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IMPACT OF THE SOCIO-CULTURAL CONTEXT ON STUDENT SCIENCE PERFORMANCE AND ATTITUDES: THE CASE OF ESTONIA

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Abstract. *This study analysed how to explain the statistically significant differences between the science mean scores and attitudes of students in different language instruction schools. Estonian schools were grouped according to their socio-economic intake relative to the national average into three categories: advantaged, disadvantaged and mixed schools. The analysis of the socioeconomic composition of different language instruction schools showed that the Estonian and Russian language instruction schools are mostly mixed schools. The results did not support the assertion that weaker performance is connected with disadvantaged background of students or schools either. Although students in Russian language instruction schools reported higher levels of motivation, more innovative classroom activities and they were more informed about science-related careers, the students in Estonian language instruction schools outperformed the Russian-speaking students in science. The results support an opinion that the students' performance and engagement differences are rather connected with classroom level instructional approaches and learning culture.*

Key words: *PISA, socioeconomic background of students and schools, students' science performance and attitudes, teaching practices.*

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Introduction

Estonian students achieved remarkably good results in international tests that purport to assess students' learning outcomes in science - International Trends in Mathematics and Science Studies (hereinafter TIMSS) 2003, in Program for International Student Assessment (hereinafter PISA) 2006 and PISA 2009 (Martin, Mullis, Gonzales & Chrostowski, 2004; OECD, 2007, 2010). High performance of Estonian students could be the result of educational reforms and curriculum improvements of the recent decades. However, these three studies also revealed that although the Estonian educational system has been quite successful in supporting the learning of all students, there were statistically significant differences in science competences and attitudes between Estonian and Russian language-instructions schools (Henno, Reiska, & Scheinin, 2008; Henno, 2010). PISA and TIMSS have shown that students' socioeconomic background and immigration status are associated with his or her performance (Martin et al., 2004; OECD, 2007, 2010). The current paper aims to study the interdependency of socioeconomic background and language-instruction in depth.

Pertinent literature has among other things stressed out the importance of the cultural dimension in studies of science learning. Parsons and Carlone (2013) have emphasised the importance of new thinking to research culture and to understand its relevance for improving science education. Seiler (2013) has pointed out that culture has been commonly used in science education research, in particular, to examine the issues of equity for students from low-income, racial, and ethnic minority communities. DeBoer (2011) has argued that individual countries have their own unique educational history and cultural values that may affect their students' science learning. LeTendre (2002) stresses that the patterns both across nations and within nations can be compared for better

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understanding of values, beliefs and practices in education systems. However, country as an analytical unit is inadequate, because it misses crucial regional variation as well as variation in subpopulations such as racial, ethnic, linguistic, religious, or other minority groups.

This study was designed to analyse the impact of schools' socio-cultural context on students' performance and attitudes on the Estonian example and shows that differences in student achievement at a country level are not necessarily due to the immigrant or socio-cultural background status, but could rather be connected with classroom level instructional approaches and learning culture.

Conceptual Framework and Literature Review

The conceptual framework for this research was developed from two literature-related aspects. The first aspect was the notion of "socio-economic status" of schools and its impact on students' achievement. The second aspect was students' attitude towards science from different language instruction schools.

Education is multicultural and socially reconstructionist. Basic concepts such as "academic achievement" are regarded as socially constructed or a "cultural" phenomena (Goldman & McDermott, 1987). Over the last two decades the science education literature has undergone an increase in interest in cultural and linguistic diversity of science classrooms (Aikenhead & Ogawa, 2007; Eijck & Roth, 2011). Educational institutions are deeply rooted in a social culture and national cultural traditions are a major determinant influencing the system of schooling in general, national curricula, and teacher's principles and classroom practices in schools. The researchers stressed out that pedagogical approaches, grounded in students' cultural background and everyday knowledge, can make a difference in learning (Lee & Luykx, 2007; Lee & Buxton, 2009).

The researchers have shown that student achievement is connected with national cultural values and that a framework of cultural understanding is essential for cross-national educational research (Planel, 1997; Osborn & Planel, 1999). Bempechat, Jimenez and Boulay (2002) have studied social cognitive factors in learning and cognitive goals that culture promotes for members of its group, and emphasised the importance of understanding social and cultural beliefs and attitudes about learning. They have examined the extent to which the available cross-national data shed light on how students have come to a deep conceptual understanding of mathematics and science and have concluded that there may be different pathways to deep conceptual understanding within and between countries. Additionally, the response style differences between different cultures have to be taken into consideration. Buckley (2009) has described systematic differences in response style across nations or cultures by studying cross-cultural differences in the usage of Likert (1932) scales.

Thus, performance differences can be explained by aptitude and student background, but also by the culture of the school that student attends. Earlier studies on school effectiveness stressed out that schools do make a difference, although the estimates of performance differences were not much higher than 10-20% among schools (Coleman et al., 1966¸ Jencks et al., 1972). Both TIMSS and PISA study have concluded that in most countries, the social background of a school (measured as a proportion of socially disadvantaged students or the average socio-economic status) is strongly associated with the science performance (Martin et al., 2004; 2008; OECD, 2007, 2010). Other recent studies have shown that schools do have a role in influencing the learning outcomes of students (Wößmann, 2003; Thomson, de Bortoli, Nicholas, Hillman, & Buckley, 2011; Tao, Oliver, & Venville, 2013).

The overall relationship between socio-economic background and student performance provides an important indicator of the capacity of education systems to provide equitable learning opportunities. The relationship between socioeconomic background and school performance is even more important as it indicates how equity is interrelated with systemic aspects of education (OECD, 2007).

