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# Conference Proceedings

**Educating the educators:  
international approaches  
to scaling-up professional  
development in mathematics  
and science education**

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in Essen, Germany**

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# Conference Proceedings in Mathematics Education

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## EDUCATING THE EDUCATORS: INTERNATIONAL APPROACHES TO SCALING-UP PROFESSIONAL DEVELOPMENT IN MATHEMATICS AND SCIENCE EDUCATION

Proceedings of the Conference hosted jointly by the project  
mascil (mathematics and science for life) and the German  
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# 1 Conference: Educating the educators

*K. Maass, D. Wernisch, K. Reitz-Koncebovski, E. Schäfer*

## 1.1 Aims and objectives

This was the first international conference specifically devoted to the topic of educating the educators. The conference targeted teachers and teacher educators, researchers, multipliers and relevant networks, educators of multipliers, policy makers, teacher professional development (PD) centres, maths and science education support centres, presidents and heads of PD institutions/centres and relevant networks. These participant groups are key to the aim of disseminating innovative teaching approaches, such as inquiry-based learning. In particular, 'Educating the Educators' served as a lever and platform for international exchange about concepts and experiences concerning such questions as: What are the features of successful concepts and professional development? What are the needs and experiences of the different target groups? Which pitfalls have to be avoided?

This international conference connected researchers and practitioners engaged in the field of maths and science education in order to discuss concepts of scaling-up teacher professional development. A special feature of this conference was that it brought together researchers and practitioners (including the target group of teacher educators themselves) and initiated an exchange between teacher education centres in the different countries. Key to scaling-up concepts - and core to the conference - was the education, professional development and support of multipliers. The conference approached the subject from the perspectives of: 1. Individual countries and their particularities; 2. Different target-groups and their needs (policy makers, educators of teacher educators) and 3. The end-users (teacher educators, teachers and their everyday classroom practice).

Innovative and interactive formats were used during the conference to bring out the specific benefit of gathering a circle of participants from both research and practice. Relevance for, and impact on, practice was ensured by using oral presentations and discussion, demonstrations (e.g. simulation of professional development situations, demonstration of materials) with subsequent facilitated reflection and practice-oriented reports from teacher educators, training centres and policy makers. The conference was rounded out with keynote lectures, a poster session and a closing plenary discussion based on the reports of track rapporteurs.

To ensure a wide distribution as well as a sustainable information basis of the conference, we created a conference website that was continuously updated to include the latest information. The website can be viewed at: <http://educating-the-educators.ph-freiburg.de>. The conference proceedings and detailed papers of the presentations may also be downloaded from the website.

## 1.2 Conference tracks: Four different means of scaling-up

The conference was organised in four different tracks that each addressed a different means of scaling up professional development in maths and science education. Each track covered the fields of science and mathematics. The aim was to present and discuss different approaches which ensure a high quality of the education of educators:

(1) *Scaling-up with multipliers in face-to-face professional development courses:*

Approaches to scale-up using training sessions provided by multipliers where participants and their educator are in the same physical space. This track examined both the research and practice-oriented perspectives

(2) *Blended learning concepts and e-learning support:*

Opportunities and limitations of teacher professional development with the help of blended learning concepts and e-learning support

(3) *Disseminating and scaling-up through materials:*

Scaling-up through appropriately designed materials that support teachers' professional development and ways to disseminate materials

(4) *Professional learning communities:*

Challenges to, and opportunities for, encouraging professional development through professional learning communities. In such groups of teachers, one member acts as a facilitator. However, learning in a PD group is considered to be much more self-organised than in a professional development course organised by a multiplier.

Each track was supported by a so-called track chairing team consisting of three to four international experts with regard to the specific track issue. Furthermore, a scientific board was established to support the track chairing teams with scientific and conceptual advice to assure a high scientific quality of the conference.

### 1.2.1 Track 1: Scaling-up with multipliers in face-to-face professional development courses

Reaching a large number of teachers with an innovative content, such as inquiry-based learning (IBL) or connecting school to the world of work, in face-to-face professional development courses, is accomplished by using a pyramid model: Engaged teachers or researchers are trained to become multipliers, who then go on to train other teachers. This pyramid model has proven efficient and effective within various contexts and projects (e.g. Sinus project in Germany, EU project PRIMAS). Nevertheless, educating multipliers poses considerable challenges inherent to the specific requirements of the multipliers' dual role. Multipliers act as experts in some subject-related content,

and at the same time, as professionals in adult education. Therefore, training multipliers has to cover both of these requirements.

