23rd Symposium on Chemistry and Science Education

Science Education Research and Practical Work

TU Dortmund University of Technology, May 26-28, 2016

Program, Abstracts and Information

(Update April 25, 2016)

The symposium is supported by

http://www.idn.uni-bremen.de/chemiedidaktik/symp2016/index.html

Rationale

The 23rd Symposium on Chemistry and Science Education will continue a long tradition begun in 1981 with the first symposium on chemical education organized by Hans-Jürgen Schmidt. The upcoming symposium will continue this tradition. It will be held at TU Dortmund University for its 2016 session.

The 2016 symposium is titled "Science Education Research and Practical Work".

There is unanimous agreement that learning in the laboratory and experiments are essential parts of any student-oriented science education. However, many promises related to learning in the laboratory proofed in the past not to be self-evident.

Research suggests that just using demonstrations or confirmatory type experiments will not dig out the vast potential of learning with experiments neither for developing an adequate understanding of the Nature of Science, nor will it contribute to the development of problem-solving and inquiry skills.

A lot of research has been done in the last 40 years on learning in the laboratory, however there are still many questions unanswered yet.

The symposium's main questions will address:

- What does research say about the most promising strategies, pedagogies and practices when it comes to practical work in science education?
- What competences are needed to successfully learn with experiments, and how can they be developed?
- What are the challenges for a sustainably connection of theory and practise?
- What topics and pedagogies are the most promising for promoting students' skills in practical work?
- Which role can the informal and non-formal educational sectors play for practical work in science education?
- Which influences do learners' cultural backgrounds have on practical work in science education?
- How can science teachers be educated to create and operate practical work successfully?
- What types of problems arise due to missing capabilities when it comes to practical work in the science classroom?
- How can learning with practical work be assessed in the classroom and beyond?

Venue

TU Dortmund University, located in the West of Germany, has been researching and teaching in the global intersection between man, nature and technology since its establishment in 1968. It has developed a unique profile with a special combination of faculties in the Natural Sciences, Engineering, the Social Sciences and the Humanities. This structure produces new knowledge, methodologies and technical innovations. It also provides deep insights into how technology drives cultural change. All this is achieved through a broad spectrum of innovative research in more than 60 Bachelor's and Master's programs, including a broad-based teacher training curriculum.

Modern research is interdisciplinary – a principle to which all TU Dortmund faculties subscribe. This is especially visible in the four profile areas established by the TU Dortmund University. Two of these are directly tied to the field of science education. One of the profile areas focuses on Chemical Biology and Biotechnology and brings together several strong partners. In this forum, Germany's largest faculty of Biochemical and Chemical Engineering, Dortmund's Max Planck Institute of Molecular Physiology, and the Faculty of Chemistry and Chemical Biology (CCB) cooperate with other research institutions. Another profile area is Youth, School and Education Research, a group providing significant impulses for national and international educational policies.

Prof. Dr. Insa Melle
Dean CCB-Faculty

Program

Thursday, 26/05/2016

10:00-10:30	Welcome – Intentions of the symposium	I. Eilks (Bremen, DE)
	Morning session	*Chair I. Eilks*
10:30-11:15	What research says about practical work in science teaching and learning: What do we know and what do we know only vaguely?	Avi Hofstein (Rehovot, IL)
11:15-12:00	From elaboratory to e-laboratory: On the history of practical work in school science	Peter E. Childs & Aishling Flaherty (Limerick, IE)
	Lunch break	
	Afternoon session I	*Chair V. G. Zuin*
13:00-13:45	Understanding science as a cultural practice from re-enacting historical experiments	Peter Heering (Flensburg/DE)
13:45-14:30	How to identify and encourage scientifically interested students through laboratory work	Sandra Frach & Bernd Ralle (Dortmund/DE)
14:30-15:15	Student learning processes in classroom and remote laboratory settings	David F. Treagust, Damien J. Carter, Euan D. Lindsay, Marjan G. Zadnik, Mauro Mocerino & Anthony D. Lucey (Perth and Bathurst/AU)
	Coffee break	
	Afternoon session II	*Chair A. Hofstein*
15:30- 16:15	Microscale experimentations in science classes: Research, development and implementation	Muhamad Hugerat (Haifa/IL)
16:15-17:00	Pupils Research Briefs - implementation of the project ''Chain Reaction'' in Georgia	Marika Kapanadze, Natela Bagatrishvili & Ekaterine Slovinsky (Tbilisi and Telavi/GE)
19:00	*Welcome evening at Hövel's*	

Friday, 27/05/2016

	Morning session I	*Chair D. F. Treagust*
09:00-09:45	Alternative experiments for the undergraduate chemistry laboratory considering the Brazilian context: The synthesis of methyl salicylate	Dorai P. Zandonai, Karla C. Saqueto & Vânia G. Zuin (Sao Carlos/BR)
09:45-10:30	Cultural background and the science laboratory learning environment: Malaysian lower secondary students' perspective	Mageswary Karpudewan & Chua Kah Eng (Penang/MY)
	Coffee break	

