# Estonian science teachers' pedagogical beliefs, teaching practices and self-efficacy based on the results of the TALIS 2008 and 2013 reports

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## Summary

### Introduction

Estonia has recognised that educational analyses constitute an important basis for national education policies, and has participated in the international comparative OECD studies PISA in 2006, 2009 and 2012, and TALIS in 2008 and 2013. Estonian students have performed remarkably well in international comparative studies that have assessed students' learning outcomes in science (OECD, 2007, 2010a, 2013a, 2016). However, the studies also revealed that although the Estonian educational system has been successful in enhancing students' achievements in general, statistically significant differences exist in science competences between the achievements of schools where children are taught either in Estonian or Russian. PISA describes student performance by seven levels of proficiency in science (OECD, 2016). In Estonian language instruction schools, there are a small number of 15-year-olds who are highly proficient (top performers) in science subjects, reaching level 5 or 6, and even fewer students, in schools where Russian is the language of instruction who reach to these levels.

The secondary analysis of PISA 2006, 2012 and TALIS results has revealed that students' performance and engagement construct differences are connected with the instructional approach given at classroom level. In both Estonian and Russian language schools traditional teaching methods dominate and are rarely applied to inquiry teaching and learning (Henno, 2015).

The method of teaching science can affect the students' performance, beliefs and interest in the subject (Kobarg et al., 2011; Seidel & Scheerens, 2005). Even if there is no single "best" way of teaching, students need teachers who have different instructional practices (Vieluf et al., 2012).

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The teaching strategies used by teachers can be grouped into different approaches: teacher-directed instruction, student-entered instruction, inquiry-based instruction etc. (OECD, 2016). The goal of teacher-directed science instruction is to provide a well-structured, clear and informative lesson which usually includes teachers' explanations and students' questions (Brophy & Good, 1986). The inquiry-based instruction deals with engaging students in experimentation and hands-on activities, and challenges and encourages them to develop a conceptual understanding (Bybee, 2006). Previous studies show that inquiry-based instruction can improve the students' learning, their attitudes towards science, and critical thinking (Blanchard et al., 2010; Furtak et al., 2012; Hattie, 2009).

The Estonian Lifelong Learning Strategy 2020 approved by the Estonian Government in 2014 includes five strategic goals. The first goal is to change the approach of students to learning and implement an approach that supports their individual and social development, learning skills and creativity. It is important to highlight that the new Estonian National Curriculum for Basic School and Estonian National for Upper-Secondary Schools (2011) was developed as a competency-based curriculum with the aim of enhancing students' scientific and technological literacy, and implement more inquiry-based teaching and learning.

Estonian researchers have studied Estonian science teachers' beliefs about teaching and classroom teaching practices. Changes to classroom practices have been very slow, but changes are shown to be possible (Laius et al., 2009; Laius & Rannikmäe, 2011; Laius et al., 2008). In recent years the need for change in the Estonian education policy and national curriculum has been clearly expressed, and changes in the training of science teachers' have taken place. However, it is important to understand the teachers' beliefs, practices and attitudes, because these are related to the implementation of science-related activities at school. The science teacher needs to decide which strategies to use in the classroom, and how much time will be devoted to explanations or hands-on activities.

The aim of this study was to determine whether the beliefs of science teachers and teaching practice have been changed in recent years. The aim was to give a picture of the situation of science teaching and science teachers' beliefs based on TALIS 2013, compared to the TALIS 2008 results. The OECD PISA and TALIS studies compile the international comparative analyses and reports and never analyse all the data collected. An inter-country secondary analyses has to be compiled by the researchers' interested in the different topics.

Answers were sought to the questions: "what were the natural science and other subjects' teachers and the Estonian and Russian-language instruction schools' science teachers' pedagogical beliefs and feedback to teaching practices in TALIS 2013?" and "what changes have taken place in science teachers' beliefs and teaching practices between TALIS 2008 and 2013?"

The research hypotheses were:

- in comparison with the other subject teachers, the science teachers strongly support constructivist beliefs, but they have the same level of self-efficacy;
- in comparison with the other subject teachers the science teachers have the same level of self-efficacy;
- there are no differences between the Estonian and Russian-language instruction schools' science teachers' constructivist beliefs and self-efficacy;
- in comparison with the other subject teachers, the science teachers pay more attention to the student-centred practices in lower-secondary science lessons.

To answer these questions, empirical studies were carried out by means of quantitative secondary analyses of TALIS 2008 and TALIS 2013 data.

