PISA 2006 – PERFORMANCE OF ESTONIA

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Introduction

The OECD Programme for International Student Assessment (PISA) was administered in Estonian schools for the first time in April 2006. Three PISA surveys have taken place so far, in 2000, 2003 and 2006, focusing on reading, mathematics and science, respectively.

The goal of this international program is to assess student performance and to collect data on the student, family, school factors that help to explain differences in the performance. More than 400,000 students in 57 countries participated in PISA 2006 (30 OECD countries and 27 partner counties) representing a total of 32 million 15-year-old students worldwide. At the time of the survey there were 19,600 students in Estonia representing PISA age group. The randomly selected sample consisted of 4865 students- 2386 females and 2479 males. 24,3% of the sampled students studied at schools with Russian language of instruction. Overall there were 127 schools with Estonian language of instruction, 38 Russian language schools and 4 mixed schools. 70,8% of the students who participated in the survey were in grade nine. 48,1% of the students were from urban schools.

PISA 2006 focused on student's competency in science. The survey assessed science knowledge and skills, as well as student attitudes towards science. Students were presented a series of questions based on scientific problems that they might encounter in their lives. The questions were of different difficulty levels covering personal, social and global topics. PISA 2006 science questions required students to identify scientific issues, explain phenomena scientifically and use scientific evidence. Data was gathered on students' attitudes towards scientific literacy in four areas: support for scientific enquiry, self-belief as science learners, interest in science and responsibility towards resources and environments.

In today's technology based societies there is a great need for people in the labour market requiring skills for complex communication, expert thinking, information processing, etc. The number of students with high and low skill levels is an important indicator in projecting economic growth and social development. PISA has defined proficiency levels for the purpose of describing science competencies that need to be demonstrated at each level. Student scores in science and mathematics are grouped into six proficiency levels (level 6 representing the highest scores and 1 the lowest), reading literacy is measured in five proficiency levels. If the student answers more than a half of the questions on the relevant proficiency level he/she is assigned to the higher level of difficulty.

PISA presents the results in two ways. The first one gives the summary of the overall performance of different countries on the science scale in terms of mean scores and the second provides results according to percentage of students at each proficiency level. According to mean scores, Estonian students ranked fifth on the science scale after Finland, Hong Kong-China, Canada and Chinese Taipei. They were thirteenth in reading and fourteenth in mathematics.
According to the percentage of students at each proficiency level on the science scale, Estonian students ranked second after Finland, twelfth in reading and ninth in mathematics. The high scores can be explained with the fact that most of the students in Estonia have achieved the baseline level at which students begin to demonstrate skills and competencies necessary for future development.

Table 1. Comparison of the Estonian students` performances on the different scales

Assessment scale		Rank of Estonia based on average performance			Rank of Estonia based on proficiency levels	
		Mean score	All countries	Europe	All countries	Europe
Combined science scale		531	5	2	2	2
Competencies	Identifying scientific issues	516			2	2
	Explaining phenomena scientifically	541			2	2
	Using scientific evidence	531			2	2
Knowledge	science	523	11	4		
	Earth and space systems	540	2	2		
	Living systems	540	3	2		
	Physical systems	535	4	2		
Mathematics		515	14	5	9	4
Reading		501	13	8	8	3

Scientific literacy of Estonian students in comparison to other countries

Assessment scales in science

Several scales were used to assess performance. The definition of scientific literacy is described in Table 4, Appendix 1. The definition consists of four aspects: context, knowledge, skills and attitudes. In addition to the overall combined science scale, students were also assessed on the basis of various knowledge domains.
1. Students were assessed in two knowledge domains: *knowledge of science* (knowledge of the natural world, understanding of fundamental scientific concepts and theories) and *knowledge about science* (scientific enquiry and scientific explanations). The content areas covered under *knowledge of science* were “Physical systems,” “Living systems” and “Earth and space systems.”

The overall student performance of different countries was assessed in terms of mean scores.

2. Students were assessed on the following science competency scales: *identifying scientific issues, explaining phenomena scientifically, using scientific evidence.* The ranking of countries has been given on a six level proficiency scale.

3. PISA gathered data on students' attitudes and engagement with science in four areas: *support for scientific enquiry, self-belief as science learners, interest in science and responsibility towards resources and environments.* Countries were not ranked on the basis of attitudes and values, only generalisations were made.