	Morning session II	*Chair P. Labudde*
10:45-11:30	Different faces of practical work: Activity-based instruction and its impact on learning	Maria Oliver-Hoyo (Raleigh/US)
11:30-12:15	To DAPS or to IAPS: That is the question	Ian Abrahams (Lincoln/UK)
	Lunch break	
13:15-14:45	*Afternoon session I* Short communications and poster session with coffee	*Chair S. Markic*
	Afternoon session II	*Chair P. E. Childs*
14:45-15:30	Supporting practical work in science education through the non-formal learning environment, ChemistryLab Gadolin	Maija Aksela (Helsinki/FI)
15:30-16:15	Supporting practical science learning for all students - A German cross-country initiative in non-formal chemistry education	Fiona Affeldt, Antje Siol, Silvija Markic & Ingo Eilks (Bremen/DE)
16:15-17:00	Effect of out-of-school science laboratories' preparation and post enhancement	Matthias Streller, Gesche Pospiech (Leipzig/DE) & Avi Hofstein (Rehovot/IL)
18:00	*Sightseeing and conference dinner* *Buses start from the conference venue at 17:30*	

<u>*Saturday, 28/05/2016*</u>

	Morning session I	*Chair M. Oliver-Hoyo*
9:00-9:45	Praxis of practical work in science with visually impaired students	Mustafa Sözbilir (Erzurum/TR)
9:45-10:30	Learning in the tertiary level chemistry laboratory: What we have learnt from phenomenology research	Santiago Sandi-Urena (San Jose/CR), Todd A. Gatlin (Gainsville/US) & Matthew Chrzanowski (Cleveland/US)
	Coffee break *Morning session II*	*Chair B. Ralle*
11:00-11:45	Experiments in science instruction: For sure! Are we really sure?	Peter Labudde (Basel/CH)
11:45-12:30	Explaining science: Between scientific explanations and science teaching explanations	Christoph Kulgemeyer (Bremen/DE)
12:30-13:00	A look back and ahead – Personal reflections on the last 15 years of symposia on chemistry and science education in Dortmund and Bremen	Rachel Mamlok-Naaman (Rehovot, IL)

Abstracts

What research says about practical work in science teaching and learning: What do we know and what do we know only vaguely?

Avi Hofstein, Rehovot/IL

Over the decade many research studies were conducted with the goal in mind to explore the effectiveness of the laboratory for attaining the many objectives (both cognitive as well as affective) that had been suggested in the science education literature. Precisely what kind of objectives and aims will be attained in the laboratory dependent on a wide range of factors? We suggest that, amongst others, these will include the teacher's goals, expectations, subject and pedagogical content knowledge as well as the degree of relevance to the topic, the students' abilities and interests, and many other logistical and economic considerations related to the school settings and its facilities. Over the years, based on research, in education in general and on science teaching and learning in particular we learned a lot about issues related to teaching and learning ,on students' behaviour and interactions in the classroom on the effectiveness of ICT in the classroom, and on methods to enhance the effectiveness of the learning. I shall devote most of my lecture in the Dortmund symposium to the issues that I believe were either neglected or were hardly researched. These are areas that that are aligned with the needs of both those who are going to embark science related careers and also future literate citizens. Among these I shall present abilities related to argumentation and metacognition resulting from students interactions with their peers and teachers in the lab, the integration of ICT in the laboratory, and issues related to the laboratory in in the context of learning of socio-scientific issues.

From elaboratory to e-laboratory: On the history of practical work in school science

Peter E. Childs & Aishling Flaherty, Limerick/IE

Science as a school subject is less than 200 years old. Our word laboratory for the place where practical work is conducted comes from the older word *elaboratory*, a place where learned effort was used to solve scientific problems. The 'e' was later dropped and the word laboratory is often shortened to lab. In the 21st century the use of ICT in teaching and learning has led to the rise of the e-laboratory, with data-logging and simulations. Science in school at the start was largely determined by a top-down diffusion of content, methods, aims and facilities (laboratories and equipment) from scientists working in universities. The teaching of science was dominated from early on by an emphasis on science as fact rather than science and practice, and assessment in the form of external examinations, set, moderated and marked by university scientists, dominated the way science was taught. This is still true in many countries. It was only in the 1960s onwards with new curricular reforms, and particularly with the move to science for all in the 1980s, that teachers began to have a bigger role in determining the curriculum (content, pedagogy, outcomes and assessment). In this talk we will trace the development of practical work in school science and the different emphases, aims and purposes it has had over the last two centuries. We will consider the philosophy underpinning practical work and the deadening effect of examinations on practical work. The work and influence of some Anglophone science educators, like Henry Armstrong (heurism), Gordon van Praagh (Nuffield) and David Waddington (Salters), will also be considered. The value of practical work in school science, and whether or not it helps understanding, is still a matter of live debate and concern.