This conference track offered an opportunity for presenters and participants to exchange experiences from the practical field and to discuss relevant research results. The track focused on key questions such as:

- What are the features of successful concepts for educating multipliers?
- Which pitfalls have to be avoided?
- How can multipliers be adequately prepared to impart key approaches that promote more meaningful and motivating science and mathematics learning consisting of complex content and competences like IBL and/or a closer connection of school to the world of work?
- How can multipliers effectively be supported in the implementation of professional development?
- In what ways can cultural factors, such as national specifics in how teachers cooperate at school – or not, or common classroom culture, be addressed and handled?
- What are the needs and experiences of the different target groups: educators of teacher educators, teacher educators themselves and teachers in their everyday classroom practice?

### **1.2.2 Track 2: Blended learning concepts and e-learning support**

Information technologies have rapidly transformed the landscape within which both academic and applied learning now takes place. Innovative technologies enable new approaches and powerful possibilities for collaborative, learner-centred and research-oriented learning and provide unrivalled access and flexibility to individuals.

E-learning courses, for example, provide opportunities not found in face-to-face educational situations. With e-learning, teachers can work together despite being geographically wide-spread. Further, teachers can work according to their own schedule, thus not affecting school hours. Teachers can work as a virtual community, mediated through synchronous (chats and virtual meetings) and asynchronous communication (forums, uploading documents and resources, giving feedback to the work of others). Asynchronous communication through e-forums allows more time for reflection and the ability to revise and repost on the given forum. Blended learning combines the advantages of e-learning support with face-to-face meetings, and thus ensures sustained interaction and collaboration both within and across school communities and networks.

Further, this track examined the issue of to what extent e-learning is suited for complex content that also affects teachers' focal points and attitudes.

This track addressed the following questions:

- What are the features of successful, blended learning concepts?
- How can e-learning impart complex content that affects teachers' focal points and attitudes (i.e. IBL, more closely connecting maths and science learning to the world of work.)?
- Which features do excellent e-learning materials have? How can existing PD materials be modified and adapted for use in an e-learning environment?
- How can e-learning support be tailored to the needs of the target groups? What do suitable tools for self-assessment, the monitoring of teachers' success and evaluation of users' experience with the e-learning environment look like?
- How can engagement and sustainability in virtual learning communities be ensured? Can a virtual learning community be as effective as one that meets in the same physical space?
- What are the needs and experiences of the different target groups: teacher educators, facilitators/instructors of e-learning forums and/or virtual meetings, and teachers using e-learning support?

### **1.2.3 Track 3: Disseminating and scaling-up through materials**

Carefully designed classroom tasks can be a powerful tool for enhancing the quality of maths and science teaching, influencing the classroom culture and fostering students' learning. Classroom tasks stimulating inquiry and/or based on real problems from the world of work give rise to more meaningful and motivating maths and science learning. Appropriate tasks support students in developing scientific reasoning, as well as transversal competences such as: critical thinking; problem solving; creativity; teamwork and communication skills. Simultaneously, good tasks secure basic knowledge, allow learning from mistakes and cumulative learning and also facilitate autonomous learning. Other possible benefits include promoting student co-operation, offering interdisciplinary approaches and contributing to the reduction of gender stereotypes. Obviously, tasks have to complement current school curricula.

In the process of developing a task culture and implementing good tasks in classrooms, a spiral model of professional development has proven efficient and effective within various projects (e.g. EU projects LEMA, COMPASS, PRIMAS). In the spiral model, teachers themselves actively experience inquiry learning with new tasks – and subsequently implement the tasks in their classes and reflect on their experiences. Teachers thus work in continuing cycles of analysis – implementation – reflection. After gaining some experience, learning communities are able to develop their own tasks. This process ensures shared ownership of tasks, and thereby facilitates their use.

In addition to exemplary, high quality classroom tasks, the spiral model of professional development requires appropriate materials designed for a learning community's teacher educator or facilitator to use and that support them in the work of supervising teachers.

Hence, this track addressed the following questions:

- What are the quality criteria for the design of materials for classrooms and/or PD?
- How can suitable quality assurance of materials be ensured?
- How can the design of materials meet the affordances out of education systems and policy context? How can constraints for the flexible design of materials be overcome?
- What are the features of materials for classroom and/or PD that are suitable for promoting IBL and/or more closely connect science and mathematics learning to the world of work?
- Which factors promote or impede the implementation of innovative materials in practice?
- How can self-explanatory materials be designed that have large potential for scaling-up?