Six proficiency levels in science

PISA 2006 constructed assessment scales for each of the scientific competencies and for each of the knowledge domains.
The following scores were used for different science proficiency levels in the PISA 2006 survey:

Proficiency Level 6 – the student scored more than **707.9** points;
Proficiency Level 5 – the score exceeds **633.3** points and is smaller than or equal to **707.9;**
Proficiency Level 4 – the score exceeds **558.7** points and is smaller than or equal to **633.3;**
Proficiency Level 3 – the score exceeds **484.1** points and is smaller than or equal to **558.7;**
Proficiency Level 2 – the score exceeds **409.5** points and is smaller than or equal to **484.1;**
Proficiency Level 1 – the score exceeds **334.9** points and is smaller than or equal to **409.5.**

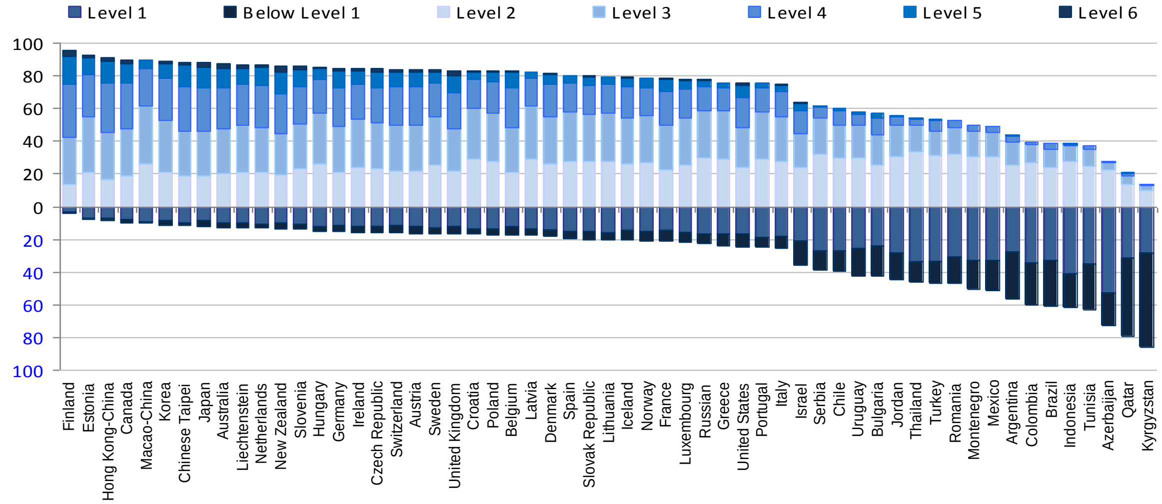
If a student scored less than required for Level 1, it did not mean that he or she had no scientific skills that could be measured in PISA. What it showed was that *such students* w*ere unable to apply their scientific abilities in the simpler contexts offered in the PISA survey.* At Level 2, students started to demonstrate science competencies that would enable them to participate actively in life situations related to science and technology.

The mean score performance of Estonian students and the percentage of Estonian students at each proficiency level compared to other countries

The general score on the combined science scale makes it possible to associate the performance of students with conceptually justified proficiency levels, considering the abilities of students (Appendix 1, Table 1).
Only the differences that are statistically significant are considered when the average performance of different countries is compared. Estonia ranked fifth and its performance was statistically significantly below the performance of just Finland and Hong Kong -China. When statistical significance is considered, the probability of a country's performance ranking in a certain interval is 95%. This means that the probability of Estonia ranking between third to eighth place is 95%.
Estonia ranks even higher when countries are compared on the basis of percentage of students at each proficiency level. Figure 1 shows that Estonia ranks second after Finland on the scale of scientific proficiency levels (between zero level – Levels 1 and 2). The high rank of Estonia can

be explained with the fact that the majority of students in this country have acquired knowledge on the level two. Moreover, the number of students at a very low proficiency is considerably smaller when compared to other countries.

The distribution of student performance across the six proficiency levels



Countries are ranked in descending order of percentage of 15-year-olds at Levels 2, 3, 4, 5 and 6.
Source: OECD PISA database 2006, Table 2.1a.