Understanding science as a cultural practice from re-enacting historical experiments

Peter Heering, Flensburg/DE

When educators refer to historical experiments, they usually address what one might call "great experiments" from the discipline. And the references usually stress the importance of the outcome of these experiments as these were constitutive for the content that is to be taught or learned. In these accounts, the experiments are usually described as being straightforward, unproblematic and providing clear evidence. However, things change when one tries to re-enact a historical experiment. Difficulties may arise already when trying to duplicate the working principle with modern materials. Things may get worse when trying to re-enact the experiment according to the source information. However, this is not only creating difficulties, but at the same time this process provides learning opportunities. Consequently, re-enacted historical experiment can enable students to develop not just a conceptual or procedural understanding. By being confronted with experiments that follow standards significantly different to the ones established nowadays, students are also enabled to reflect on scientific practices as being time dependent. Consequently, these experiments offer an opportunity to experiences scientific procedures as a cultural activity.

How to identify and encourage scientifically interested students through laboratory work

Sandra Frach & Bernd Ralle, Dortmund/DE

Generally, in Germany student-labs are informal learning environments that are highly convenient for students to explore interesting scientific topics through experiments. Often these experiments attach to current research topics of the lab-operators, which are for example universities or research centres. Moreover, commonly the experiments allow inquiry based learning by considering the students interest. Consequently, student-labs facilitate a perfect setting for sustainably encouraging scientifically interested students. Yet there is a lack of information about how to identify these students. Thus, it is difficult to motivate as much interested students as possible to evolve their abilities according to scientific literacy that finally is crucial for sustainably encouraging them. Therefore, we designed and investigated a learning environment for ascertaining indicators that allow the identification of scientifically interested students. Ensuing from the underlying concept of the learning environment the talk will present and discuss our findings according to the identification of these students in informal learning settings, which include experiments.

Student learning processes in classroom and remote laboratory settings

David F. Treagust, Damien J. Carter, Euan D. Lindsay, Marjan G. Zadnik, Mauro Mocerino, Anthony D. Lucey, Perth and Bathurst/AU

Existing literature of both classroom and remote laboratories has focused more on learning outcomes and less on learning processes. This project aims to examine the mechanisms through which students learn in classroom and remote laboratory settings and answer key questions such as: With whom and with what do students interact, and what is the purpose of these interactions?, How do the patterns of these interactions correlate with students' learning and assessment outcomes?, and Which of these interactions must be preserved in a shift to the remote access mode? These questions are answered by observing, recording and analysing students in physical laboratory classes and by using this analysis to guide the development of the next generation of remote laboratory interfaces. The presentation will provide a summary of the background literature and update of progress on the research project.

Microscale experimentations in science classes: Research, development and implementation

Muhamad Hugerat, Haifa/IL

Professional development of educators at different levels is leading to change and improve the capabilities and achievements of the education. Teachers can act as powerful mediators in introducing change. In order to introduce a change, the teacher, himself, must go through a learning process. In this process, the teacher is an active partner in the creation of change. This involvement is a constructivist teaching model, which is essential in the introduction of such a process. Pre- and in-service teachers training workshops encourage the implementation of approaches, attitudes and scientific - technological - and social literacy among the participating teachers. In this lecture we will present simple and feasible idea to introduce the microscale experiments using accessible materials in the classroom. We introduce this activates for pre- and in-service teachers and we examine the impact of this implementation. We believe that these activities motivate the pre- and in-service to be more creative in designing new methods in teaching and learning chemistry, and encouraging their students to be more active learning and creative in their classes. The project was taught by inquiry while using strategies that promote higher-order thinking skills (HOTS) like case studies and reading scientific research articles. The study found that learning methods had a significant effect on developing HOTS among the study participants. Also, the teachers expressed positive attitude, both emotionally and cognitive as a result of the intervention.

Pupils Research Briefs - implementation of the project ''Chain Reaction'' in Georgia

Marika Kapanadze, Natela Bagatrishvili, Ekaterine Slovinsky, Tbilisi and Telavi/GE

''Chain Reaction'' is a three years (2013-2016) project funded by the FP7 program of the European Commission. The project aims at developing Inquiry-Based Science Education (IBSE) across twelve partner countries. The resources used in the ''Chain Reaction'' are based on Pupil Research Briefs (PRBs), which are problem solving and inquiry-based classroom activities covering topics from space science, via environmental education, to the impacts of climate change. Using critical thinking, reasoning, and problem solving skills students in the age range of 14-16 years work together in groups to solve scientific scenarios. The implementation of ''Chain Reaction'' in Georgia will be discussed. The feedback of the teachers and students after implementation of the Pupil Research Briefs, the development of their IBSE competences and the results of the study on Georgian science teachers' constructs of IBSE will be presented as well.