This study used Estonian data from TALIS 2008 which was collected from a total of 3321 teachers and from 598 science teachers. For this study, the science teachers were divided into two groups – Estonian language instruction school teachers ($N$=513) and Russian language instruction school teachers ($N$=85).

The next study used Estonian data from TALIS 2013 which was collected from 3129 teachers and from 837 science teachers. The science teachers were divided into three groups – Estonian language instruction school teachers ($N$=665), Russian language instruction school teachers ($N$=82) and school teachers in mixed language instruction schools ($N$=90).

## The science teachers' pedagogical beliefs, self-efficacy and teaching practices

Six TALIS 2008 teachers' beliefs and teaching variables/indices (efficacy, direct transmission beliefs, constructivist beliefs, structuring practices, student-oriented practices, enhanced teaching activities), three TALIS 2013 teachers' beliefs and constructivist learning indices (efficacy in classroom management; efficacy in instruction and student engagement; constructivist beliefs) and different TALIS 2013 teaching practices questions/items ($N$=28) were selected for the analysis. The sub-set was needed because in TALIS 2013 the teaching indices had not been compiled and single items for analyses were used.

Within the TALIS study, all items of questionnaires were measured on a four-point scale, where meaning of 1 was "not at all", 2 was "to some extent", 3 was "quite a bit", and 4 was "a lot" or 1 was "strongly disagree", 2 was "disagree", 3 was "agree" and 4 was "strongly agree" (OECD, 2009b, 2014b).

It appeared that the Estonian science teachers' perceptions of constructivist beliefs have not changed significantly in recent years. The secondary analysis of the 2008 and 2013 results revealed that science teachers' constructivist estimates were significantly higher than other Estonian teachers' estimates. The results confirm the other researchers' findings (Kikas, 2013) that the Estonian science teachers have gained the knowledge that constructivism is important to implement in the classroom, but they do not rely on it for everyday teaching. The Russian language instruction schools' science teachers support constructivist beliefs significantly less than in TALIS 2008.

The Estonian science teachers' estimates of self-efficacy in TALIS 2013 were significantly higher than in TALIS 2008, but in comparison with science teachers in the Estonian language instruction schools, the science teachers in the Russian language instruction schools claimed to be more effective in classroom management, in instruction and setting up, as well as student engagement.

The authors' TALIS 2008 analyses showed that in comparisons with other teachers, practices implemented by Estonian science teachers most frequently were structure-oriented teaching practices and less students' cognitive development-oriented practices.

The first hypothesis was confirmed. There was a significant difference between the other subject teachers and the science teachers' constructivist beliefs practices in TALIS 2013. The science teachers gave more support to constructivist beliefs. The second hypothesis was not confirmed. The science teachers' self-efficacy estimates were significantly higher.

The third hypothesis was not confirmed. There were significant differences between the science teachers in Estonian and Russian-language instruction schools in respect of constructivist beliefs and self-efficacy. The Estonian-language instruction schools' science teachers' constructivist estimates were significant higher and self-efficacy estimates lower.

The fourth hypothesis was not confirmed. The statistically significant differences between the science and the other teachers' estimates were not observed in the implementation of active teaching practices. In comparisons with estimates by other subject teachers, the science teachers paid no more attention to students' active practices in lower-secondary science lessons.

The TALIS 2013 analyses (OECD, 2014b) revealed that science teachers frequently claimed that their role as a teacher was to facilitate students' own inquiry, but at the same time, they reported that they paid less attention to the development of students' motivation.

The study confirmed the previous studies' findings that the Russian school science teachers gave more positive feedback and that this feedback was controversial (Henno, 2015).

It seems that the Estonian science teachers' perceptions of constructivist beliefs have not changed significantly in recent years as it appeared to, and also that Estonian science teachers' frequency of estimates about the implementation of inquiry-based instructional practices (even they support constructivist view of teaching and learning) were low. These results may be linked with the PISA 2015 findings. The PISA findings showed that only 9% of Estonian students (OECD average 21%) reported that they are allowed to design their own experiments or spend time in the laboratory doing practical experiments (OECD, 2016).

Given the Estonian science teachers' need to implement the National Curriculum and change the new approach to teaching and learning, based on their perceptions, we can claim, that the Estonian science teachers do not sufficiently encourage students to be deep learners and to inquire about a science problem using scientific methods, including experiments.

To sum up, it can be said that there are needs for methodical materials and in-service training and important changes should be made to the training of teachers in Russian language instruction schools. This topic is very urgent and needs to be addressed in further studies.

*Keywords:* science teachers' constructivist beliefs, teaching practices in science, TALIS 2008 and 2013, science teaching in Estonian lower-secondary school