INTERNATIONAL EXPERT SEMINAR:
IMPACT OF RESEARCH IN SCIENCE EDUCATION. ADDRESSING THE NEED FOR A KNOWLEDGE-BASED SOCIETY

30 September 2021
Venue: Estonian Academy of Sciences
Tallinn, Estonia

THE CONCEPT OF THE EXPERT SEMINAR

The idea of, and the need for, research in science is well known. Today, the world is coping with the covid-19 situation, putting much reliance on the use of research-developed vaccines. Yet as an aspect of human nature, there is persons, for whatever reason, who reject such an approach. To relate to awareness, conceptualisations and person interactions research also needs to focus on educational thrusts and hence the field of science education. In a changing world, research in science education seeks not only to embrace advances in science, but also the manner in which educational advances can be applied in a changing scientific world.

This seminar reflects on research endeavours in the field of science education, bringing together well known and eminent science education researchers around the world to highlight different directions in how best to overcome the gaps existing between students' needs and science teaching and between the education for science teacher and the changing societal expectations and between the science research community and advancements in science education research. This seminar seeks to address science education researchers, PhD students, science teachers and science teaching staff in Estonian Universities as well as science education policy-makers and funding bodies. It is particular addressed to science education research and policy-makers and is intended to promote suggestions on how different parties can work together to support advancement, from a science education perspective, for a future knowledge-based society.

This seminar is supported by Horizon 2020 Twinning project "Addressing Attractiveness of Science Career Awareness" (SciCar)

PROGRAMME

Chair: Prof. Miia Rannikmäe, University of Tartu

10:30–11:00 Opening words. Tarmo Soomere, the President of the Estonian Academy of Sciences.

Introduction of the programme. Prof. Miia Rannikmäe, University of Tartu

11:00–11:45 *STEM Education as a Paradigm Shift: What Research says about STEM Education?* Professor Do-Yong Park, Illinois State University, USA

> One key concept in STEM education is 'integration'. Integration is not new and can be traced back to the 19th century. Biochemistry was established as a specific scientific discipline in the 19th century and Molecular biology was established as an official scientific discipline in the 1930s. Allegedly, these two new disciplines are deemed as a paradigm shift. In this case, integration is not just combining the two, but going beyond the border line of each discipline and creating a new area of study. After World War II, since the 1950s, science in the US returned to its unique and single area of study without much dialogue on integration. However, in the 1990s, integration rekindled attention to STEM education as a new discipline area. It took more than two decades to initiate STEM education, bring the STEM reform to 'scale' and to sustain and evaluate STEM education reform in the U.S. Today, based on a plethora of research-based evidence, STEM education has been infused into the 'school curriculum' based on research inputs into the Next Generation Science Standards, published in 2013 and the paradigm shift began in science education.

11:45–12:15 *A Research-driven View on Science Teacher Education.* Prof Jari Lavonen, University of Helsinki, Finland

> In the presentation, the new directions of Initial science teacher education are analysed. Initially a two science education research outcomes and their potential influence on science teacher education are considered, especially focussing on outcomes related to learning, engagement and coherence of science education., New directions are analysed in the frame of research on teacher knowledge and, more broadly, research on teacher education. Several research point of view are raised, e.g., research on domains and the origins of teacher knowledge, the coherence of teacher education programmes and the role of university pedagogy research. Moreover, the role of research in science teacher education is discussed. Finally, competences teachers to promote learning for the future in science classrooms is considered emphasising the learning of 'transversal' competences. Based on these three views, aims for future science teacher education are outlined.

12:15–12:45 *Research in Science impacting on Science Education.* Prof Ron Naamann, Weizmann Institute of Science, Israel

Typically, when one relates to Science, one assume that it is “all intellect” and rational. Like being an educator, to be a scientist actually requires, of course, the intellectual part, but above all, it requires passion. In fact, in my opinion, Science requires three main abilities – first, and above all, one does need to have Curiosity. To ask “How and Why”. Additionally, one needs ‘grit’ to perform the hard work and to be persistent all the way until you find the answer. Finally, it is, of course, important to have the knowledge of the facts and methods to be able to perform the study that leads you to the answer.

Traditionally, Science education puts the emphasis on the third component. By describing, in short, my research on a new phenomenon called the ‘Chiral Induced Spin Selectivity’, I strive to demonstrate the importance of all three components both in science education and in scientific research.

12:45–13:30 Lunch

13:30–14:00 *What does Research in Science Education say about students learning?* Dr Rachel Mamlok-Naamann, Weizmann Institute of Science, Israel

Different ideologies and different research agenda led to the development of research tools that try to assess science students’ learning. The challenges and big questions which literature research explores, and which will be included in this presentation refer to students, to the curriculum according which they are taught, and to the science teachers. Research about students’ learning will consist of examples such as (1) cognitive and affective skills, (2) motivation vs. learning difficulties, and (3) misconceptions and alternative conceptions. It is connected to the curriculum as well, by asking questions such as: Is it relevant to students’ lives? Is it up-dated according to scientific and technological discoveries? Society is constantly changing, scientific knowledge is accumulating owing to new discoveries and innovations, and information and communication technologies (ICT) became an intrinsic part of our lives. The challenges for teaching and learning science increase, and teachers should receive sustained support in order to gain knowledge of different teaching strategies and of assessment skills. This can be done by attending professional development workshops that deal with those topics, which will consequently stimulate their creativity and diversify their instructional strategies in the classroom. Such skills should improve their ability to teach and understand their students learning difficulties, since they will better understand the goals, strategies, and rationale of the curriculum. In the presentation, there will also be an example of how the active learning for which we strive in order to stimulate and motivate students towards developing of scientific literacy, also stimulates and motivates the teachers.

14:00–14:20 *How does Research in Science Education support the Practicing Science Teacher?* Helen Semilarski, PhD student, biology teacher, Tartu MHG

Interdisciplinary science learning can play a central role in promoting students' 21st century skills. However, students tend to have low perceived self-efficacy towards 21st century skills, limiting application of their actual science competence. Based on a 1.5-year intervention research study, which sought to promote students' conceptualisation of 'core ideas' in science and raise science career awareness, implications are discussed on its effectiveness for everyday school science teaching and the manner in which it can promoted. Suggestions are put forward for practicing school science teachers.

14:20–14:50 *Overview of Research-driven, Paradigm Shifts in Science Education.* Visiting prof Jack Holbrook, University of Tartu

Advances in the way conceptions of science education change can be viewed as research driven, evidence-based changes. Just as education became a 'for all' phenomena (a paradigm shift) following the impact of the technology driven, industrial revolution, so science education developments have followed research endeavours both in the field of science and in the technological, philosophical and digital impacted science education field, often through promoting paradigm shifts driven general acceptance. Whether this is through a STEM approach, even within single science school curriculum areas, or the perceived role played by the science teacher in student competence development for a changing society, research in science education is focussing not only on guiding the manner in which science educational refocuses for the future generation, enabling re-orientation through an awareness of future career needs, but also supporting the preparation of future teachers for society to benefit from such paradigm shifts. This presentation seeks to reflect on and highlight the science education research advances driving the perceived paradigm shifts related to the earlier presentations.

14:50–15:00 Concluding remarks

15:00–15:30 Closing reception (all participants)