Alternative experiments for the undergraduate chemistry laboratory considering the Brazilian context: The synthesis of methyl salicylate

Dorai P. Zandonai, Karla C. Saqueto & Vânia G. Zuin, São Paulo/BR

This work presents an alternative green experiment to the synthesis of methyl salicylate by esterification with microwave irradiation for a first-year undergraduate course in Chemistry at a federal university in São Paulo state, Brazil. The proposal began with an introductory lecture with an emphasis on a Brazilian scientific problem, which focused on the application of methyl salicylate as repellent to Boophilus microplus larvae. An investigative laboratory practice was then proposed, which included the conceptual content initially comprehended in the course syllabus associated with new procedural and attitudinal contents emphasising environmental and Green Chemistry education. In addition, the practice using a holistic metric known as Green Star (GS) was reviewed. The analysis of the results showed that the proposal enabled students to understand the contents in a complex context, including socio-scientific issues and Green Chemistry in a critical investigative approach, understood as an important requirement for initial teacher training nowadays.

Cultural background and the science laboratory learning environment: Malaysian lower secondary students' perspective

Mageswary Karpudewan & Chua Kah Eng, Penang/MY

Science practical work is an essential element that determines the success of science education. Practical work permits students to transfer their content knowledge learnt in the science classroom into practice. Science laboratory work provides students with hands-on opportunity to explore the real science and at the same time give them the insights of science theory as well as knowledge transfer. For this reason, a positive science laboratory learning environment is important for science learning. Students' cultural background plays an important role in engaging in science practical work. Following this claim through this study attempt was made to investigate how Malaysian students from difference cultural background perceive the science laboratory learning environment. For this purpose, Science Laboratory Environment Inventory was administered to 433 lower secondary students, aged between 13-15 years from Northern Region of Malaysia. The data was analysed using One-Way ANOVA to determine how different cultural groups perceive the learning environment. Results have shown that there are statistically significant differences on how students from different cultural background perceive the science laboratory learning environment. As such the findings of this research suggest that cultural background of the students need to be considered in designing effective laboratory learning for the students to experience better science learning environment.

Different faces of practical work: Activity-based instruction and its impact on learning

Maria Oliver-Hoyo, Raleigh /US

Transforming lecture into activity-based instruction allows the incorporation of practical work into the classroom, and this approach has shown to promote student's engagement and to positively affect both students' performance and attitudes. The format is known as cAcL2 (concept Advancement through chemistry Laboratory-Lecture) and its most prominent characteristic is the combination of laboratory and lecture components into one integrated mode of instruction. In this integrated approach, lecture time is minimized while time devoted to inquiry-guided activities is maximized.. Our studies have provided evidence of the benefits this integrated format can offer to student's learning and to their attitudes toward learning chemistry. Developed activities target the exploration of concepts and may involve wet chemistry, simulations, worksheets, or analogies. Over one hundred activities have been developed for the general chemistry curriculum (first year chemistry). Highlights of the different types of activities will demonstrate the diverse nature of practical work. A more detailed description will be presented on the development and use of original analogies designed to connect core scientific principles to those pertinent to the nanoscale. Evidence of analogical transfer surfaced during both group discourse and post-activity individual interviews.

To DAPS or to IAPS: That is the question

Ian Abrahams, Lincoln/UK

This paper considers how practical skills, developed within the context of practical work, are currently summatively assessed in school science in a number of countries and makes comparisons with how other subjects, such as music and modern foreign languages, summatively assess practical skills. Whilst practical skills in school science are seen by many, at least when loosely defined, as being important there remains a lack of clarity as to what these practical skills actually are and, significantly, how such skills might, most effectively, be validly assessed. Countries vary greatly in the extent to which they employ what have been termed DAPS (Direct Assessment of Practical Skills) or IAPS (Indirect Assessment of Practical Skills) as a means of assessing students' practical skills across a range of subjects. However, whilst each of these approaches has advantages and disadvantages an over reliance on IAPS raises questions about its validity as a means of assessing students' proficiency in what are, essentially, 'hands-on', rather than 'minds-on', practical skills.

Supporting practical work in science education through the non-formal learning environment, ChemistryLab Gadolin

Aksela Maija, Helsinki/FI

ChemistryLab Gadolin is a eight-year-old non-formal learning environment at University of Helsinki built together with university and chemical industry. It is supporting and developing meaningful chemistry teaching and learning through three different roles: (i) it is a research and development center beside the Unit of Chemistry Teacher Education in which novel research-based practical activities are developed, (ii) it is a modern study visit place-free of charge-for students aged 7–20 in which novel practical activities can be tested, and (iii) it is a training place for teachers and future teachers. About 4000 students are visiting ChemistryLab Gadolin every year. The study visits can include practical work, computer modelling and visits to the research laboratories, including communicating with scientists about their research. School teachers can choose the contents best serving the content and method objectives suitable for their curricula. The basics of the subject at hand are studied in school before the study visit in Gadolin and continued afterwards to support the meaningful chemistry learning. Student teachers are trained to guide the students during the visits. Novel practical activities are developed through design research as a part of teacher education. Some examples are explained in details.

