

FOREWORD

Chemistry teaching and learning is one of the areas of focus in research in the Department of Chemistry in the University of Helsinki. Research creates a base for supporting the understanding of chemistry and for the development of good-quality chemistry teaching from basic education to higher education and to teacher education. With the use of evidence-based teacher education in chemistry, we support chemistry teaching and its development communally. The characteristic of our research is researching in the interfaces of formal, non-formal and informal teaching.

In honor of the 15th Anniversary of the Unit of Chemistry Teacher Education in Department of Chemistry, this book is published, where our research is presented, and specialists in research on chemistry education, who have grown up in the unit are brought out. The writers of these articles are PhDs, who have graduated from the unit, and doctoral students. The articles have been peer reviewed communally. In the articles, the central concepts of topics are described briefly, the benefits and challenges from the point of view of previous research and the writer's own research and as well it is brought out, how teachers are able to exploit information in chemistry teaching. The articles can be used freely in teaching, teacher training and research. At the end of each article, you can find information on the writers, about their research and specializations concerning their education as well as their contact details. Our specialists are accessible in different education -, development - and research plans, nationally and internationally.

The main aim of our unit that emphasizes research and communality, is to train inquiring and inspiring specialists of chemistry teaching and learning for different tasks in society, to research chemistry teaching and learning and as well to promote interest and meaningfulness in learning about chemistry. Our research-based, communally and continuously developing teacher education program (B.Sc, M.Sc., Ph.D.) in Department of Chemistry with its courses is presented in our web page¹. To better quality of teacher education we cooperate with specialist in chemistry from our department, with different workers of our University's tripartite teacher education and with several national and international partners. The ChemistryLab Gadolin² operates as a center for our development and research activities and it has been awarded with an international recognition.

Skillful teachers make up a good future for chemistry. So far nine PhDs, five licentiates, 395 subject teachers teaching chemistry as their major or minor subject, have graduated from The Unit of Chemistry Teacher Education. The graduated students have been placed widely in different specialist tasks from educational work to the world of companies. At the moment, there are approximately 130 students and 12 postgraduate students studying in our unit. We make our unit's theses also in cooperation with other universities or subject departments. Since autumn 2017, we are a part of University of Helsinki's new teacher education program for subject teachers in mathematics, physics and chemistry. We train also yearly 300-500 teachers in different levels to achieve readiness and tools for new challenges in chemistry teaching.

The student is in the core in our training. Students' thinking and knowledge as well as knowledge and understanding of their targets of interest through research are our starting points in developing chemistry teaching. For example from PhD Sakari Tolppanen's doctoral dissertation³, valuable further information from talented, international adolescents' thoughts and questions and the need for support in the context of climate change, was received. It has promoted in many ways one of our unit's emphasized themes, the teaching of sustainable development, and as well the development of teacher training.

The Unit of Chemistry Teacher Education – a part of the learning LUMA community

Our aim is to work actively both in the national and international LUMA (math, science and technology education) operations, and to cooperate with different players in society⁴ (e.g. educational administration, industrial organizations, companies, museums, science centres, educational establishments). Our research is strongly connected to LUMA operations, which has been built based on research around different development -and research projects. Four of them are part of the national LUMA FINLAND development program, which is funded by the Ministry of Education and Culture. Researchers in our team have taken part also in the planning process of the National Core Curriculum come up by the Finnish National Board of Education, they have taken part in several trainings as specialists and they have made support materials.

KEMMA centre⁵ for Chemistry Education that is a part of the LUMA Centre in University of Helsinki and its ChemistryLab Gadolin are in constant cooperation with teachers in different levels and with other cooperation quarters. In a good interaction, everyone learns from each other. Also through our online services (web sites, newsletters and social media), we are able to reach thousands of teachers as well as parents every year. Yearly approximately 4000 children and adolescents visit ChemistryLab Gadolin, at the same time they take part in most of our research and development projects. We participate also actively in the FINLAND 100 - Centenary Year StarT project⁶. The motto of LUMA operations is "Together we are more".

Communal design-based research – national and international cooperation

We research teaching of chemistry in schools, teaching in teacher education and in the institutions of higher education as well as studying and learning. During the past 15 years we have published a total of around 250 publications. We conduct research ordinarily exploiting communal design-based research⁷. With the help of that, besides theories we get as well new pedagogical innovations that have been developed based on research. Thus the theory is straight away taken into use in chemistry teaching from early childhood education to institutions of higher education, curriculum work, teacher training, teaching methods and to the developing of teaching materials as well as to use in our cooperation quarters. We want to make relevant research in which practice and theory are in a good balance.

Specialists in chemistry and its teaching, teachers and students from different educational establishments and specialists in companies take part in our communal design-based research. We

spread information about our research through LUMA television and with the help of different trainings, events and online materials. We also take part in national, research-based developing of teacher education through national teacher training forums.

One important part of our operations is international research cooperation, which we are currently conducting with many countries. It is important that every young researcher takes part regularly in international research conferences and be a part of international research family. For example in the ESERA 2015 conference, there were nine presentations from our unit and in the ECRICE 2016 conference there was a keynote statement and as well seven other oral presentations. An example of an international research project is COMBLAB⁸, where in cooperation with specialists from five countries, we developed new inquiry-based working instructions based on research that exploit modern technology and as well we wrote research publications⁹ together.

Sustainable chemistry is one of the emphasized areas both in the Department of Chemistry and in our unit. The following themes are a part of our research on sustainable chemistry: (i) Concepts in chemistry, models, thinking and visualization in chemistry teaching, (ii) Chemistry as a science: the history and philosophy of chemistry in teaching, (iii) Science, Technology, Society, Environment (STSE) in chemistry teaching, (iv) Modern technology in chemistry teaching, (v) Student-centered inquiry-based studying and teaching and (vi) Non-formal and informal science education.

Together we are more

24 years ago I took part in the first international conference on research in chemical education, ECRICE. Since then, the evidence-based promotion of chemistry teaching and learning as well as teacher education has been close to my heart.

In this connection, I want to thank the numerous people, who have helped me in building and developing our unit – our wonderful students and members of our research group, specialists in administration, colleagues in chemistry and its teaching, partners, as well as financiers and my family. Together we are more!

Joy of chemistry, its studying and teaching and collaboration!

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