The socioeconomic status (hereinafter SES) of students in PISA was measured through the PISA index of economic, social and cultural status (hereinafter ESCS) (OECD, 2007; 2010). The following family background variables were included in ESCS index: the highest level of parental education among the two parents, highest parental occupation among the two parents and the index of home possessions. The average socioeconomic background of the school was calculated as the ESCS average of the sampled students in the school (OECD, 2010). The degree to which the socio-economic background matters for PISA achievement scores differed, varied significantly across countries. For some of the higher performing countries in terms of average science achievement scores like Canada, Estonia, Finland, Hong Kong, China, Iceland, and Korea, the socio-economic background of students mattered the least (OECD, 2007; 2010).

PISA tests have consistently shown a link between disadvantaged background and poor performance (OECD, 2013). Across OECD countries in the PISA study of 2009, 31% of students from disadvantaged backgrounds are shown to be "resilient". The resilient students are those, who succeed at school despite a disadvantaged background (OECD, 2010). PISA tests have shown that the more self-confident and the more motivated the students are, the greater are their odds of being resilient (OECD, 2011). Over 34% of disadvantaged students in Estonia were also shown to be resilient students and it is important to know the resilient students' motivation in the different language instruction schools.

Many studies have indicated students' declining motivation to learn science (Galton, 2009; Osborne, Simon & Collins, 2003; OECD, 2007). Vedder-Weiss and Fortus (2012) have demonstrated that student' motivation to learn science develops differently in different schools and that the non-declining motivation of adolescence was related to the culture of the school. The concept of 'attitude' has been used to label variables of engagement. Generally, attitudes are seen by social psychologists as cognitive, affective, and behavioural reactions of an individual to some object or phenomenon (Pekrun, 2006). In PISA, attitudes are seen as a key component of an individuals' science competency and include an individuals' beliefs, motivational orientations and sense of self-efficacy. PISA 2006 measures included questions on self-efficacy in science and self-concept in science. Interest in science measures included questions on interest in learning science topics, general interest in science; importance of learning science; enjoyment of science; instrumental motivation to learn science; future-oriented science motivation; expectations for a science-related career; and participation in science-related activities. (OECD, 2007)

There are many critics related to PISA to. The critical points relates to some of the results that have emerged from analysis of PISA data: It seems that students in high-scoring countries also develop the most negative attitudes to the subject, that the scores are negatively related to the use of active teaching methods, inquiry based instruction and etc (Mortimore 2009; Sjøberg, 2012). For understanding how school culture influences students' motivation to learn science this study takes into account not only the student, teacher and classroom but also the context in which they operate.

The Situation in Estonia

The following section provides an understanding of the origins of ethnical, cultural and educational background of the Estonian education system, a short overview of curriculum developments and highlights instructional practices in the different language instruction schools.

The Estonian education system includes schools operating in two languages of instruction: Estonian and Russian. Stemming from movements of the Soviet period and the dissolution of the Soviet Union, Estonian population (about 1.3 million people) consists of two main ethnicities (based on the 2011 census results): Estonians (68,7%) and Russians (24,8%).

Estonia scored 531 in science and ranked on the 5th place in PISA 2006 and scored 528 and ranked on the 9th place in PISA 2009 (OECD, 2007, 2010a). Estonia performed comparatively well on indicators of quality and gender equity in science. There were no statistically significant gender differences in science performance and a weaker relationship was revealed between SES and achievement. It can be said that all Estonian students were successful, but there was a statistically significant difference in science performance between the Estonian and Russian language instruction school students. An average science scale score was 541 points for Estonian language instruction (hereinafter ESTLI) school students in PISA 2006, 535 points in PISA 2009 and 498 points for Russian language instruction (hereinafter RUSLI) schools' students in both studies (Henno, 2010). In PISA 2006 the students of ESTLI schools were stronger in all main science competencies: explaining phenomena scientifically, identifying scientific issues and using scientific evidence. Whereas, students in RUSLI schools were more motivated to learn science and more supportive of scientific enquiry as an area of learning (Henno et al., 2008). Although ethnically

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Russian students in Estonia had somewhat lower scores, they outperformed the students from Russia. In Latvia, which is with similar ethnical and historical background, students of Russian ethnicity had also somewhat lower scores, but there was no statistically significant difference in science performance between the Latvian and RUSLI school students (Geske, Grīnfelds, Kangro, & Kiseļova, 2010).

In PISA 2006, 24% (1184) of involved students studied through the medium of Russian and were tested using Russian language and 76% (3681) were tested using the Estonian language. In PISA 2009, 18.7% (886) of the students were tested using Russian language and 81.3% (3841) were tested using the Estonian language. The current educational landscape in Estonia shows, that about 20-25% of the total number of Estonian students are studying in the Russian-medium schools. According to Tire (2011), these students are mostly third or even fourth generation immigrants, and technically they are in the same situation as native students. Both language groups have participated in the same formal education system with the same curriculum and textbooks for the same number of years (Henno et al., 2008). The Russian speaking students in Estonia are neither academically disadvantaged, because they have entered a new education system, nor because they need to learn a new language for learning.

Students' performance and attitudinal differences may be associated with school culture and teaching approaches. In Estonia, 46% of teachers at secondary education level are 50 years old and over (Eurydice, 2012) and these teachers have undergone formal training during the Soviet period. Soviet era school system differed from much of the rest of the world with its extremely huge study content and difficulty of study programmes (Unt, 2000). The Soviet curricula were characterized by a strong preference for encyclopaedic knowledge, primarily regarding factual material in natural sciences, not about problem solving, learning how to make decisions or bringing about changes (Henno, 2008). These traditions affect current teaching in Estonia, both in ESTLI and RUSLI schools. However, the fifty years of the Soviet period education system in Estonia is not comparable with the rest of the Soviet Union. Compared with other Soviet republics, there were some organisational and substantive differences in the ESTLI schools: longer study periods on the general education level; some differences in curricula; using original textbooks and workbooks compiled by Estonian authors (Nagel, 2006).