Supporting practical science learning for all students - A German cross-country initiative in non-formal chemistry education

Fiona Affeldt, Antje Siol, Silvija Markic & Ingo Eilks, Bremen/DE

Non-formal learning environments for secondary school students, called *Schülerlabor*, were founded in many German universities originally for motivational purposes to overcome a shortage in young people embarking into academic careers in science and engineering. Thus, *Schülerlabor* settings in the beginning were mainly focusing older and higher achieving students. These students can be considered being generally skilful and interested in learning science. This paper reports another approach. The project "Chemistry, Environment, Sustainability: Non-formal Learning Environments for All Students" focuses thoroughly science learning for all students in a *Schülerlabor* environment. A special model for differentiated teaching and learning *Schülerlabor* environments was developed and will be presented. This model takes into account students' diversity in their personal interests, cognitive achievements, problem-solving skills, and linguistic capabilities. The project also focuses creative approaches to chemistry experiments for motivating also those students who are less skilful and less motivated.

Effect of out-of-school science laboratories' preparation and post enhancement

Matthias Streller, Gesche Pospiech, Dresden/DE, & Avi Hofstein, Rehovot/IL

Research on science laboratories revealed numerous educational benefits. The same applies for out-of-school science laboratories. Especially the promotion of students' interest in science is one of most decisive objectives of such laboratories. However, despite their positive temporary effects, approaches to increase outcomes or to develop sustained changes are in demand. Therefore, this research investigates the impact of a preparation and post enhancement on the out-of-school laboratory effects. The implementation was realized via an online portal. In order to compare students who used the online portal with those who just regularly visited a one-day activity in an out-of-school laboratory, a control treatment empirical research was conducted. The evaluation follows a longitudinal approach with pre-, post-, and follow-up measurements. Based on the results of this research, it could be confirmed that the online portal, as a tool to prepare and post enhance students, had a positive impact on the outcome of out-of-school laboratories' activities. Accordingly, students' interests as well as related features were promoted. Effects on subgroups are furthermore presented, including three different classes of students which were identified based on students' interest in science.

Praxis of practical work in science with visually impaired students

Mustafa Sözbilir, Erzurum/TR

Science education is essential to the development of any nation. That is why every nation take science education serious at all stages of schooling. The mission of science education, in terms of school establishments, is to prepare individuals who would develop a certain level of scientific understanding and basic scientific process skills. Developing basic scientific process skills requires practice in and out of school. Therefore, practical works are seen as a prominent feature of school science teaching in many countries, and it is acknowledged that good quality practical work promotes the engagement and interest and curiosity of students as well as developing a range of skills, science knowledge and conceptual understanding. Learning science requires intensive use of our senses, particularly eyes to be a good observer. However, some of the individuals, have difficulty in using their eyes due to visual impairments. Although there are different definitions, visual impairment is used as an overall term that encompasses all people with decreased vision, regardless of the severity of their vision loss. In terms of educational purposes, the visual impairment is used to describe children whose visual condition in such that special provisions are necessary for their successful education. In this presentation, visually impaired students' needs in carrying our practical works and learning science will be discussed. In addition, sample learning materials which were developed to meet those students' needs will be presented. Recommendations will be made how to adapt science curriculum to visually impaired students.

Learning in the tertiary level chemistry laboratory: What we have learnt from phenomenology research

Santiago Sandi-Urena, San Jose/CR, Todd A. Gatlin, Gainsville/US & Matthew Chrzanowski, Cleveland/US

In 1915 E. B. Spear posed one of Chemistry Education's persisting questions: Is the potential of chemistry laboratory instruction being effectively realized? Despite its widely professed centrality, the academic chemistry laboratory is often a neglected area of teaching and, it could be argued, of research as well. Research has mostly focused on secondary education, single institutions, and isolated interventions as opposed to searching understanding of broader aspects of learning through experimentation. This paper argues for the need of tertiary-level, subject specific research that shifts from a fragmented and instruction-based emphasis to one that is comprehensive and learning-centred. In doing so, it discusses a series of studies that investigate the learning experiences of students and their instructors across three universities and four laboratory programs using diverse learning environments. Furthermore, it puts forth qualitative approaches such as phenomenology may be better suited to deal with the complexities of learning through experimentation. The current state of research in the field, associated methodological challenges, and outcomes and implication from this series of phenomenological studies will be discussed.

Experiments in science instruction: For sure! Are we really sure?

Peter Labudde, Basel/CH

"Each lesson at least one experiment!" A credo in science education: Almost all science educators, teachers, and students agree on this statement. In science instruction the planning, performance, evaluation and interpretation of experiments dominate most of the lessons. Science standards and curricula focus on experiments; teachers are in favour of hands-on-activities and practical work; students love activities in biology, chemistry, and physics. So far - so good? But, many empirical studies show severe problems in doing experiments. In the talk, some of the problems are presented and discussed:

- the role of hands-on-activities and practical work in German and international competence models and curricula;
- the quantity and quality of experiments in physics classes grade 9 and 10 in the tri-national study QuIP (Quality of Instruction in Physics) in Finland, Germany and Switzerland;
- formative and summative assessment of students during inquiry based learning.