#### **1.2.4 Track 4: Professional learning communities**

Regardless of the intervention mode (face-to-face, e-learning, blended learning...), professional development is most successful and sustainable when it involves collaboration between teachers and encourages reflection and mutual support. This is especially true when the PD focuses on innovative content (i.e. IBL, school lessons more closely connected to the world of work). Maximum intervention impact is achieved when several teachers (either from a single school or neighbouring schools) take part in a PD course and form a learning community. Such learning communities of teachers are sustainable because the members have a common aim, are mutually engaged and supportive, and share the experience and passion of involvement in a joint enterprise.

Learning communities that involve teachers from secondary and primary schools, or from general education and vocational schools have proven to be particularly interesting and valuable. Experience (i.e. in the EU projects PRIMAS and mascil) has shown that in such diverse learning communities, teachers benefit mutually from their different areas of pedagogical and content-related expertise.

This conference track offered an opportunity for presenters to exchange experiences from the practical field and discuss relevant research results.

The track focused on key questions such as:

- What are the pre-conditions for setting up self-sustaining learning communities? How can sustainability be ensured?
- What are the requirements for learning community facilitators? How can teachers be educated and prepared to take on the role of learning community facilitators in their schools?
- What are the experiences with supporting learning communities in e-learning or blended learning environments?
- Which methods of working within the group have proven efficient?
- How can learning community members be effectively supported in acquiring complex content and competences that are key approaches to promoting more meaningful and motivating science and mathematics learning? (i.e. IBL, more closely connecting school to the world of work).
- What does research say about the cultural dimension? In what ways can cultural factors, such as national specifics in how teachers cooperate at school – or not, or common classroom culture, be addressed and handled?
- What are the needs and experiences of the different target groups: facilitators of learning communities, educators of teacher educators, and teachers in their everyday classroom practice?

## **2 Conference outcomes and conclusions**

*K. Maass, D. Wernisch, E. Schäfer*

### **2.1 Teacher professional development: Europe-wide perspective on current needs and trends**

Mascil was strongly committed to focusing the mid-term conference on connecting researchers and practitioners engaged in the field of maths and science education in order to discuss concepts of scaling-up teacher professional development. The need for this is great as teachers are the key factor in ensuring the achievement of creative and sustainable learning outcomes in mathematics and science education, in fostering young peoples' competences and enabling them to become critically thinking, responsible and active citizens. Therefore, teacher professional development is of great relevance and always an essential key to effecting change in education, regardless of the national educational system. Teacher PD and research about it is a growing field throughout Europe. The difficulty consists in the fact that there is little knowledge about how to scale-up PD successfully – and sustainably.

For these reasons, the conference was organised to provide opportunities for leveraging international exchange amongst target group members. Here, we were successful in promoting fruitful, mutually beneficial discussion about many relevant questions, such as PD concepts and approaches that work, target groups' particular needs and experiences, challenges and hindrances of successful PD and the crucial role of multipliers and their training and support. The four tracks (as described above in section 1.2) were also extremely useful for highlighting the major aspects involved when addressing how to effectively and successfully 'educate the educators'.

### **2.2 Bringing together a unique circle of participants: researchers, practitioners and policy makers**

Addressing the conference issue by means of the four tracks also allowed a broad perspective on relevant approaches of educating the educators for research, as well as for practice. A dynamic and increasing field of research on professional development of teachers and teacher educators is arising. Scaling-up teacher PD in maths and science and, thus achieving improvement of education, is receiving increased public attention and policy support. We also see a beginning institutionalisation across Europe.

The tracks allowed discussions and insights into the concepts, approaches and programmes currently being developed and applied across Europe. Having over 170 participants with varying professional backgrounds and coming from more than 20 nations added to diverse perspectives given in discussions and contributions. Among the presenters and conference

participants were multipliers, teacher educators and multipliers, researchers, policy makers, relevant networks and representatives of national ministries. A high-level policy maker introduced core topical issues in the conference welcome address: Sylvia Löhrmann is the Minister of Schools and Further Education of North Rhine-Westphalia, Germany and president of the Standing Conference of the Ministers of Education and Cultural Affairs of the States 2014 (KMK). Her attendance emphasised the importance and timeliness of our chosen topic. Highly regarded keynote and track plenary speakers presented state-of-the-art research and practice with regard to scaling-up teacher professional development.<sup>1</sup>

### **2.3 Innovation: Establishment of a future-oriented, European network of teacher training centres**

Through the attendance of teacher professional development centres and institutions in maths and science education, the conference organisers brought together a further group of actors who are of increasing importance in the European arena. The relevance of this group for issues relating to teacher professional development becomes apparent through an increasing number of specialised centres which have been set up across Europe in recent years. Mascil and the DZLM responded to these current developments and needs by offering a special pre-conference meeting for presidents and heads of professional development centres and institutions. Especially important to the field, and also a particular success of the conference, is that this was the first meeting of teacher professional development centres in maths and science education from across Europe. More than a dozen such institutions were represented at the first meeting.