Ainley & Ainley (2011) studied the cultural perspective of student interest in science and compared contrasting cultural values as defined in the World Values Surveys and the European Values Surveys (Inglehart & Baker, 2000; Inglehart & Welzel, 2005) in Colombia, Estonia, USA, and Sweden. They emphasized that the differences in the strength of the associations, between science knowledge and interest in science, support the proposition that the interconnections between knowledge, affect and value need to be understood in relation to the student's broader historical and cultural context. In Estonia, knowledge had moderate, positive correlations with enjoyment of science and personal value of science, indicating deviation to the pattern in the other countries. They argued that models of interest in science, developed in Western traditions, may not always fit the pattern of relations developed in different cultural contexts, the implication being that cultural contexts in Estonia may differ.

Various Estonian researchers have found differences between the attitudes and values of the two main language groups in Estonia. Realo and Allik (1999), who studied the questions of collectivism and individualism in Estonian, North American and Russian populations, found that ethnic Estonians were more individualistic than ethnic Russians. A research carried out in 2005 has revealed significant differences between the two ethnic groups. ESTLI schools were more oriented towards the success of students' individual achievements, whereas in the RUSLI schools, teachers support more the collective success of the whole class. The students in ESTLI schools were more sensitive about academic success or failure than their peers in Russian-medium schools. ESTLI schools valued more liberal views, personal autonomy, functional and rational links in collective. RUSLI schools cared for more students' security and health, but also put more emphasis on discipline and encyclopaedical knowledge. (Ruus et al., 2007; Sakk, Veisson, & Lukk, 2009)

The quality of instruction is fundamental to student learning. Scheerens and Boskers (1997) brought out that characteristics of instruction have a strong effect on student achievement. They agreed that there is no single, well-defined best way of teaching, but the effectiveness of classroom practice depends on the cultural context and professional traditions. Secondary data analysis, carried out in the OECDs' Teaching and Learning International Survey showed differences in teacher beliefs about teaching and classroom teaching practices between teachers in ESTLI and RUSLI schools. In general, teachers in ESTLI schools had a rather constructivist view on learning and instruction. They supported both direct transmission (traditional) and constructivist views of learning and teaching, whereas teachers in RUSLI schools believed more in knowledge transmission, direct instruction of students and fact-based teaching. (Loogma, Ruus, Talts, & Poom-Valickis 2009).

Popov and Bogdanov (2005) compared Russian and Swedish science teachers and found that the future Russian teachers tended to be more academic and formalised and highlighted that the strict and formal style of teaching and learning still dominates in Russian teacher education. Estonian researchers have studied Estonian science teachers' beliefs about teaching and classroom teaching practices. The classroom practices changes are very slow, but changes are found to be possible (Laius, Rannikmäe, & Yager 2008; Laius, Kask, & Rannikmäe, 2009, Laius & Rannikmäe, 2011). Based on the secondary analysis of PISA 2009 functional literacy data by Säälik (2012), teaching-learning approaches in ESTLI and RUSLI schools were different largely due to differences in how students were taught to learn. The school language of instruction was a statistically significant predictive value, taking into account the socio-economic background, teaching-learning methods and the size of the school. Stricter discipline, more teacher-centered methods and students' weaker metacognitive skills were typical for Russian schools.

As RUSLI schools emphasize much more politeness, academic success and discipline, this can also be called a socialist rudiment (Ruus et al., 2007). The reason might be teachers, because many teachers, especially those who received their education during the Soviet time value still obeying behaviour more than students' critical thinking. To expand the knowledge and understanding of not only cross-national, but national differences in achievement, the students' socio-economic status, performance and attitudes were the central research focus of the current paper.

The different aspects and results previously presented have posed the central question of this study – "how could the statistically significant differences between science attitudes and mean scores achieved by students in different language instructions schools in international studies be explained on the Estonian case." In responding to the central question indicated above, the study examines:

- the socio-economic composition of different language instruction schools and the extent to which the SES relates to the students' science performance;
- differences between schools observed and predicted science performance of students in disadvantaged, mixed and advantaged schools;
- the attitudinal patterns towards science learning in Estonian schools;
- the science teaching practices in ESTLI and RUSLI schools.

The different language instruction schools were compared based on the schools socio-economic intake and the average actual performance.

Methodology of Research

Data Sample

The current study is based on secondary data analysis of PISA 2006 and 2009 survey data and was carried out as an addition to the national analysis of achievement. No additional data were collected. The Estonian data for PISA 2006 were collected from 169 schools and for PISA 2009 from 175 schools. Since the purpose of this study was to explore the differences of language groups, the PISA 2006 schools were divided into the two groups – ESTLI (N=130) and RUSLI (N=39) schools.

Measures and Variables

The following PISA variables were selected for undertaking the analysis for this study:

1. The standardised (m=0; SD=1) PISA index of economic, social and cultural status (ESCS) and test language were used in the analyses to stand for student level background variables.
2. Four different background indices: family wealth possessions (hereinafter WEALTH), cultural possessions (hereinafter CULTPOS), home educational resources (hereinafter HEDRES)

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and home possessions (hereinafter HOMEPOS) covering the following items at student's homes: desk for studying, own room, quiet place to study, educational software, access to the Internet, classic literature, books of poetry, works of art, number of books, dictionary, dishwasher, a DVD player and some country specific items: the number of mobile phones, cars, televisions and computers.