Explaining science: Between scientific explanations and science teaching explanations

Christoph Kulgemeyer, Bremen/DE

The laboratory as a learning environment plays an important role in science education. Experiments are used with a broad range of aims in science classroom, including learning science content (with the experiment serving as kind of a "medium"), achieving experimental skills (where skills to conduct experiments are an educational objective) and learning about the nature of science. In this talk I will focus on the role of experiments for explaining science. I will start by distinguishing two perspectives: (1) scientific explanations and the nature of science and (2) science teaching explanations. Later I will focus on the latter and report on the development of science teaching explain skills in academic teacher education and a core question for teacher education: what is more important for teacher trainees to learn in order to perform well in actual teaching – content knowledge or pedagogical content knowledge? I will present the results of a large-scale assessment of teacher trainees at German universities that used written test instruments and an innovative performance test for explaining skills.

Short Communications / Posters

1. Natela Bagatrishvili, Marika Kapanadze and Ekatarine Slovinsky (Tbilisi, Georgia)
   Inquiry Based Science Education in Georgia
2. Meliha Zejnilagić-Hajrić and Ines Nuić (Sarajevo, Bosnia and Herzegovina)
   Study Programms and Practical Work for Chemistry Student-Teachers in Bosnia and Herzegovina
3. Snježana Smerdel and Meliha Zejnilagić-Hajrić (Split, Croatia; Sarajevo, Bosnia and Herzegovina)
   The Impact of Research-Based Activities on the Students` Affective Experience
4. Lana Šarić (Zagreb, Croatia)
   "Kitchen Chemistry" in Croatian Kindergartens and Primary Schools
5. John Oversby (Reading, UK)
   Practical Work Provoked and Promoted by the History of Science: A Way into the Nature of Chemistry
6. Johanna Dittmar and Ingo Eilks (Bremen, Germany)
   Practical Work, Cooperative Learning and Internet Forums - An example on Teaching about the Chemistry of Water
7. Johanna Dittmar, Christian Zowada, Shuichi Yamashita and Ingo Eilks (Bremen, Germany; Chiba, Japan)
   Pimping Experiments with Alginate Bubbles - Examples from the TEMI Project in Germany
8. Milada Teplá, Eva Stratilová Urválková and Hana Čtrnáctová (Prague, Czech Republic)
   Courses on Teaching with Mysteries Incorporated in the Czech Republic
9. Miroslav Pražienka, Petr Šmejkal and Pavel Teplý (Prague, Czech Republic)
   Murder of Jeweler Beketov - Teaching Electropotentioal Series with TEMI
10. Laurie Ryan and Peter E. Childs (Limerick, Ireland)
    To Develop, Implement and Evaluate a Transition Year Module Based on the Principles of the Teaching Enquiry with Mysteries Incorporated Project
11. Elisabeth Hofer, Anja Lembens and Simone Abels (Vienna, Austria; Lüneburg, Germany)
    Enquiry-based Science Education in Austrian Teacher Professional Development Courses
12. Catharina Schmitt and Michael Schween (Marburg, Germany)
    Understanding Organic Chemistry – Introducing Basic Concepts with New Experiments on the SN1-Mechanism
13. Andreas Trabert and Michael Schween (Marburg, Germany)
    From Reactions to Mechanisms – A Concept-based Approach to Proposing Mechanisms Illustrated by the Example of Alkaline Ester Hydrolysis
14. Canan Cengiz (Trabzon, Turkey)
    The Evaluation of General Chemistry Applications Based on Reflective Thinking
15. Silvija Markic, Katharina Schneider and Anja Wessels (Bremen, Germany)
    Parents and Students Cooperatively Experiencing Chemistry

16. Cana Bayrak and Bernd Ralle (Dortmund, Germany)
    Language around the Curriculum: A new Learning-setting for Pre-service Teachers in Chemistry
17. Aishling Flaherty, Anne O'Dwyer, Peter Childs and Sibel Erduran (Limerick, Ireland)
    A Pedagogical Framework for Graduate Teaching Assistants in Facilitating Meaningful Learning Experiences during General Chemistry Laboratory Sessions
18. Marianna Leuckefeld and Johannes Bohrmann (Aachen, Germany)
    The Influence of Guided Inquiry-based Learning in a Student Laboratory and Scaffolding Materials on the Quality of Motivation
19. Nina Hamidah, Susy Yunita Prabawati, Imelda Fajriati and Ingo Eilks (Yogyakarta, Indonesia; Bremen, Germany)
    Lesson Learned from Germany in Incorporating the Principles of Green Chemistry in Chemistry Education
20. Stefanie Langenstück, Ullrich Englert, Michael Schröder and Kerstin Kremer (Aachen, Germany; Kiel, Germany)
    Crystal Structure Determination and Structural Chemistry - An Experimental Interdisciplinary Approach Bridging Educational Contents and Technological Contexts
21. Thomas Elert and Maik Walpuski (Essen, Germany)
    The Relationship between Prior Knowledge, Aim Orientation and Course Success in the General Chemistry Lab
22. Miia Rannikmäe, Jack Holbrook and Klaara Kask (Tartu, Estonia)
    Scientific Problem Solving Embedding Practical Work in the Frame of a Student Relevant Context Based Approach
23. Doris Elster und Julia Birkholz (Bremen, Germany)
    Context-based Learning and Practical Work at the Basci-lab Bremen - Issues and Challenges