Figure 1. Percentage of students at each proficiency level on the science scale

The share of students at high proficiency levels (Levels 5 a) was 9% on average across OECD countries. More than 20% of students achieved Levels 5 or 6 in Finland and **11.5%** of students achieved the same levels in **Estonia.** The number of students with low proficiency levels is also an important indicator. Level 2 is considered the level for relevant literacy. These students are able to demonstrate scientific knowledge at a level that allows them to cope in everyday situations associated with science and technology. 19.2% of students in OECD countries scored below Level 2 on the combined science scale. The share of students at low levels was the smallest in Finland (4.1%) and **Estonia (7.7%)** (Table 2). The percentage of students at low levels in the neighbouring countries was as follows: 16.4% in Sweden, 17.4% in Latvia, 20.3% in Lithuania and 22.2% in Russia.

Estonian student performance of different science competencies

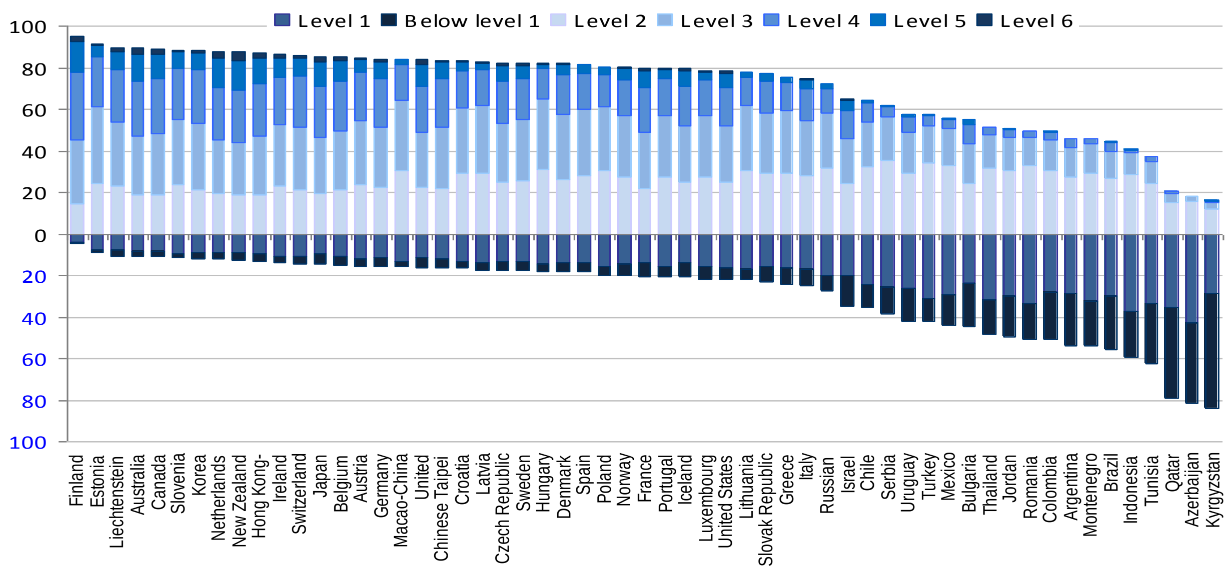
Table 2 gives an overview of the division of Estonian students according to proficiency levels in the different assessment areas of science. The table shows that 1% of Estonian students did not reach Level 1 on the combined science scale. It is worth reminding here that the same result was also achieved in the international TIMSS 2003 survey. The TIMSS 2003 science survey showed that 99% of students exceeded the so-called low level in Estonia. This was the best result among all participating countries.

Table 2. Percentage of Estonian students at each level of proficiency on the different science scale

Assessment scales	% of students						
	Below Level 1	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
Combined science scale	1	6,7	21	33,7	26,2	10,1	1,4
Explaining phenomena scientifically	1	6,5	20,2	29,5	27,1	12,9	2,9
Identifying scientific issues	1,1	7,8	24,6	36,9	23,9	5,5	0,3
Using scientific evidence	1,9	8,2	20,3	30,7	25,2	11,6	2,2

Performance of Estonian students on the *identifying scientific issues* scale

The focus in *identifying scientific issues* was on recognising issues that can be explored scientifically, recognising keywords to search for scientific information and recognising the key features of a scientific investigation. The most typical scientific knowledge in *identifying scientific issues* is knowledge associated with understanding scientific processes of the major content areas of "Physical systems", "Living systems" and "Earth and space systems".