3. PISA 2006 attitudinal and motivational indices were used in this study. This included: student information on science-related careers (hereinafter CARINFO); school preparation for science-related careers (hereinafter CARPREP); general value of science (hereinafter GENSCIE); instrumental motivation in science (hereinafter INSTSCIE); general interest in learning science (hereinafter INTSCIE); enjoyment of science (hereinafter JOYSCIE); personal value of science (hereinafter PERSCIE); science teaching - focus on applications or models (hereinafter SCAPPLY); science teaching - hands-on activities (hereinafter SCHANDS); science activities (hereinafter SCIEACT); science self-efficacy (hereinafter SCIEEF); future-oriented science motivation (hereinafter SCIEFUT); science teaching - interaction (hereinafter SCINTACT); science teaching - student investigations (hereinafter SCINVEST); science self-concept (hereinafter SCSCIE). (OECD, 2007) There were no missing values for any of the variables for all student and school level data.

Procedures for Data Analysis

Statistical software package Statistical Package for the Social Sciences was used for the data analysis tests of significance. T-test was used to compare the mean of two samples and the analysis of variance (ANOVA) between groups to observe whether or not the means of several groups were equal. Multiple regression analyse was carried out to measure the extent to which the SES explained the science performance differences and how much the increase of one unit of the index of different attitudinal indices corresponded a score points performance difference of different language instruction school students. In the regression analysis the intercept was interpreted as the achievement score in science for a student who has the national mean in all variables included in the model. Based on PISA procedures, the model coefficients and statistics were estimated using a full maximum likelihood procedure. Normalized students final weights (W_FSTUWT) were used, so that the sum of the weights was equal to the number of students in the dataset. Five plausible values (PV1SCIE-PV5SCIE) for the students' science performance were used for computing the outcome variable. Throughout the analysis, the effect was considered statistically significant if the *p*-value was below 0.05.

The socio-economic gradient tool, determined by PISA, was used to analyse the relationship between socio-economic background and student performance. For analysis the *strength* of the association between student performance and background and the *height* of the gradient line were used to indicate the impact of students' socio-economic background on student performance in school. *The strength* of the gradient measured the proportion of the variation in student performance that is accounted for by socio-economic background and the *height* of the gradient line measured the performance after accounting for socio-economic background. (OECD, 2010)

At the individual level, PISA analysis considered the relationship between students' socio-economic background and one's individual performance. At the school level, the relationship between the average socio-economic background of 15-year-old students and the performance scores of students attending that school were considered. The average socio-economic background of the school is calculated as the average of the students sampled. The current study examined the data with the respect to the above variables for the purpose of seeking comparisons between students in ESTLI and RUSLI school at both, the individual and school levels.

For such analyses, the authors grouped schools in two ways:

1. In answer to the PISA 2006 question - how did a schools' socio-economic composition relate to the science performance of students from different socio-economic backgrounds, the 169 schools were grouped according to their socio-economic intake relative to the national average. Based on the example of PISA 2009 the school's socio-economic background categories

the authors compiled a special formula for PISA 2006 Estonian schools grouping.

Three categories of schools were identified:

- socio-economically disadvantaged schools (N=36), in which the average socio-economic background of students was below the national average;
- socio-economically advantaged schools (N=40), in which the average socio-economic background of students was above the national average; and
- socio-economically mixed schools (N=93), whose socio-economic intake was around the national average.

2. In answer to the question, in what type of schools is the average mean for students' science performance higher or lower than was expected, for this the schools' mean science performance (the average student scores) before and after accounting for socio-economic profile, was taken into account. This hypothetical adjustment (the *height* of the gradient line) assumes that schools have the same average PISA index of ESCS, equal to the OECD average. The schools were sorted by these differences into three groups:
   - schools where students' average actual or observed performance was statistically significantly higher than expected (N=82);
   - schools where the performance was higher than expected, but the difference was not statistically significant (N=63); and
   - a combined group including schools, where students performed at statistically significantly lower level than expected (N=2) and schools, where the performance was lower but the performance was not statistically significant (N=22).

Results of Research

Part A – ESCS and the Household Possession Differences of ESTLI and RUSLI Schools

To find out the students of different language instruction schools' SES differences and the extent to which SES relates to the students' science performance, a one-sample T-test was performed. Figure 1 shows mean differences between student-level ESCS and the household possession indices for Estonian and Russian speaking students.

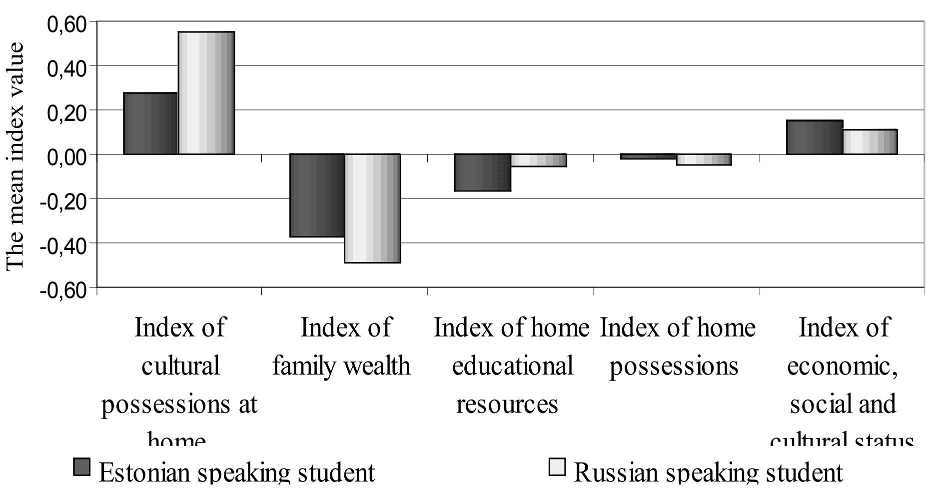

Figure 1: The mean differences of student-level ESCS and household possessions indexes.