The main goal of the pre-conference was therefore to provide a platform for the mutual exchange of ideas and experiences. The centres all have similar aims and agendas, namely: investing in teacher professional development to substantially improve maths and science education as it happens day-to-day in schools. The meeting enabled discussion about the challenges and opportunities such institutions face. The circle of participants shared critical aspects that need to be considered when cooperating with the educational administrations, appropriate strategies for doing so and how the various centres might benefit from an exchange on the similar scope and focus of their work in the different countries. A further major issue that was discussed centred on different approaches for promoting professional development of teachers and making these activities sustainable.

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<sup>1</sup> For more details on the keynote issues, please see section 3.

One of the most significant developments of the pre-conference was: those attending strongly urged the conference organisers to provide an opportunity for a second European meeting of the professional development centres. We are therefore pleased to announce that a second meeting of the centres is in the works. It will take place in connection with the 2015 mascil project meeting in Lithuania. Due to the high topicality of the discussed issues in the pre-conference, many participants have already confirmed that they will take part in the next meeting. As we aim to enlarge the circle of participants, we are currently inviting professional development centres from all over Europe to participate in the second European professional development centres network meeting. European Schoolnet has already accepted our invitation to present the SCIENTIX teacher support platform to the meeting participants.

In the long run, it would be desirable and advantageous to hold such meetings on a regularly basis. Indeed, the dates for a third meeting are already being fixed (2-3 December 2015 in Sofia) and we see this as an encouraging development with respect to forging stronger links and networks between these important actors in teacher professional development in maths and science education.

## **2.4 mascil and DZLM - combining research and practice**

The conference was jointly hosted by mascil and the German Centre for Mathematics Teacher Education (DZLM). This collaboration of two important entities from the fields of research and practice proved highly successful. Mascil is coordinated at the University of Education Freiburg, Germany. The institution has been coordinating international projects fostering innovation in math and science education for over a decade. This made it possible for the conference to revert to an international network of currently almost 1000 stakeholders in 'scaling-up professional development in maths and science education' across Europe. The DZLM has a leading role in the field of mathematics teacher professional development in Germany, and therefore represents particularly the practice side.

This co-organisation and co-responsibility were foundational to conference success. Collaboration between research and practice, as demonstrated at the conference, is not only fruitful - but indeed essential, so as to take innovation in maths and science education forward in a coherent and effective manner. Projects like mascil and the research teams and universities behind them and the international community of researchers in maths and science education contribute the research perspective: concepts, approaches, materials and the research-based development, evaluation and improvement of these. Organisations such as the DZLM, other teacher professional development centres across Europe, as well as further actors (multipliers, teacher trainers, etc.) bring in the practice perspective: the needs, affordances, the experiences and feedback to research including calls for where more research is needed. Providing a platform for exchange between researchers and practitioners and

achieving impact became possible only through such collaboration at the organisational level. In fact, this need for continuing to support an exchange between research and practice was one of the core conclusions reached by conference participants.

## 2.5 Trends and needs in Europe to scale-up teacher professional development

The conference was highly topical, meaning that the platform provided by the organisers served to foster discussion and exchange about approaches and challenges to improving the education of educators in maths and sciences – and thus, improve education in these subjects and schools. A final panel and plenary discussion brought key insights from the different tracks together, looked to the future and defined core strategies that are needed for a ‘scaled-up’ teacher professional development.

One of the core messages from the conference is that further and more strongly linking of research and practice is indispensable to moving forward. Also, linking policy to research and practice is necessary.

An example of the urgent need of these links is the demand from the side of policy for innovation in class which could be implemented through use of new teaching and learning materials, such as those based on inquiry-based-learning methods and/or that combine school subjects with the world of work. However, successful, classroom innovation also requires curriculum updates and modification – which, in turn, are reliant upon the availability of appropriate example materials. With this example, the mutual dependency of, and the need for, coordinated action between policy and practice becomes obvious. In addition to having good tasks and providing for their distribution, innovation in class also necessitates knowledge of which learning processes and goals are addressed. This is where the link to research becomes relevant.