Countries are ranked in descending order of percentage of 15-year-olds at Levels 2, 3, 4, 5 and 6.
Source: OECD PISA database 2006, Table 2.2a.

Figure 2. Percentage of students at each proficiency level on the *identifying scientific issues* scale

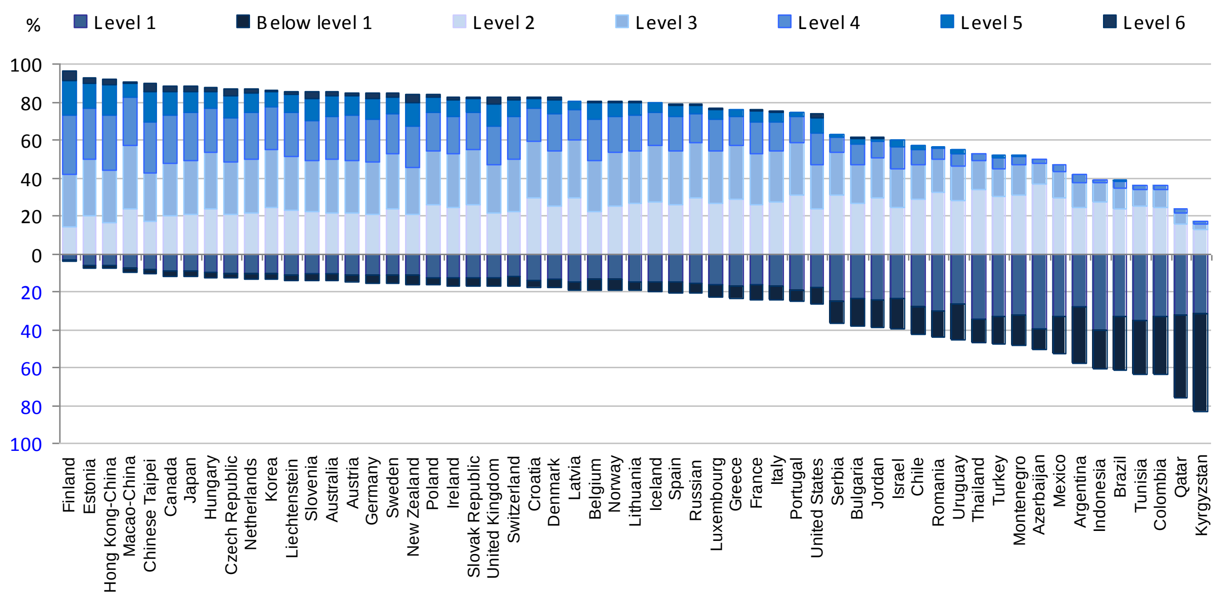
When the skills of students were analysed according to proficiency levels, it became evident that there were relatively few students in all countries who could solve the questions under *Identifying scientific issues* on the highest level – an average of 8.4% of the students of all OECD countries. The percentage of students on Level 5 and Level 6 is high in New Zealand (18.5%) and Finland (17.2%). The share of such students in **Estonia** was **5.8%** (Table 2).

At the same time, Estonia ranked **second after Finland** with its percentage of students at level 1 and below. The percentage of such students in Finland was 4.9% and in **Estonia 8.9%.** The percentage of students on low levels in the neighbouring countries was as follows: 17.8% in Sweden, 17.4% in Latvia, 21.9% in Lithuania and 27.5% in Russia (Figure 2).

Performance of Estonian students on the scale: *explaining phenomena scientifically*

The ability to *explain phenomena scientifically* is associated with traditional areas of science such as physics and biology. The main areas investigated in *Explaining phenomena scientifically* were application of scientific knowledge in a given situation, description or interpretation of phenomena scientifically and predicting changes.

During the analysis of student performance, it was discovered that on the scale of *explaining phenomena scientifically*, the percentage of students who were able to resolve questions at the two highest levels was relatively low in all countries – 9.8% on average across all OECD countries. The percentage of students at the scale of this skill was high in Finland (22.6%), Hong Kong-China (18.8%) and Chinese Taipei (20.3%). Among other countries, the percentage of students who achieved two of the highest levels was also high in the Czech Republic (15.5%) and **Estonia** (15.8%). The contrast is particularly noticeable in Estonia, where 15.8% of students achieved Level 5 and Level 6 on this scale, but only 5.8% on the scale of *identifying scientific issues.* The percentage of students of the relevant level in the neighbouring countries was 10.4% in Sweden, 7.3% in Lithuania, 4.7% in Latvia and 5.1% in Russia (Figure 3).