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Comparison the different language instruction school students revealed that, RUSLI school students reported more:

- cultural possessions [M_{EST} = 0.27, *SD* = 0.83; M_{RUS} = 0.55, *SD* = 0.69, in general, *t*(4842) = -9.94, *p* = 0.000];
- home educational resources [M_{EST} = -0.17, *SD* = 0.81; M_{RUS} = -0.05, *SD* = 0.74, in general, *t*(4850) = -3.32, *p* = 0.000];

and less:

- family wealth possessions [M_{EST} = -0.37, *SD* = 0.89; M_{RUS} = -0.49, *SD* = 0.75, in general, *t*(4854) = 5.64, *p* = 0.000],
- and home possessions [M_{EST} = -0.02, *SD* = 0.90; M_{RUS} = -0.05, *SD* = 0.78, in general, *t*(4854) = 2.16, *p* =0.031].

The student-level ESCS mean value of ESLI schools student's was slightly higher than the one of RUSLI schools students' [M_{EST} = 0.15, *SD* = 0.84; M_{RUS} = 0.11, *SD* = 0.71, in general, *t*(4851) = 2.28, *p* = 0.004].

According to the PISA 2006 report, the differences in socio-economic background explained 9.3% of the variation in Estonian students' performance in science in PISA 2006. Multiple regression analysis was employed by authors in order to explore how significant the predictor variables of socio-economic background was in different language instruction school students' performance in science in PISA 2006 and 2009. According to the authors' analyses, the differences in socio-economic background explained 9.3% (as it also argued PISA 2006) of the variation in Estonian students' performance in science in PISA 2006 and 7.2% in PISA 2009 (Table 1).

Table 1. Student and school level regression of PV1SCIE to PV5SCIE on ESCS by language of test in PISA 2006.

	IND	PISA 2006		PISA 2009	
		STAT	SE	STAT	SE
Estonian language instruction school students	R-SQUARE	0.100	0.013	0.081	0.012
	INTERCEPT	536.798	2.723	530.575	2.843
	ESCS	30.577	2.223	28.814	2.245
Russian language instruction school students	R-SQUARE	0.079	0.019	0.039	0.018
	INTERCEPT	494.607	4.641	495.926	5.376
	ESCS	32.522	4.199	22.173	5.236
Estonian students total	R-SQUARE	0.093	0.011	0.072	0.010
	INTERCEPT	527.183	2.406	523.913	2.537
	ESCS	31.372	2.027	28.069	2.110

Students' performance in science (i) PISA 2006 and (ii) PISA 2009, in the different language of instruction schools, indicated that (i) 10%, (ii) 8.1% of the variance in ESTLI schools and (i) 7.9% (ii) 3.9% of the variance in RUSLI schools science was explained by socio-economic background. Socio-economic background played a more important role for the ESTLI school students' (Table 1).

PISA 2009 data on reading literacy explored in the Tires' (2011) study also showed that socio-economically both Estonian and Russian-speaking population show significant differences. The results of the Tires' analyses revealed that schools in Estonia have a homogeneous student population with very few non-native speakers in both language school types. Socio-economic background played a more important role for the Estonian-speaking students than for the Russian-speaking students by explaining only 3.2% of the variance in reading literacy in PISA 2009 (Tire, 2011).

Part B Socio-economic Comparisons of ESTLI and RUSLI Schools

Figure 2 shows the percentage distribution of ESTLI and RUSLI schools by the socio-economic intake of their students

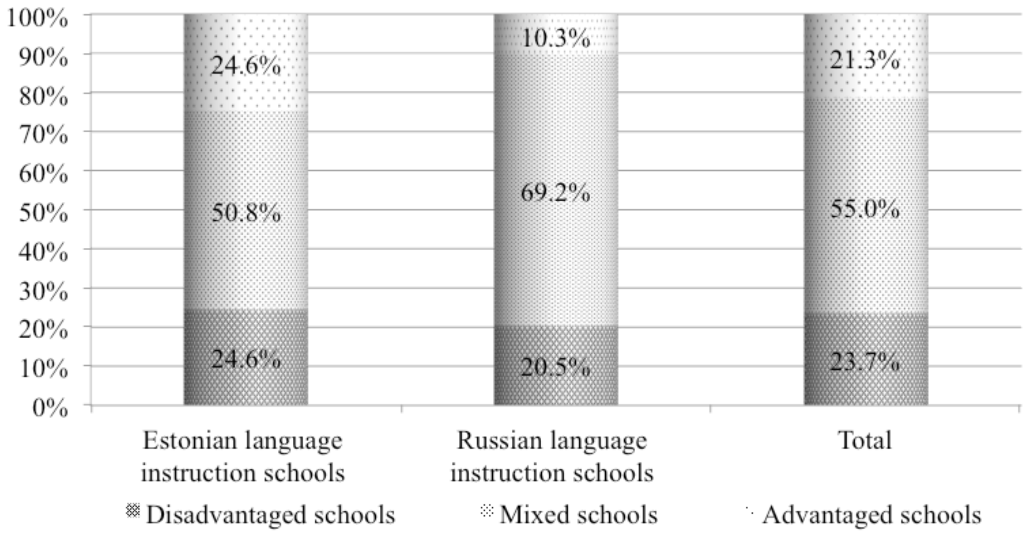

Figure 2: Distribution of Estonian and Russian language instruction schools by the schools' socio-economic intake.