A further outcome of the conference and its final discussion was the acknowledgement that policy, practice and research might have different perspectives on learning processes and goals. Such differences are legitimate - however to achieve well-founded and sustainable innovation, such differences need to be the subject of open, mutual exchange. Here, it is the task and demand for practitioners, researchers and policy makers to increase collaboration and communication amongst each other and step up coordinated efforts. This is especially apparent when it comes to detecting and responding to current national and European-wide trends and perspectives. Developing a strong network for European teacher training centres and strengthening the voice of the practice side is therefore an important approach – and a next step towards doing so is the aforementioned second meeting of the centres’ representatives in May 6-7, 2015 in Vilnius, Lithuania.

Another important conference conclusion is that although a range of promising approaches already exists about PD for multipliers who in turn carry out professional development for teachers, much more needs to be done. There is an increased need for development activities (such as the development and evaluation of materials for multiplier and facilitator PD) and most of all, a strong need for more research. Conference participants discussed that it is essential to strengthen further conceptualisation, research and practice-based

testing of effective concepts - like the multiplier concept - in order to implement teacher professional development on a solid basis. Open questions in relation to the multiplier concept are, for example: What are the needs of multipliers when carrying out professional development activities? How can they support teachers who struggle with the implementation of innovative teaching approaches? How can they deal with teachers' fears and complaints?

Furthermore, bringing together different concepts and trends, like the 'use' of multipliers and the establishment of professional learning communities in schools needs to be further elaborated in research. Although a research need, such elaboration should involve the practice side from the beginning. Responding to these research needs will require the support of specific projects, the use of existing networks in research and practice and possibly setting up specialised new research groups to facilitate progress.

This leads us back to the broad need of conceptualising scaled-up teacher professional development in order to target and overcome obstacles to its success. A viable approach discussed at the final plenary was to in future more strongly utilise the concept of professional learning communities. In such communities, one of the teachers, or on occasions, an external 'expert', acts as the facilitator. This means that the learning community is more self-directed and immersed in the realities of day-to-day professional practice than in multiplier-provided PD courses. Combining both the concepts of multiplier-led PD with that of professional learning communities (both in research and in practice) promises to lead to sustainable approaches to scaled-up teacher PD. Professional development is most successful and sustainable when it involves collaboration between teachers and encourages reflection and mutual support. Learning communities are an excellent method of fostering these practices, as teachers' day-to-day professional lives contain inherent hurdles to setting up self-sustaining and sustainable learning communities. These hindrances include factors such as time, engagement or distances – and school-based, professional learning communities can help overcome such obstacles.

In addition, e-learning environments may also be a strategy that helps surmount hindrances to scaled-up teacher PD and at the same time, facilitates the use of professional learning communities. However, as we also learned during the conference, e-learning in teacher professional development has its own inherent obstacles. These include: some educators have reservations about using online learning, difficulties involved in adapting PD materials for use in an e-learning environment and the challenge of securing engagement and sustainability in virtual learning communities. In consequence, the use of e-learning in teacher professional development has been identified as an area with tremendous research needs.

The conference made first crucial contributions to achieving scaled-up professional development of European maths and science teachers by discussing different means of scaling up. In the course of the conference and especially during the final plenary discussion, it became clear that it is

necessary to delve even deeper into key issues relating to 'educating the educators' and the improvement of maths and science education at school. The mascil project and the DZLM are working intensively to meet this request within the framework of the project's final conference to be held in 2016.

## 3 Conference Hosts

### 3.1 mascil: maths and science for life!

K. Maass, D. Wernisch, E. Schäfer, A.-M. Aldorf

*University of Education Freiburg, Germany*

Mascil is a research, development and dissemination project that aims to advance a widespread use of IBL in mathematics and science in primary and secondary schools. A second – but equally important – mascil goal is to directly connect IBL with the world of work (WoW). This second aspect is a major innovation of the mascil project, so as to make students' learning experiences more meaningful and further, to eventually motivate their interest in careers in science and technology.

Education today needs to go beyond helping students increase their knowledge of various subjects. Greater emphasis must be placed on helping young people achieve competences and skills crucial to their lives beyond school, for example being able to work both autonomously and in teams, engage in critical citizenship and take on responsible roles in a knowledge-driven and technology-based society. However to date, 21st century school lessons remain all too often teacher-centred and do not leave much space for students to acquire relevant competences and skills. Next to subject-matter knowledge, students should learn how to: critically investigate problems and phenomena on their own; find solutions independently (supported by the necessary guidance of their teachers); work in groups; and also justify and present their procedures and conclusions. IBL is an effective way to support building such student competences in mathematics and science lessons. Further, IBL equips young people with skills needed to flexibly acquire new competences within their jobs, use their knowledge in concrete situations and to work successfully in teams and become life-long learners. In the dissemination of IBL within the mascil project, much attention is paid to connecting maths and science, as well as to clearly linking these subjects to work-related contexts and using real-life situations. This helps students to experience mathematics and science as meaningful for their personal – and future professional – lives.