General information

Conference chairs and contact

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Venue
TU Dortmund University, International Meeting Center (IBZ), Emil-Figge-Straße 61, Dortmund

Information on the Web
Symposium
http://www.idn.uni-bremen.de/chemiedidaktik/symp2016/index.html

TU Dortmund University
www.tu-dortmund.de

How to get to Dortmund
http://www.idn.uni-bremen.de/chemiedidaktik/symp2016/index.html

Dortmund
http:/www.dortmund-tourismus.de

Accommodation
http://www.dortmund-tourismus.de or any other booking portal

We have booked a limited contingent of rooms for "SoSy2016":
NH Hotel, Königswall 1. D-44137 Dortmund
www.nh-hotels.de/nh/de/hotels/deutschland/dortmund/nh-dortmund.html
Tryp-Hotel, Emil-Figge Strasse, 41, 44227, Dortmund
http://www.melia.com/de/hotels/deutschland/dortmund/tryp-dortmund-hotel/index.html
Hotel IBIS Dortmund West, Sorbenweg 2, 44149 Dortmund
http://www.ibishotel.com/de/hotel-0489-ibis-dortmund-west/location.shtml
Mercure Hotel Dortmund City, Kampstraße 35-37, 44137 Dortmund
http://www.mercure.com/de/hotel-2900-mercure-hotel-dortmund-city/index.shtml

Social Program

Early Arrivals, Wednesday, May 25, 2016, 19:00

For those who already arrived on Tuesday/Wednesday we will make a reservation at 19:30 in the restaurant `Alter Markt´ (Markt 3, 44137 Dortmund). Dinner is served a la carte. All costs are on the participants.

Welcome evening, Thursday, May 26, 2016, 19:00

The welcome evening will take part on Wednesday at 19:00 in the restaurant Hövel's in the centre of Dortmund (Thier-Galerie Dortmund, Hoher Wall 5-7, 44137 Dortmund). On this evening dinner will be offered a la carte. All costs of this evening are on the participants.

To allow our planning please register for this evening with the registration form up to April 25, 2016.

Sightseeing and Conference Dinner, Friday, May 27, 2016, 18:00

1995

2015

In 2001 started a new era for the district Hörde in Dortmund, 160 years of industrial history ended with the beginning of the Phoenix See, the largest urban development projects in Germany. On the area of the former blast furnace and steel plant site of ThyssenKrupp newly formed and developed a new recreational area. In 2005 the first cornerstone was laid on the Phoenix area. The work started with full speed to manage the work with over 2.5 million cubic meters of ground motion and 420,000 cubic meters of ferroconcrete.

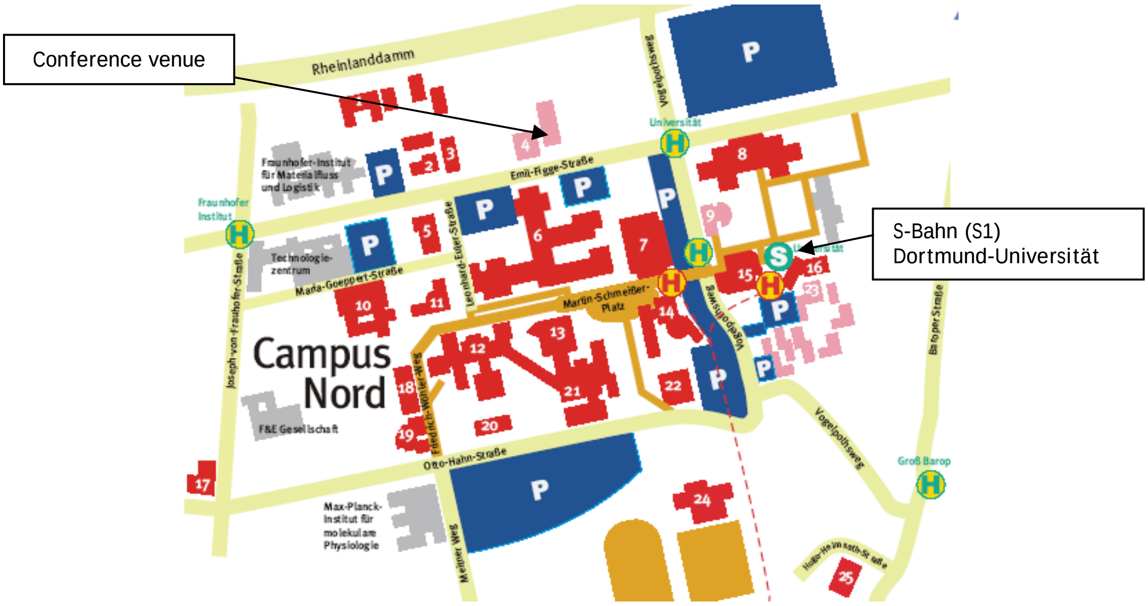
The new lake invites for walking, jogging, cycling or skating. The 3.2 km long pedestrian and bicycle paths invite visitors to relax, as well as to sporting activities. Not only sports has the Phoenix See to offer, on the shores of the lake form high-end residential units, commercial offices, a floating stage with a marina and a promenade with restaurants. Ten years was scheduled, the official start of the flooding was on October 2010. Since May 9th 2011, the fences disappeared and the Phoenix See has been completed.

