundations
   ( ) Research institutions ( ) PD-centre ( ) Educational authorities ( ) other:
3. Please describe briefly up to three cooperation/collaborations which you regard as most important:

S4: We would like to know more roughly about the budget of your centre.

1. Do you have your own budget? ( ) yes ( ) no
   • If no: please continue with S5
2. How much budget (in euro) do you roughly have per year?
   ( ) less than 100,000 ( ) up to 500,000 ( ) up to 1,000,000 ( ) more than 1,000,000
3. Please fill out the chart:

<table>
<thead>
<tr>
<th>Sources of the money</th>
<th>Rough percentage of the whole sum</th>
<th>What is the money spend on?</th>
<th>Rough percentage of the whole sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>University</td>
<td>%</td>
<td>Staff</td>
<td>%</td>
</tr>
<tr>
<td>Educational ministries</td>
<td>%</td>
<td>PD initiatives</td>
<td>%</td>
</tr>
<tr>
<td>Third party funds from the economy</td>
<td>%</td>
<td>Materials (development)</td>
<td>%</td>
</tr>
<tr>
<td>Centre’s intake (participant fees, publishing,...)</td>
<td>%</td>
<td>Other:</td>
<td>%</td>
</tr>
</tbody>
</table>
**S5**: We would like to know more about the number of your staff.

1. Who works for your centre? Please fill out the chart:

<table>
<thead>
<tr>
<th>Staff of your centre</th>
<th>Number of full time equivalent staff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academics as researcher</td>
<td></td>
</tr>
<tr>
<td>Academics as facilitator</td>
<td></td>
</tr>
<tr>
<td>Non academics</td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
</tr>
</tbody>
</table>

**S6**: We would like to know more about the role research plays in your centre.

1. Does your centre do research? ( )yes ( )no
   - If no: please continue with S7.
2. Does research play a minor role, an equal or a major role in your centre? ( )minor ( )equal ( )major
3. Is research done by individuals or by groups? ( )individuals ( )groups
4. Please describe how research influences the work of your centre:

5. Please list some references of typical publications of your centre (if they are neither English or German please add keyword about the content of the publications)

**S7**: We would like to know more about the role PhD-programs play for your centre.

1. Does your centre offer a PhD-program? ( )yes ( )no
   - If no: please continue with S1.
2. Please give a brief description of your PhD-program.

**Situation in your country**

**S1**: We would like to know more about the existence of Professional Development Centres in your country.

1. Are there further STEM-centres in your country? ( )yes ( )no
   - If no: please continue with S2
   - If yes: please list exemplary other centres:

<table>
<thead>
<tr>
<th>Name of other centres</th>
<th>Homepage (in English or German) or short description of the centre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Si2: We would like to know more about the professional development and education in your country. 
1. Please fill out the chart:

<table>
<thead>
<tr>
<th>Profession</th>
<th>Typical education (university degree, vocational training, nothing, ...)</th>
<th>Typically used professional development (regular courses, working in Professional Learning Communities, nothing, ...)</th>
<th>How many of these people do you reach per year (give an estimation) by offering what kind of PD format (e.g. courses, professional learning communities, conferences, materials for lessons, ...)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nursery school teacher</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-service-teacher</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Facilitator for in-service-teacher</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Facilitator for pre-service-teacher</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School-leaders</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mission of your centre and your activities

M1: We would like to know more about the mission of your centre. 
1. Please tell us about the main goals of your centre:

M2: We would like to know more about the characteristics of your activities. 
1. Please describe briefly what main ideas your institution pursues in its offers. (list the three most important ones)

2. In how far are the following types of knowledge covered in your Professional Development-offers (please mark the applicable with a cross and try to give an estimation of their frequency)?

<table>
<thead>
<tr>
<th>Types of knowledge</th>
<th>Percentages of your offers that focus on this type of knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>( ) CK (content knowledge)</td>
<td></td>
</tr>
<tr>
<td>( ) PCK (pedagogical content knowledge)</td>
<td></td>
</tr>
<tr>
<td>( ) PK (pedagogical knowledge)</td>
<td></td>
</tr>
</tbody>
</table>

3. Please list typical activities (e.g. a 3-day long course about chance; a conference for teachers about the teaching of climate, ...):

4. Are the offers always designed by your centre? ( )yes ( )no
   - If yes: please continue with MC1.
   - If no: Please describe who designs your offers (e.g. teachers in cooperation with the centre, ...):
**Major challenges and best-practice examples**

MC1: We would like to know more about your challenges.
1. Please list major challenges your centre faces:

MC2: We would like to know more about your success.
2. Please list best-practice examples of your centre:
3. Are they documented? ( )yes ( )no
   If yes: Please list where we can find them:

### 3.2 Appendix 2: Questionnaire 2

**QUESTIONNAIRE: The Profiles of the PD-centres**

Questionnaire to all project partners to get more details on the top 4 main categories of the first questionnaire.

The questions which answers we would like to know are the following:

- Is there an annual job calendar with regularly upcoming and discussed task?
- What are the standard tasks in your centres?
  - Preparing and running CP courses?
    - What are the precise steps?
    - Who is responsible? Who is the initiator?
    - Who is checking quality standards?
    - What is done in advance for a 'job'?
    - What is done after the measure resp. job?
  - Reviewing and evaluating jobs for other institutions?
- Is your centre integrated into curriculum discussions and developments?
- Does there exist some private communication between your centre and individuals? Does individual counselling is happening? Often?

- Addressees:
  - Are you addressing students (pupils)?
  - Are you responsible for math resp. science fairs and exhibition?

- Cooperation with learned societies:
  - Are you asked to be present at annual conferences of the learned societies?
  - How intensive is the cooperation with the learned society in your country?

- Support for the employees by the centre its own:
  - ... for the scientific development of the employees?
  - ... to visit international conferences?
  - ... to publish in research papers
  - Is there an internal public discussion of joint scientific papers? Jour fixe?
• Facilities:
  o Do you have internal access to educational journals within your centre? Or do you have to use the library of a university?
  o Business cards of your institution

• Public relations work
  o Chance to introduce yourself and your work
  o Is there an annual report to the outside world of your centre?
  o Invitation to other events