Mascil therefore aims to support a stronger uptake of IBL and connection to the WoW in everyday teaching practices in mathematics and science in schools across Europe. The question essential to reaching mascil's goal is: How can we achieve such a change in teaching and learning methods? Despite the manifold activities and important work of mathematics and science educators in the last decades, changes in day-to-day teaching continue to take place slowly. The key element in the trajectory of change and innovation in schools and education is the teacher. This is why the project activities are centred around the teacher, their teaching and their professional development.

Strategies that effectively support the scaling-up of teachers' professional development are therefore at the core of the mascil project. A distinguishing feature of mascil is the interaction of the work carried out on the international level and the concrete efforts on the regional and local level with teachers, schools and national advising boards. This multi-level cooperation supports an effective and sustainable implementation of project activities.

The key project actions can be summarized as a complex multi-level dissemination and implementation strategy of five pillars:

1. Developing and implementing high-quality teacher training courses in IBL. Teachers taking part in mascil training courses experience inquiry-based teaching methods and are able to integrate these into their school practice through interactive cycles of implementation followed by reflection. Within this concept, IBL-trained teachers become mascil multipliers who in turn offer courses to further teachers.
2. Creating IBL materials for use in mathematics and science classrooms which support engaging students in inquiry in rich contexts from the world of work.
3. Carrying out dissemination activities with target groups ranging from policy and educational authorities, to schools and practitioners to parents and pupils to inform them about inquiry-based learning and the activities of mascil. The regularly published mascil newsletter, two international project conferences, (inter)national project website(s) as well as an international teacher communication platform round off mascil's strategies aimed at achieving maximum dissemination and impact at the international level.
4. Fostering local and European level networks that have the potential to scale up the professional development of teachers and support the take-up of inquiry-based learning with a variety of stakeholders such as representatives from industry, teachers from vocational education and school authorities.
5. Supporting these key measures by a research-based analysis of the implementation and policy context(s) and also offering workshops that are specifically devoted to policy makers.

Integrated into the project is a rigorous continuous and summative evaluation strand. The summative evaluation focuses on the overall impact of the implementation of inquiry-based learning and the connection of mathematics and science to the WoW in day-to-day teaching. The ongoing, formative evaluation targets the implementation and dissemination processes and allows for optimisation during mascil lifetime, as well as a deeper insight into the processes, thus contributing to project sustainability and the informing of future work.

The summative evaluation focuses on teachers involved in teacher training and IBL uptake during mascil. Main objectives of this evaluation are: Evaluating IBL implementation in partner countries at national and European

levels; and gathering information to determine if change takes place. In order to accomplish these objectives, a baseline study was conducted. With this tool, the project investigated the current status of IBL and the connection of mathematics and science to the WoW in the different teaching cultures and collected data about existing approaches and implementation challenges in the partner countries. This study provides reliable information about the status quo at project begin:

cf. <http://www.mascil-project.eu/images/pdf/mascilD102FinalVersion.pdf>.

Mascil will be able to use its results to help ascertain changes that occur during and after mascil interventions. The pre-post study uses the status-quo study as a baseline and collects project-related data from the perspectives of 50 - 100 teachers per mascil partner country. This study will give information about participants' use of new knowledge and skills, their learning and their reactions to the experience. Furthermore the consortium will try to focus on organizational support. For example, the following aspects will be evaluated:

- beliefs about IBL
- problems with classroom management
- description of current teaching practice
- connection to the world of work

Additionally, analyses will be carried out looking for effects of independent variables like gender or subject. The overall aim is to identify successful ways of implementation and to describe problems and hindrances in terms of successful implementation.

The objective of the formative evaluation along the course of the project is to provide particular insight into: the professional development (PD) process; the impact of the PD courses; the dissemination process; the impact of the dissemination actions during project lifetime; and factors that either support or hinder the widespread uptake of inquiry-based learning and making connections to the WoW. The formative evaluation is based on the scientific case study approach and takes into account the following aspects of the project:

- It is based on the design of mascil as a whole.
- It takes into account the theoretical concept of the PD course and its aims.
- It takes into account the results of the analysis of the educational background.
- It takes into account the different ways of implementation in the various countries.