A secondary analysis on the PISA data showed that the total of 21.7% of Estonian students attended disadvantaged schools, in which the average socio-economic background of students was below the national average, 55.0% attended mixed schools (schools with a mixture of socioeconomic intake) where performance was not statistically significantly differently from the country average) and 23.7% attended advantaged schools, in which the average socio-economic background of students was above the national average. Using Chi-squared, the schools' socio-economic intake and language instruction of schools were compared. It was found out, that there was not a statistically significant difference between these school groups, χ^2 (2, N = 169) = 4.975, $p > 0.05$.

Part C Relating Test Performance and School Socio-economic Intake

Generally the results from the PISA studies confirmed that a schools' socio-economic composition has an effect on student performances. Students attending schools showing a disadvantaged socio-economic intake performed, on average, lower than what would be predicted based on their socio-economic background. In order to analyse actual and expected performance, three categories of schools were identified (see methodology). The differences between the observed performance and the adjusted performance reflect the extent to which performance differences are driven by the average socio-economic background of the schools' student population (OECD 2010a).

Using Chi-squared, the three groups of schools' by socio-economic intake and average actual performance were compared. There was statistically significant difference between the average actual performance of schools and different school groups by socio-economic intake, χ^2 (4, N = 169) = 10.444, p =0.034.

46.9% of ESTLI schools and 53.8% RUSLI schools performed better in science than was expected. 13.8% of ESTLI and 15.4% of RUSLI schools students performed at lower level than expected (Figure 3).

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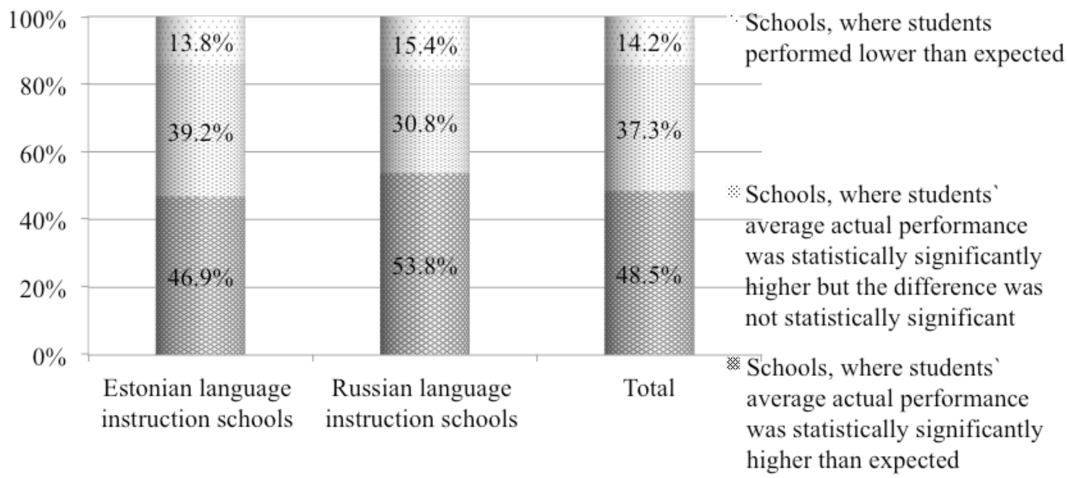

Figure 3: Distribution of PISA 2006 schools by the students' average performance and schools' socio-economic intake.

Using Chi-squared test, the three groups of schools' average student performance related to the schools' socio-economic intake and their language instruction were compared. There was not a statistically significant difference between the language of instruction and different school groups by socio-economic intake, χ^2 (2, N = 169) =0.923, p =0 .63.

As in Estonian case are revealed a weak relationship between SES and different language instruction school students' science performance, we analysed also performance differences relations with attitudinal aspects and classroom's teaching practices

Part D Students' Attitudes and Teaching Practices Differences in ESTLI and RUSLI Schools

The differences in attitudes are connected with cultural values and background, but differences in attitudinal indices may also be connected with the way different scales are answering within different cultures.

An one way ANOVA analysis of variance showed that the differences inside the socio-economically disadvantaged schools, mixed schools and advantaged schools groups on the some engagement construct indices were significantly different. It came out that the students in advantaged schools' group were less informed on science-related careers [F (2, 162) = 4.40, p = 0.014]. They reported higher level general interest in learning science [F (2, 162) = 18.82, p = 0.000], self-efficacy [F (2, 162) = 12.59, p = 0.000], enjoyment of science [F (2, 162) = 4.49, p = 0.013] and personal value of science [F (2, 162) = 4.22, p = 0.016]. But they did less hands-on activities [F (2, 162) = 4.81, p = 0.009] and student investigations [F (2, 162) = 9.31, p = 0.000].

ANOVA was used to find out the mean differences between engagement indices of the ESTLI and RUSLI schools groups. It was revealed that the students from RUSLI schools' groups tended to agree more with the statements that they are informed on science-related careers and the school prepare them for science-related careers (table 2). They had higher level instrumental motivation and future-oriented science motivation and general interest in learning science. The comparison of classroom science-related activities showed that RUSLI schools' students reported higher level that their science teaching focus on applications or models, hands-on activities, interaction, student investigations and different science-related activities. The students from ESTLI schools' groups valued more science in general.

Table 2. The mean differences between engagement indices of the ESTLI and RUSLI schools groups.

