mascil statement in preparation for the Policy Seminar

„Scaling-up STEM teacher professional development: Overcoming challenges through a research-policy-practice dialogue“

This papers offers main theses and key questions to be discussed at the Policy Seminar on 8th November 2016 within the 2nd Educating the Educators Conference in Freiburg, Germany. In order to achieve maximum impact, discussions at the Policy Seminar will involve high ranking representatives of policy, research and practice.

1. Main challenges and key questions

Europe needs well educated citizens who are able to tackle current and future social and economic challenges with high professional competences, ethical values and well developed thinking skills. Future citizens of Europe, in particular, need a better understanding of science and technology, if they are to participate actively in informed decision-making and knowledge-based societal discourse.

> *European policy discourse has recently emphasized the need to address the so-called grand EU challenges: to promote smart, sustainable and inclusive growth, to find ways to create new jobs and to offer a sense of direction to our societies (EC, 2010) [1]. Addressing these challenges requires future citizens having a better understanding of science and technology, if they are to participate actively in informed decision-making and knowledge-based societal discourse. It also requires future researchers to be equipped with the necessary knowledge and tools to fully participate and take responsibility in the research and innovation process (EC, 2015) [2].*

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This creates a great demand for innovative STEM (science, technology, engineering and mathematics) education of the highest quality. High quality STEM education equips future citizens to understand socio-scientific issues and form evidence-based opinions, applying scientific knowledge, ethical values and inquiry skills. High quality STEM education fosters basic life skills, employability and careers in STEM fields.

> *The key role of STEM education has also been stressed by the European policy discourse. Science education has been defined as “creative education to foster the future needs of society” (Sutcliffe, 2011) [3].*

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To provide for high quality STEM education and to foster change in classrooms, we need effective STEM teacher education and continuous professional development (PD). Effective teacher PD, according to research findings, is grounded in classroom practice and supports the development and evaluation of classroom-based activities; it addresses teachers' pedagogical and subject knowledge, as well as their diagnostic competencies; it is sustained over time and includes phases of knowledge transfer, implementation and reflection. There are encouraging best-practice examples of successful research-based STEM teacher PD, not least from the mascil project (see below), but these are far from widespread.

> *This necessity was identified in the 2015 report to the European Commission "Science Education for Responsible Citizenship" [2] as one of six key objectives and associate recommendations: "The quality of teaching, from induction through pre-service preparation and in-service professional development, should be enhanced to improve the depth and the quality of learning outcomes" (EC, 2015, 8) [2].*

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For a broad-scale implementation of research-based, innovative models of teacher PD — which have visible effects on the teaching culture and on students' learning outcomes in science classrooms — we need effective concepts for scaling up.

> *The 2015 report to the European Commission "Science Education for Responsible Citizenship" [2] has named several problems and challenges in science education, inter alia concerns about quality arising from a mismatch between demand and supply of qualified teachers and about the gap between science education research findings and what happens in the classroom (EC, 2015, 16) [2].*

Key question 1:
How can we provide high quality professional development for large numbers of teachers?

In the endeavour to improve and scale up teacher PD, we encounter challenges and problems on different levels:

- Systemic factors: Inflexible curricula which focus on subject knowledge rather than future-oriented competences; Assessment in tests or end of year exams which do not reward competences fostered by innovative STEM education; Lack of support from school authorities for teachers' continuous professional development; Crowded schedules, not enough working time reserved for PD, lack of incentives for PD (PD being purely voluntary), etc.
- Personal and cultural factors: teachers' competences and beliefs which are challenged by the change of role required when implementing innovative teaching approaches; lack of a culture of collaboration amongst teachers in some countries; low prestige of the teaching profession; insufficient understanding of the high demands of the teaching profession and of the breadth of competences required of teachers and teacher educators.
- Lack of evidence based structures and systems for scaling up: There are few research outcomes to inform the education of multipliers/facilitators, or how to establish professional learning communities (PLC), or how to create materials (including e-learning) for learning in PLC – and there are problems in transferring existing research findings into practice.

(cf. also EC, 2015, 16, [2]; [4]).

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To overcome these challenges all actors and stakeholders in STEM education need to join forces and cooperate — and cooperation requires structures and networks.

This calls in particular for a research-policy-practice dialogue and negotiation over the strategic aims of policy priorities for further educational improvement. Research-policy-practice dialogue is key to, and a prerequisite for, overcoming obstacles and developing ways to scale up high quality teacher PD.

> *This demand is in accord with the following key objective in the 2015 report to the European Commission "Science Education for Responsible Citizenship" [2]: "Emphasis should be placed on connecting innovation and science education strategies, at local, regional, national, European and international levels, taking into account societal needs and global developments." (EC, 2015, 11) [2].*

Key question 2:
How can different stakeholders cooperate in order to pave the way for scaling up high quality professional development for teachers?