Countries are ranked in descending order of percentage of 15-year-olds at Levels 2, 3, 4, 5 and 6.
Source: OECD PISA database 2006, Table 2.3a.

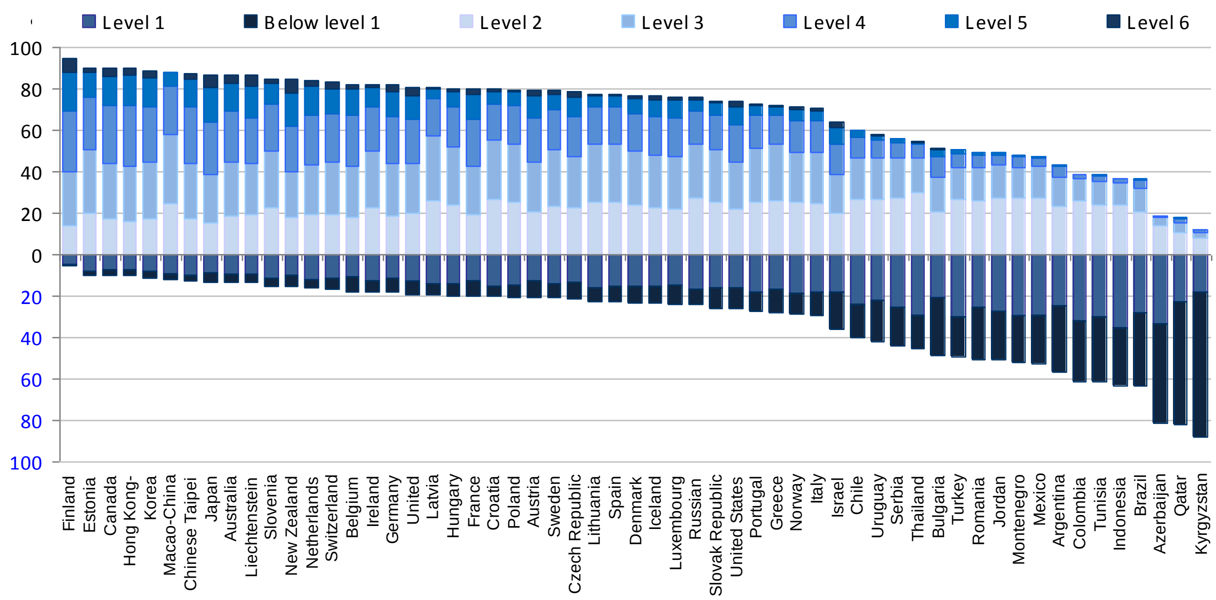
Figure 3. Percentage of students at each proficiency level on the *explaining phenomena scientifically* scale

On average across OECD countries, 19.6% of students remained at Level 1 or below. The percentage of such students was the lowest in Finland (4.0%) and **Estonia** (7.5%). The percentage of students below the level two in the neighbouring countries was 15.6% in Sweden, 19.3% in Latvia, 19.6% in Lithuania and 20.9% in Russia.

Performance of Estonian students on the *using scientific evidence* scale

This competency requires from students to synthesise *knowledge of science* and *knowledge about science* as they both can be applied in the context of a life situation or contemporary social problem. The main features of competency *using scientific evidence* are: interpreting scientific evidence to draw conclusions and to explain them; identifying the assumptions, evidence and reasoning behind conclusions; and to reflect on the implications of scientific and technological development on society.

21.9% of students across OECD countries were at Level 1 or below. The lowest percentage of students at these levels was in Finland (5.4%) and **Estonia** (10.1%). The percentage of students at the lowest levels in the neighbouring countries was 20.8% in Sweden, 19.8% in Latvia, 22.4% in Lithuania and 24.5% in Russia (Figure 4).



Countries are ranked in descending order of percentage of 15-year-olds at Levels 2, 3, 4, 5 and 6.
Source: OECD PISA database 2006, Table 2.4a.