In order to make the case studies comparable, a common research question was committed. A definition of cases that should be covered within every partner country was constituted as well:

- Common research question: In relation to the implementation of IBL and WoW, what impact has our overall PD concept on participants? What are the reasons for this impact?
- Common definition of cases across all partnership countries. One professional development course in each country should form the framing from which all cases should be drawn. Within each framing data from the multiplier and several teachers will be collected

Data collection for the case studies involves interviews with teachers and multipliers, PD observations and classroom observations, short teacher questionnaires as well as portfolios of evidence from the teachers and the multipliers. By means of these methods of data gathering, amongst others, mascil aims to receive feedback relating to the professional development courses, the mascil professional development toolkit as well as the material collection.

This multi-faceted evaluation concept allows adapting the processes in mascil, if necessary, and gives in-depth insights into the impact of the professional development courses on selected participants, the multiplier concept and the impact of mascil on participants as a whole.

## **Background information**

Mascil is the currently running project of a long series of European projects (LEMA, COMPASS, Primas) which all aimed at implementing innovative teaching concepts in day-to-day teaching. In all this projects knowledge from research was transferred into practice. All these projects were coordinated by Prof. Dr. Katja Maaß from the University of Education of Freiburg, Germany. Since the start of LEMA in 2006 the University of Education in Freiburg has developed into a hub for international cooperation. Within our international network we have more than 1000 contacts with a growing tendency. More information on the projects and especially on Primas, the precursor project of mascil, with a theoretical concept and a research similar to mascil can be found in Maaß & Doorman (2013).

Project mascil ([www.mascil-project.eu](http://www.mascil-project.eu)) has received funding from the European Union's Seventh Framework Programme. During the four-year mascil lifetime (2013 – 2016), 18 partners from 13 countries are working together to achieve project goals:

- University of Education Freiburg, Germany, coordinating institution
- Foundation for Research and Technology Hellas, Greece
- Utrecht University, The Netherlands
- University of Nottingham, Great Britain
- University of Jaén, Spain
- Gesine Kulcke, Germany (terminated 30 April 2014),
- University of Nicosia (Educational Excellence Corporation Ltd.), Cyprus
- National and Kapodistrian University of Athens, Greece

- Sør-Trøndelag University College, Norway
- Leibniz Institute for Science and Mathematics Education at the University of Kiel, Germany
- Babes-Bolyai University, Romania
- University of Hradec Králové, Czech Republic
- Divulgación Dinámica SL, Spain
- Hacettepe University, Turkey
- Vilnius University, Lithuania
- University of Innsbruck, Austria (terminated 31 August 2013)
- Johann Wolfgang Goethe University Frankfurt a. M., Germany (terminated 28 February 2013),
- Institute of Mathematics and Informatics at the Bulgarian Academy of Science, Bulgaria
- University of Münster, Germany (accessed 01 March 2014)
- University of Vienna (accessed 01 September 2014)

## References

Maaß, K., & Doorman, M. (2013). A model for a widespread implementation of inquiry-based learning. *ZDM - The International Journal on Mathematics Education*, 45(6), 887-899.

## 3.2 DZLM - German Centre for Mathematics Teacher Education – *DZLM Team*

Initiated and founded and financed by the Deutsche Telekom Stiftung, a consortium of eight universities started the German Center for Mathematics Teacher Education (DZLM for short) in summer 2011.

### **Mission**

Both, the universities and all other partners involved in the DZLM have a common mission: To accompany mathematics teachers during their whole career. The continuous professional development (CPD) courses are following a competence framework and design guidelines according to the latest research results in teacher education.

Also, comparable concepts for the support and to secure early education in mathematics are developed. These concepts result in CPD courses for kindergarten and elementary educators.

Federal state laws regulates 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.

### **Activities**

The DZLM is operating within the 16 German federal states in cooperation with partners in these states. Its activities are in line with a coherent concept for mathematics education from kindergarten and elementary education to upper secondary level that includes diagnosis and advancement of students' learning processes in mathematics. The theoretical framework constitutes the foundation of its activities and builds upon theory and is evidence based. A competence model 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 through transparent criteria.

The activities of the DZLM can be structured in four main strands:

### **Certified Qualification Measures**

- Creation of a nation-wide 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

## **Networking and Information**

- Networking 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 in Teacher Education and Professionalization**

- Evaluation of activities of the DZLM 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 fliers
- Joint development of concepts with teacher education institutes and ministries in the German federal states.

## 4 Keynotes: Abstracts and Speaker Information

For the keynotes we could win renowned speakers from the fields of math and science education: Konrad Krainer, Professor and Director of the School of Education at the Alpen-Adria-University Klagenfurt, Austria; Justin Dillon, Head of the Graduate School of Education, University of Bristol, UK and Peter Birch, Coordinator for Education Policy and Systems Analysis, European Commission.