2. mascil as an example

The European project mascil (mathematics and science for life, 2013 – 2016) has explored possible steps to address the above mentioned key questions and has made valuable experiences, which we would like to present here.

mascil has promoted inquiry-based learning (IBL) and connecting mathematics and science learning to the world of work — in order to make mathematics and science teaching at school more meaningful for young people and to better prepare them for the challenges of a quickly changing European society. Research has shown that both aspects, IBL and connecting school with the world of work, have not found their way into daily teaching practice yet, but teachers are positively oriented towards them (mascil/ Engeln 2014, 30f.) [5].

mascil has developed an innovative concept of teacher professional development, based on latest research findings about effective continuous professional development — and successfully implemented this concept and thereby made valuable experiences and gathered important research evidence.

mascil has developed a concept for scaled up professional development – by using a variation,depending on the needs of the country, of the Multiplier-Concept, e-learning and blended learning and thereby reached more than 1300 teachers across Europe.

mascil has initiated and promoted networking, and established structures for cooperation on different levels (local, regional, national, EU-wide) between various actors in science and maths education, e.g.

- networks of PD centres and teacher associations across Europe;
- expert regional and European advisory boards comprising representatives of research, policy and practice.

mascil itself comprises research, policy and practice — in the persons of consortium members and associates. In mascil researchers in maths and science education have cooperated with teacher educators, teachers and policy makers, gaining profound insights and making an impact on STEM education and teacher PD. During the course of mascil the cooperation between the different stakeholder groups has significantly increased.

mascil illustrated: Practical examples from implementation in different countries

Norway: Scaling up teacher PD by multipliers, e-learning and e-communication

The Norwegian mascil team has implemented, on the one hand, pre-service teacher training activities for primary science, including the theoretical background for IBL in science, the connection to the WoW, lesson planning, the implementation at classroom level (during practicum) and its analysis/reflections. Additionally, they developed PD courses to train teachers to become multipliers. The PD course concept followed the spiral model, including phases of input – implementation – reflection, and comprised face-to-face sessions, e-learning activities and support through discussions on the international teacher communication platform. The spiral model was supported mainly through the e-communication.

A key factor in the success of mascil teacher PD in Norway has been to involve the whole school/learning community in the PD-programme, even though it was challenging to include teachers who were not teaching mathematics or science. In the training of the multipliers, a key factor for success has been to use lesson studies. This created a fruitful milieu for discussions about important aspects of learning and teaching in general, and of important IBL- and WoW-aspects in particular. The multipliers report that they valued the lesson study cycle highly, they found it interesting to observe each other's teaching, and claim that they learned much through the reflections afterwards. They also state that they became convinced about the tasks and ideas of mascil when they saw that pupils were really engaged and motivated and even involved their parents in evenings and other staff at school.

Besides PD activities on the national level, the Norwegian mascil team has also run several virtual conferences for teachers and/or students in different European countries. The virtual conferences were of great benefit for the participating students and gave teachers the opportunity to learn from each other on an international level.

Turkey: research – policy – industry – practice cooperation live

The Turkish mascil team has developed good relations at a high level, and intensive cooperation with the Turkish Ministry of Education, as well as with key stakeholders and organisations that are influential in the field of science education, e.g. The Scientific and Technological Research Council of Turkey, Feza Gursey Science Center and Small and Medium Enterprises Development Organization. Members of the Turkish mascil team were involved in the development of the new Turkish science curriculum. As a result of far-reaching networking and dissemination activities mascil has been having a substantial influence on policy makers, researchers and practitioners in Turkey.

mascil teacher professional development activities reached large numbers of teachers directly. For example, more than 200 in-service teachers participated in the two-day mascil teacher workshop in Ankara, Nevsehir and Adana, focussing on inquiry-based learning (IBL) in connection to the world of work (WoW). Many teachers reported that the mascil

professional development programme had an important impact on their classroom practices.

A large STEM teacher conference with more than 2000 participants was organised in collaboration with the mascil team on September 3-4, 2016 in Ankara. During a special mascil teacher workshop, around 60 science teachers got to know the mascil resources in detail. Considering the significant number of teachers reached by such workshops, more than 10 000 students are influenced by mascil in Turkey per year.

In order to connect science teaching to the world of work, mascil has cooperated with several Turkish industrial companies. As part of a mascil teacher workshop participants visited the "R&D and manufacturing company of automobile technologies" which produced the first Turkish electrical car. On location, the teachers received first-hand information from the engineers on the application of scientific and mathematical knowledge in the professional practice. Teachers developed awareness that science and mathematics as tools for solving real world problems in the world of work are important aspects of school teaching.