Figure 4. Percentage of students at each proficiency level on the *using scientific evidence* scale.

Student performance in different knowledge domains

Students were assessed in two knowledge domains: *knowledge of science* (knowledge of the natural world, understanding of fundamental scientific concepts and theories) and *knowledge about science*. The first of these can be divided into the following content areas: “Physical systems”, “Living systems” and “Earth and space systems”. *Knowledge about science* is scientific enquiry and scientific explanation. A detailed analysis of these categories is important for relating PISA 2006 results to national curricula.

When comparing these knowledge domains, France shows the largest difference in favour of *knowledge about science*– with 29.2 points, followed by Belgium with 16.6 points and in New Zealand with 14.6 points. The opposite tendency where the score is in favour of *knowledge of science* can be seen in, for example, Azerbaijan (55 points). A relatively noticeable difference in mean scores in favour of *knowledge of science* can be seen in such Eastern European countries as Slovenia (16.9 points), Bulgaria (15.8 points) and Lithuania (10.7 points), as well as in **Estonia** (15.4 points). This means that Estonian students are less successful in *knowledge about science* (such as scientific enquiry and scientific explanation) than in explaining main concepts and theories.

The mean score of **Estonian** students in different knowledge domains and its rank among other countries is as follows:

- On the basis of the mean score on the living systems scale of scientific knowledge, Estonia ranked third with 540 points after Finland (574 points) and Hong Kong -China (558 points).
- On the basis of the mean score on the physical systems scale of scientific knowledge, Estonia ranked fourth with 535 points after Finland (560 points), Chinese Taipei (545 points) and Hong Kong -China (546 points).
- On the basis of the mean score on the earth and space systems scale of scientific knowledge, Estonia ranked second with 540 points after Finland (554 points).
- In the domain of *knowledge about science*, Estonia ranked eleventh with 523 points after Finland (558 points), Hong Kong-China (542 points), New Zealand (539 points), Canada (537 points), Australia (533 points), Japan (532 points), Holland (530 points), Korea (527 points), Liechtenstein (526 points) and Chinese Taipei (525 points).

In conclusion it can be said that Estonian students were the least successful with: *identifying scientific issues* and *knowledge about science.*

Dependence of Estonian mean score on gender and language of instruction

Gender differences are barely noticeable in student performance in OECD countries on the general PISA science scale.

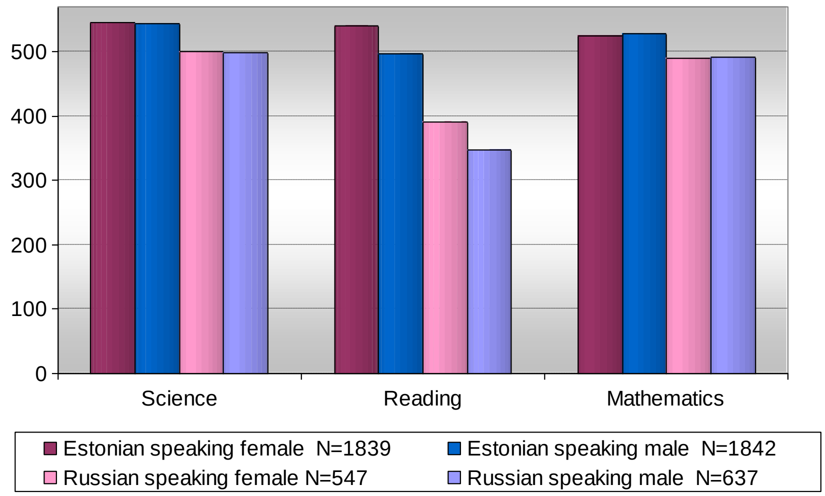


Figure 5. Dependence of the mean score of Estonian students on gender and language of instruction in science, mathematics and reading

A statistical analysis of the results shows that in Estonia, females are stronger in reading. Also, a statistically significant difference appears between the mean scores achieved by students in Estonian and Russian language schools. In international comparison, students of Estonian language schools are more successful in the main assessment areas (science, mathematics and reading) than students of Russian-language schools.

The performance of Estonian students also depends on gender in several scientific skill levels and knowledge domains (Table 3).

