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Towards Research-based Science Teacher Education: Reflections from a Symposium

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The 18th symposium on Chemical Education entitled *"Research-based Science Teacher Education"* was held at the University of Bremen from 15-17 June 2006. The Symposium attracted researchers and practitioners from the five continents and fifteen different countries. The individual presentations and consequent extensive discussions tapped on various aspects of the knowledge base related to science teachers and science student teachers, and/or their ways of learning and their paths of professional development. The book of proceedings makes available the different presentations and thus encourages further discussion and use by teachers, teacher trainers, and science education researchers. The book also encourages reflections among different stakeholders and future collaboration and work for a continuous and sustainable improvement in the practice of science teacher education.

Participants of the Symposium in front of the Chemistry Building of the University of Bremen

The different presentations focused on new and innovative approaches supported by research evidence, concerning either the professional preparation and development of science teachers. The participants expressed diverse points of view in terms of research approaches and methods, but they also reached some unanimous conclusions.

One main point of discussion touched upon research on Pedagogical Content Knowledge (PCK) of prospective and in-service science teachers.Knowledge about teachers' and student teachers' pre-conceptions was unanimously considered as being crucial for improving science teaching in general. The idea of documenting and evaluating science teachers' PCK was considered as an important catalyst for better understanding their professional development and satisfaction. The nature of this knowledge is considered as sound foundation for developing appropriate training courses and materials. The existing knowledge base is presently limited, but rapidly expanding. Research aligned towards understanding PCK seems to be an actual and important 'hype' in science education research. Coordinated and intensive research efforts targeting PCK knowledge seems to be justified and productive as well.

Shulman's concept of PCK may offer a fruitful framework for describing teachers' domain specific knowledge. But, the concept of PCK is not clearly defined and there exist different models of how to describe teachers' PCK. Loughran's approach of using a combination of Content Representations (CoRe) and case studies on teachers Pedagogical and Professional Experience Repertoires (PaP-eRs) seems to be an interesting way for a better understanding of aspects of PCK in certain content domains. Nevertheless, there is need to elaborate new models describing teachers' PCK in a more detailed way including the factors that influence the development of teachers' PCK at different stages of their training and within different educational systems. It is also relevant to carefully examine how the concept of PCK relates to the learning environment. For example, when integrating ICT in the learning environment the concept of ICT-related PCK may prove fruitful (Valanides, & Angeli, 2005). It is also relevant to examine the implications of teachers' beliefs on science teaching, or the influence of teachers' personality characteristics on PCK development and to what extent teachers' background and studies (physics, chemistry, or biology) determine their PCK .

Discussion on PCK was unavoidably connected to the necessary knowledge and competencies that are required by teachers in order to become successful professionals and effective science teachers. Teachers' content knowledge is always important, but it cannot alone provide appropriate solutions. Teacher should be supported to develop other capacities and appropriate reasoning skills as well. Thus, teacher pre- and in-service education should be tailored to the needs of teachers and should equip them with higher order cognitive skills, evidence-based argumentation capabilities, and science related communication and values within the STS framework.

Another point of emphasis stressed the need to design and implement pre- and in-service education of teachers guided by research evidence. Teachers' involvement in small scale action research was accepted as an effective strategy for transferring research results into classrooms. This strategy recognizes the need to avoid considering teachers as consumers of research evidence and is considered as a

promising strategy for empowering teachers to become and develop as professionals feeling ownership of any attempted innovation, and responsible for their own learning and sustainable professional development.

While discussing research-oriented ways of teacher training, the discussion quite often came to the point to re-conceptualize the teacher more thoroughly as the learner within the teacher training programs. Science teachers seem to hold a great variety of beliefs, ideas, and competencies. Teachers' learning at several points was related to recent research about students' learning and became evident that teachers' learning pathways seem to be very different and individual. Restructuring teachers' learning in a constructivist way asks for evaluating a broader knowledge base of teachers' beliefs and conceptions. Such a research base may offer chances to contrast teachers' initial thoughts to research evidence and design conceptual change approaches for teacher learning.

In conclusion, recent practice of pre- and in-service teacher education seems to follow more traditional concepts of learning and instruction. Research on students' learning in schools may provide interesting perspectives for science teacher education and a sound basis for improving prospective teachers' competencies, capabilities, and beliefs. Research evidence should not only be infused in teacher education courses, but it should also frame the guidelines for reforming teacher preparation and professional development.

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