Lithuania: scaling up teacher PD by research – policy – practice cooperation

In Lithuania the mascil team closely cooperates with the Ministry of Education and Science in the field of teacher professional development. In a national policy workshop, organized by Ministry on 20th of January 2015, main issues of the mascil project were presented and discussed under the title "IBL in relation with STEM and desirable results". 21 key persons, representatives from the Ministry of Education and Science, the Centre of Teacher development, the Centre of National Exams as well as the gymnasiums and Universities took part in the workshop. The Deputy Minister of the Ministry of Education and Science and the mascil National Advisory Boards also participated in this event.

This national policy workshop was followed by a second workshop later that year (on 6th of May 2015), when representatives from the international mascil team (from Germany, Spain and the Netherlands) were invited to the Ministry of Education and Science to present experiences from the implementation of the mascil in their countries, and to discuss perspectives for the development of STEM education and teacher professional development in Lithuania.

The latest report on the Lithuanian view of IBL and WoW shows that education policy makers are taking into account IBL and STEAM ideas. But the exam system in Lithuania limits teachers' choice of methods. In reaction to this, the Lithuanian mascil team started to work with teachers all over the country, offering professional development courses for teachers and multipliers. Each multiplier was a teacher and had taught practical lessons at school for at least 5 years. The structure of the training was well designed, comprising two face-to-face sessions and a 4-6 weeks break between them for participants to implement IBL tasks and WoW in their teaching. The implementations were observed by the teacher trainers and reflected and evaluated in the professional learning community, thus ensuring high impact on the teachers' classroom practice.

mascil scaled up: European STEM Professional Development Centre Network

As part of the project activities, mascil promoted the establishment of a practice network of STEM Professional Development (PD) Centres across Europe. The network builds on a European trend, namely, the increasing establishment of specialised centres to support professional development in STEM education. At the same time, the network is responding to the need to strengthen European-level exchange and networking of the practice-side of education. PD Centres, some of which are also involved in the mascil project, met concurrently to the mascil mid-term conference for the first time in 2014. To date, four meetings of the evolving network have taken place; the 5th meeting will take place within the time frame of the Educating the Educators II Conference on 7 November 2016. Currently, the network consists of around 20 STEM professional development centres and other organisations with similar aims and foci such as educational authorities or Ministries of Education from 13 European countries. The University of Education Freiburg serves as the Network Coordinator.

The European STEM PD Centre Network's overall aim is provide a platform for knowledge exchange among its participants and to strengthen their position within their national contexts. Through each of its members the network aims to substantially improve STEM education as it happens on a day-to-day basis in schools, by investing in teacher professional development, ensuring that the design, provision and delivery of STEM professional development is of the highest quality, research-based and corresponding to teachers' needs. The network's aims and activities, as currently defined are geared towards supporting these goals.

The main aims and activities of the network are to:

- Ensure quality in PD
  - enhance and support PD activities across Europe
  - draft common standards and guidelines based on research and including evaluation
  - share experiences, practices & materials
  - share outcomes of research relevant to PD activities
- Communicate to policy makers
  - strengthen the voice of PD centres at the local as well as the European level
  - foster an upward influence of PD Centre's work towards the policy level
  - provide information about European PD centres and their activities to policy makers
- Promote cooperation between all relevant actors – PD centres, universities and researchers in the field, schools and teachers, policy-making entities
  - intensify cooperation between different affiliations of PD centres
  - contribute to scaling-up teacher PD by cooperation
  - create conditions for sustainable PD

3. Stimulus for discussion

The stimulus for exchange of experiences and challenges in international groups stems from on one of two key questions mentioned above in section 1:

1. How can we provide high quality professional development for large numbers of teachers?
   OR:
2. How can different stakeholders cooperate in order to pave the way for scaling up high quality professional development for teachers?

- What experiences have you made addressing this key question? Do you know a best practice example from your country?
- What is your country's greatest challenge concerning this key question?
- Have you profited from mascil or could your country profit from mascil experiences in the future? Have examples/experiences presented within this discussion group inspired you?
- What are the gains from international cooperation?

Stimulus for a following discussion in country groups on "Your country's next steps":

- What are the most important insights you gained from the previous discussion?
- What ideas from other countries could you apply in your country?
- Have you found any cross-country networking opportunities?
- What are your plans for the immediate future? Which steps do you want to take?
- Which steps can each of you take within your position towards improving and scaling up teacher PD and/or networks?
- Which key actors from policy, research and practice do you want to involve in your plans?

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