Table 3. Mean score, variation and gender differences in Estonian student performance on the science scales (the statistically significant difference in favour of males or females has been marked in bold)

	All students			Gender differences					
	Mean score			Males		Females		Difference (Male - Female)	
	Mean	S.E.	Standard deviation	Mean	S.E.	Mean	S.E.	Score dif.	S.E.
Combined science scale	531	(2,5)	84	530	(3,1)	533	(2,9)	-4	(3,1)
Identifying scientific issues	516	(2,6)	77	504	(3,1)	528	(2,6)	**-25**	(2,8)
Explaining phenomena scientifically	541	(2,6)	91	544	(3,2)	537	(3,0)	6	(3,3)
Using scientific evidence	531	(2,7)	93	529	(3,2)	533	(3,0)	-5	(3,3)
Knowledge about science	523	(2,1)	82	516	(2,5)	531	(2,5)	**-15**	(2,9)
Earth and space systems	540	(2,4)	98	545	(3,2)	535	(2,9)	**10**	(3,7)
Living systems	540	(2,4)	97	534	(3,0)	546	(2,9)	**-12**	(3,3)
Physical systems	535	(2,0)	87	547	(2,7)	522	(2,4)	**25**	(3,1)

The table shows that a statistically significant difference between the performance of Estonian males and females can be seen in the following areas: *identifying scientific issues, knowledge about science, earth and space systems*, *living systems* and *physical systems.* Females in Estonia are better at *identifying scientific issues,* their *knowledge about science* and *living systems* is better. Males in Estonia have better knowledge at *earth and space systems* and *physical systems.*

Students in schools with Estonian language of instruction are better at *explaining phenomena scientifically*, *identifying scientific issues* and *using scientific evidence*. Students in Russian-language schools have been more motivated to learn science and support the application of scientific enquiry (Figure 6).

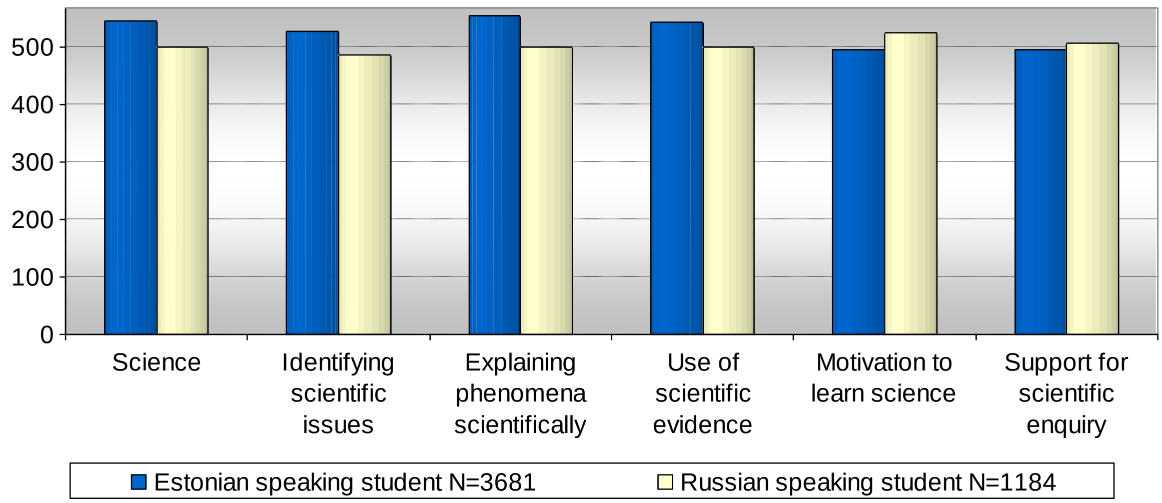


Figure 6. Dependence of Estonian mean score on language of instruction

No statistically significant difference on the general science scale could be seen between the mean scores of males and females in Estonian-language schools. However, females are more motivated to learn science and they are more successful at identifying scientific issues. Males are more successful at explaining phenomena scientifically.

No statistically significant difference on most scales could be seen between the mean scores of males and females in Russian-language schools. Russian females (similarly to Estonian females) were more successful at identifying scientific issues and Russian males were more successful at explaining phenomena scientifically.

The division of Estonian students according to language on the basis of proficiency levels in different assessment areas is shown in Table 4. Table 5 shows the comparison of the division of Russian language students in Estonia and students in Russia on the lower and higher proficiency levels.