### **Scaling-up professional development: chances and challenges**

K. Krainer

*Professor and Director of the School of Education at the Alpen-Adria-University Klagenfurt, Austria*

The keynote showed that scaling-up professional development as larger regional or even nation-wide initiatives needs taking into account the learning of individuals, schools, teacher education institutions, educational administration and policy and the whole educational system itself. Asking some questions related to the scaling-up of professional development (why, how, how long, with whom), a naïve, a technical and a reflective rationality approach are compared. Based on international experiences and research, the keynote elaborates crucial conducive and hindering factors for sustainable scaling-up of professional development. Finally, some of these factors are discussed related to the Austrian PFL- and IMST-programme (focusing mainly on mathematics, science and language education) which combine nation-wide scaling-up professional development with other measures like the establishment of competence centres and networks.

### **Biography**

Konrad Krainer is professor and director of the School of Education at the Alpen-Adria-University Klagenfurt (Austria). He worked several years as mathematics teacher and wrote his doctoral and habilitation theses in the field of mathematics education. His recent research focuses on mathematics teacher education, school development and educational system development. He is co-editor of several books (e.g., one volume of the International Handbook of Mathematics Teacher Education) and leader of the nation-wide IMST project. Krainer was associate editor of JMTE and is co-editor of the newly established “Journal Praxisforschung”. He was founding and board member of ERME and is member of international scientific committees (e.g., Education Committee of EMS, advisory board of DZLM). He gave several plenary presentations at international conferences (e.g., ICME and PME) and is the Chair of the IPC for CERME 9 (Prague 2015).



## The role of informal science institutions in teacher education

J. Dillon

*Head of the Graduate School of Education, University of Bristol, UK*

In many countries, preservice and inservice teacher education take place under the aegis of university/school partnerships. There is a danger, perhaps, that such a system perpetuates some of the weaknesses in the formal education system. In the US, a significant amount of professional development takes place in museums and science centres and has done for many years. A number of EU projects have provided opportunities for exploring the possible affordances of such informal science learning institutions.

This talk described some of the strategies that have been used in projects such as FEAST (Facilitating the Engagement of Adults in Science and Technology) and INQUIRE (which focused on teacher education in botanic gardens). A number of issues emerged from those and other projects which might assist in the development of more integrated approaches to teacher education across formal and informal institutions.

### **Biography**

After taking a degree in chemistry from the University of Birmingham, Justin Dillon trained to be a teacher at Chelsea College (University of London). He taught in six London schools over a period of 10 years with spells as Head of Chemistry and Head of Science. During this time he studied for an MA (Science Education). Prof. Dillon joined King's in 1989 as a Lecturer in Science Education. He was Deputy Director of the PGCE (Postgraduate Certificate in Education) from 1992-5 and Director of International Education from 1995-2003. In 2006 Prof. Dillon was appointed Senior Lecturer in Science and Environmental Education having completed his PhD and he was awarded a personal Chair in 2010. He has been Head of the Science and Technology Education Group since 2007. Together with two colleagues, Prof. Dillon coordinated the ESRC's (Economic and Social Research Council) Targeted Initiative on Science and Mathematics Education and he has directed King's involvement in a number of research projects including PENCIL, INQUIRE, FEAST and IRIS. He co-edits the International Journal of Science Education and was President of the European Science Education Research Association from 2007-11.



## **Teacher professional development in Europe: perceptions, policies, and practices**

*P. Birch*

*Coordinator for Education Policy and Systems Analysis, European Commission*

Peter Birch will provide an overview of policies and practices for continuous professional development (CPD) in European countries. His presentation focused on the status of CPD and the different approaches that responsible authorities in education have towards professional development of teachers.

The presentation also dealt with the relatively recent findings of the TALIS report (OECD, 2013) on professional training for teachers, and illustrate the paths of investigation that the Eurydice network is undertaking on the subject, as well as the main policies of the European Commission in this area.

### **Biography**

Peter Birch is coordinator for education policy and systems analysis at the Executive Agency Education Audiovisual and Culture of the European Commission. Among other things, he is currently coordinating a report on the teaching profession in Europe focusing on initial teacher education, continuous professional development, job satisfaction, and attractiveness and retention. He has a degree in foreign languages and Master degree in Education with the Open University UK. He has been involved in projects dealing with e-Learning, language learning, and school quality assurance. He has experience as teacher and trainer.