Index	ESTLI schools		RUSLI schools		*F*(1, 167)	*p*
	Mean	SD	Mean	SD		
CARINFO	-0.09	0.23	0.26	0.25	64.29	0.000
CARPREP	0.25	0.28	0.39	0.20	7.73	0.000
INTSCIE	0.16	0.21	0.29	0.19	11.06	0.001
INSTSCIE	0.04	0.22	0.16	0.16	11.47	0.001
SCIEFUT	-0.18	0.23;	0.21	0.20	91.29	0.000
SCAPPLY	0.15	0.23	0.44	0.24	46.91	0.000
SCHANDS	-0.20	0.37	0.26	0.33	46.00	0.000
SCINTACT	0.21	0.26	0.41	0.21	19.00	0.000
SCINVEST	0.12	0.32	0.38	0.35	19.27	0.000
SCIEACT	0.38	0.23	0.49	0.18	8.52	0.004
GENSCIE	0.20	0.25	-0.17	0.21	28.92	0.000

Next the differences inside the different language instruction school groups by socio-economic intake were studied. An analysis of variance showed that the advantaged schools' students in both language instruction schools reported higher level general value of science and science self-efficacy (Table 3, 4).

Table 3. The differences between engagement indices inside the Estonian language instruction school groups by socio-economic intake.

Index	ESTLI schools							
	Advantaged		Mixed		Disadvantaged		*F* (2, 127)	*p*
	Mean	SD	Mean	SD	Mean	SD		
SCHANDS	-0.34	0.34	-0.16	0.37	-0.12	0.37	3.63	0.029
SCINVEST	-0.06	0.21	0.14	0.34	0.25	0.29	9.03	0.000
SCIEEFF	0.17	0.30	-0.02	0.24	-0.06	0.20	8.87	0.000
GENSCIE	0.35	0.20	0.18	0.25	0.08	0.20	12.34	0.000

Table 4. The differences between engagement indices inside the Russian language instruction school groups by socio-economic intake.

Index	RUSLI schools							
	Advantaged		Mixed		Disadvantaged		*F* (2, 36)	*p*
	Mean	SD	Mean	SD	Mean	SD		
PERSCIE	0.39	0.32	0.06	0.16	-0.02	0.22	6.54	0.004
JOYSCIE	0.24	0.23	-0.06	0.17	-0.15	0.41	3.50	0.041
SCIEEFF	0.32	0.29	0.06	0.20	-0.11	0.11	6.96	0.003
GENSCIE	0.24	0.15	-0.03	0.20	-0.21	0.17	0.13	0.002

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ESTLI advantaged schools students reported lower level hands-on activities and investigations activities at school than students of disadvantaged schools (table 3). RUSLI advantaged schools student's reported higher level enjoyment of science and personal value of science (table 4).

The ANOVA analysis of engagement construct indices differences between the different language instruction school groups by socio-economic intake revealed (table 5) that RUSLI disadvantaged, mixed and advantaged schools' students claim more that they are informed on science-related careers, their teachers focused more on applications or models, they do more hands-on activities, and have higher future-oriented motivation to learn science. It was found out that the RUSLI mixed and advantaged schools reported

Table 5. The ANOVA analysis of engagement constructs indexes' differences inside the different language instruction school groups by socio-economic intake.

	Disadvantaged schools				Mixed schools				Advantaged schools			
	df	Mean Square	F	Sig.	df	Mean Square	F	Sig.	df	Mean Square	F	Sig.
CARINFO	1, 38	0.606	13.243	0.001	1, 91	2.009	30.578	0.000	1, 34	0.842	20.554	0.000
INSTSCIE	1, 38	0.157	3.578	0.066	1, 91	0.225	4.748	0.032	1, 34	0.153	6.029	0.019
INTSCIE	1, 38	0.087	1.448	0.236	1, 91	0.307	8.614	0.004	1, 34	0.145	4.672	0.038
SCAPPLY	1, 38	0.557	7.384	0.010	1, 91	1.418	30.893	0.000	1, 34	0.514	9.637	0.004
SCHANDS	1, 38	1.467	11.929	0.001	1, 91	2.787	20.931	0.000	1, 34	1.411	12.033	0.001
SCIEFUT	1, 38	1.231	18.767	0.000	1, 91	2.951	66.428	0.000	1, 34	0.465	9.383	0.004
SCINTACT	1, 38	0.214	3.781	0.059	1, 91	0.509	7.599	0.007	1, 34	0.496	8.422	0.006
SCINVEST	1, 38	0.474	3.852	0.057	1, 91	0.747	7.111	0.009	1, 34	0.679	13.721	0.001

Discussion

Estonian and Russian Language Instruction Schools

Outcomes from the PISA 2006 and 2009 studies showed a relatively moderate relationship between Estonian students' background and science performance. This analysis showed that the socio-economic background played a more important role for students in Estonian language instruction schools and explained less of the variance in the science performance of students in Russian language instruction schools. A comparison of Estonian and Russian language instruction school students ESCS and family background indices revealed that Russian language instruction schools' students claim even more that they have at home a desk to study and a quiet place to study or in their home there are classic literature; books of poetry; works of art items.

PISA has consistently shown a link between disadvantaged background and poor performance. Generally the results from PISA studies in Estonia confirmed that the socio-economic composition of school has an effect on student performance. Students attending schools with disadvantaged socio-economic intake performed on average lower than what would be predicted based on their socio-economic background (OECD, 2009b). However, the analysis of the socio-economic composition of different language instruction schools showed that Estonian education system is not segregative. The Estonian and especially the Russian language instruction school students attended mostly mixed schools. It did not appear that Estonian language instruction school students' better performance was the result of a better socio-economic composition or lower performance of the students from Russian language instruction school to have been affected by disadvantaged socio-economic intake.

PISA studies revealed that some students from disadvantaged backgrounds are "resilient", but exhibit high levels of school success (OECD, 2010). The examination of the differences between the schools' mean score in science, as predicted by the socio-economic distribution of schools' students and the actual mean performance scores revealed that almost half of the Estonian schools performed statistically significantly better than expected. In percentages of Russian language instruction schools there were even more than Estonian that performed statistically significantly higher than might be expected. Both Estonian and Russian language instruction schools showed high levels of performance despite the fact that their students came from less advantaged backgrounds.