The price including bus-transfer and dinner (restaurant 'Die neue Ess-Klasse') is **50 €**. A reduced price of **40 €** is offered to students and doctoral students with half a salary or less. Please add a respective attestation to your registration. Number of reduced tickets is limited. Costs for drinks have to be paid individually.

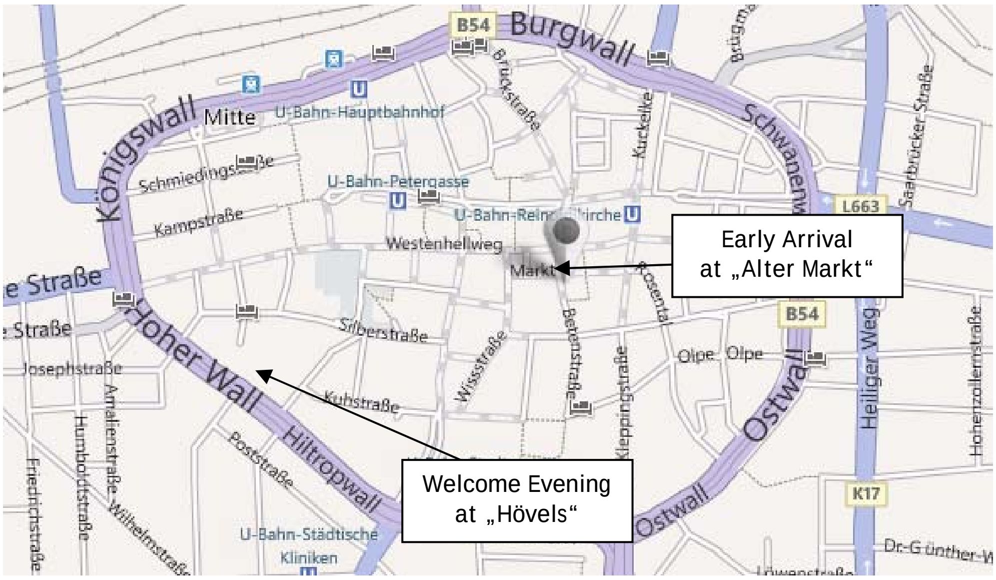
Payment is required up to April 15, 2016, to Volksbank Dortmund IBAN: DE70441600142480686900*, SWIFT/BIC:* GENODEM1DOR*. Keyword "SoSy2016". Participants from outside the EU may pay at the conference office on Thursday.*

Registration for this evening is obligatory with the registration form not later than 15 April 2016. The capacity of the reduced price tickets is limited.

Map A: Dortmund Campus



Map B: Dortmund City



Science Education Research and Practical Work

23rd Symposium on Chemistry and Science Education in Dortmund, May 26-28, 2016

Registration Form

The 23rd Symposium on Chemistry and Science Education at the TU Dortmund University is free of charge. Nevertheless to allow better planning all persons interested to come are asked to register up to **25 April 2016**.

Name: ____

Affiliation/Address: ____

____

Email: ____

I will participate: YES ◯ NO ◯

A book of invited papers inspired by the symposium will be published in late summer 2016. The book will be 30 Euro (p&p included) if ordered on the conference. Order can be given at the conference office or via fax to Ingo Eilks (Fax: +49 421 218 63288).

I'm interested in the book of proceedings: YES ◯ NO ◯

For the social events registration is requested not later than **25 April 2016**.

I will participate on the Early Arrival Evening and Dinner on Wednesday, May 25, 2016 (On this evening all costs are on the participants. Registration is just to allow planning for the restaurant.)	*YES* ◯	*NO* ◯
I will participate on the Welcome Evening and Dinner on Thursday, May 26, 2016 (On this evening all costs are on the participants. Registration is just to allow planning for the restaurant.)	*YES* ◯	*NO* ◯
*I will participate on the Conference Dinner on Friday, May 27, 2016 Costs are **€ 50**. The price includes the bus transfer, sightseeing and a buffet dinner included. Drinks are on the participants. Payment is required up to April 25, 2016, to Volksbank Dortmund IBAN: DE70441600142480686900, SWIFT/BIC: GENODEM1DOR. Keyword "SoSy2016". Participants from outside the EU may pay at the conference office on Thursday.*	*YES* ◯	*NO* ◯
*Student, co-worker with not more than half a salary A reduced price of **€ 40** is offered for the conference dinner evening and sightseeing to students or scientific co-workers with less than half a salary. Please send a respective attestation together with your registration. Number of reduced tickets is limited.*	*YES* ◯	*NO* ◯

Please send this form by email to rfofana@uni-bremen.de
or via fax to +49 421 218-63288