As the results did not support an assertion that the weaker performance of one sub-group of students' population could be connected with disadvantaged socio-economic status, the relation of schools' performance and SES differences with attitudinal aspects and classrooms teaching practices were analysed. Student's engagement in science is crucial for the acquisition of proficiency, but it is also an important outcome of education. When student's emotional relationships with a certain subject are low and the motivation to learn is low, it may also influence students' preferences and science-related occupational aspirations (Pekrun, 2006).

It was found that in all Estonian schools, where the performance was statistically significantly higher than expected, the students were not more interested in science. They did not have higher levels of general interest in learning science, instrumental motivation in science, enjoyment of science or future oriented science motivation. The all students of Estonian schools, where students' average actual performance in science was statistically significantly higher than expected, tended even to answer that they were less informed about science-related careers topics, less engaged in science-related activities, less did students' investigations at school in comparison with students from schools, where students' average actual performance was statistically significantly higher but the difference was not statistically significant.

It became evident that Russian language instruction school groups, where students' average actual performance was statistically significantly higher than expected, they tended to answer more that they are informed on science-related careers, their teachers focused on applications or models, they did hands-on activities and had higher future-oriented science motivation. Higher performing students from Estonian language instruction schools agreed less that the school prepared them for science-related careers; they did student investigations. They had lower instrumental motivation in science and general interest in learning science.

The analyses revealed that the students from Russian language instruction schools tend to agree more that the school prepared them for science-related careers and they were informed on science-related careers. They had higher level of instrumental and future-oriented science motivation and general interest in learning science. The comparison of classroom science-related activities showed that Russian language instruction schools' students reported more often that their science teaching focuses on applications or models, hands-on activities, interaction, student investigations and other different science-related activities.

No differences were found between Estonian and Russian language instruction schools in relation to the attitudinal and motivational indices as science enjoyment and personal value of science and self-related cognitions – science self-efficacy and academic self-concept in science. This means that there were not differences in students' confidence to solve problems between the two language groups. Beliefs of both groups of students in their ability to succeed in a particular situation were uniform. Students'perceptions of the personal, subjective importance of science and enjoyment in science were similar.

Socio-economically Advantaged, Mixed and Disadvantaged Schools

Analysis on how a school's socio-economic composition relates to the students' science performance and attitudes in Estonia revealed that all the students from advantaged schools in comparison with the mixed and disadvantaged schools' students in both language instruction schools reported higher level of general interest in learning science and science self-efficacy, but lower level of infor-

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mation on science-related careers. All the students from advantaged schools reported a lower level hands-on activities, student investigations and participation in interactive lessons. The study did not give evidences that the socio-economic background of the schools has a direct impact on students' general interest in learning science, instrumental motivation, future-oriented science motivation or self-concept in science. Only students from Russian language instruction advantaged schools reported higher level of enjoyment of science and personal value of science.

The central study questions posed in the beginning of this research was got answers. As a result, the SES did not play an essential role in explaining science performance differences in different language instruction schools in Estonia. The students from Estonian and Russian instruction schools attend mostly socio-economically mixed schools.

The different attitudinal patterns of science learning and teaching practices between Estonian and Russian instruction schools and students became evident. Based on generalisations above, it could be said that there are no coherent relationships between the attitudes and performance of students from different language instruction schools in Estonia. The performance and attitudinal differences of the two language instruction schools in Estonian case are not due to the language problems, immigrant or socio-economic background, or low motivation rate, but rather connected with classroom level instructional practices and cultural background. It is important to take into consideration that the Likert scales response style differences between cultures may differ. Although ESTLI schools' average mean performance in science was higher than in RUSLI schools, the Russian students reported higher level of motivation to learn science, information about science related career and student-oriented classroom practices. Kobarg et al., (2011) reported, the idea of spending more time on hands-on activities does not necessarily have a positive association with achievement. Effective science teaching and learning is a mixture of teaching and learning activities that allow practical engagement and theorizing, reflection and discussion of science concepts, scientific approaches. The Estonian teachers from different language instruction schools implement different teaching practices (Loogma et al., 2009; Säälik, 2012). More fact-based teaching and weaker development of students' metacognitive skills are more typical for Russian language instruction schools (Säälik, 2012). If ESTLI schools seem to be able supply the children with modern learning tools and the RUSLI schools less, this is may be a reason why Estonian schools outperform Russian schools in all PISA domains. Of course, a stronger science performance alone does not guarantee successful engagement of ESTLI students with science in the future.

Conclusions

In the Estonian case, the analysis of PISA 2006 and 2009 data does not support an assertion that weaker performance is associated with the disadvantage background of students or schools. The better performance of the students of Estonian language instruction schools could not be the result of a better socio-economic composition of schools. The analysis showed that the Estonian students attend mostly schools with mixed socio-economic intake. However, the socio-economic background played a more important role for students in Estonian language instruction schools and explained less of the variance in the science performance of students in Russian language instruction schools.

It was revealed that the students' achievement differences are not due to language problems, immigrant, socio-economic status or motivational differences. The results support an opinion that students' performance and engagement construct differences are rather connected with classroom level instructional approaches and learning culture. Although students in Russian language instruction schools reported higher levels of motivation and interest in science, more innovative classroom activities and that the school prepares them for science-related careers, the students in Estonian language instruction schools outperform them in science. It is important to take into consideration the responses differences between cultures. The findings indicate that the simple claims of spending more time on, for example, hands-on activities, students' investigations, using more applications, in itself, do not associate with better achievement.

The data needs follow-up data interpretations. The case where one language group outperforms another, although both receive instruction in mother tongue language and use the same national curriculum and textbooks, prompts the need for more detailed research on the reasons underlying such differences.

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