Table 4. Division of students(%) in Estonia according to language of instruction and proficiency levels in different assessment areas.

Level	Below Level 1		Level 1		Level 2		Level 3		Level 4		Level 5		Level 6	
Test language	Estonian	Russian	Estonian	Russian	Estonian	Russian	Estonian	Russian	Estonian	Russian	Estonian	Russian	Estonian	Russian
Science	0,5	1,4	4,5	12,2	17,7	28,1	33,6	34,9	29,6	17,0	11,8	5,8	2,2	0,5
Mathematics	1,4	5,2	7,3	13,4	20,0	28,5	30,6	29,4	25,6	15,8	11,7	6,8	3,5	0,8
Reading	1,6	7,2	6,8	20,1	21,2	34,0	35,8	28,3	26,5	9,5	8,1	0,9		
Motivation to learn science	2,2	1,1	8,8	4,0	31,9	21,2	37,9	43,2	15,7	25,2	3,1	4,5	0,4	0,8
Supporting scientific enquiry	1,4	0,8	11,8	8,9	31,9	32,2	33,8	32,5	16,5	19,2	3,9	5,4	0,7	1,0
Explaining phenomena scientifically	0,6	2,7	4,2	12,2	16,4	28,1	29,4	30,1	30,5	19,3	15,2	6,8	3,8	0,8
Identifying scientific issues	0,5	2,5	5,2	13,8	21,5	32,6	38,3	33,0	27,8	15,2	6,3	2,8	0,4	0,1
Use of scientific evidence	1,2	3,9	6,2	12,2	17,2	26,8	31,3	29,9	27,8	19,8	13,4	6,7	2,9	0,7

Table 5. Division (%) of Russian-language students in Estonia and students in Russia at the lower and higher proficiency levels in different assessment areas.

	Russian-language students in Estonia	Total Russia	Russian-language students in Estonia	Total Russia
	% of students on Level 1 and below Level 1		% of students on Level 5 and Level 6	
Science	13,7	22,2	6,3	4,2
Identifying scientific issues	16,3	27,5	2,9	2,5
Explaining phenomena scientifically	14,9	20,9	7,6	5,1
Use of scientific evidence	16,1	24,0	7,4	6,6
Mathematics	13,5	26,6	7,7	7,4
Reading	27,3	35,3	0.9 (Level 5)	1.7 (Level 5)

Interest of Estonian students in science in comparison to other countries

In addition to the scientific and technological knowledge of students and their skills in applying such knowledge, PISA survey also assessed students' attitudes.. Attitudes are seen as key components of an individual's science competency and include individual's beliefs, motivation and sense of self-efficacy. PISA 2006 gathered data on students' attitudes in four areas: *support for scientific enquiry, self-belief as science learners, interest in science and responsibility towards resources and environments.* These areas were selected because they give an overview of students' general attitudes towards science, personal belief in learning science, scientific attitudes and values and responsibility for national and international scientific issues.

PISA 2006 produced three measures of students' value of science. Two were created from the responses to the student questionnaire *(general value of science* and *index of personal value of science)* and one was based on responses to the questions integrated in the science assessment *(support for scientific enquiry scale).*

Results of the PISA survey showed that **Estonian students value science and support scientific enquiry.** 94% of Estonian students agreed that science is important for understanding the natural world. However, whilst an average of 92% of students on the international level agreed that advances in science and technology usually improve people's living conditions, only 74% of Estonian students agreed with this. 70% of students on average across OECD countries and almost 80% of students in Estonia showed great support of scientific enquiry. On average across OECD countries, 75% of students responded that science had helped them to understand things around them and the same indicator was as high as 82% in Estonia. Less students said that they would apply scientific knowledge after leaving school (59% on average across OECD countries, 65% in Estonia) or as an adult (64% on average across OECD countries, 60% in Estonia) or that scientific understanding helped them associate themselves with other people (61% on average across OECD countries, 77% in Estonia). Only 58% of students in Estonia agreed that science is very important for them (the average in OECD countries is 57%).

PISA 2006 also measured students' confidence in being able to handle scientific tasks effectively and overcome difficulties *(self-efficacy in science)* and belief in their academic abilities *(self-concept in science).*

Estonian students believe they are able to do scientific tasks, however it depends on the task. For example, 71% of students in Estonia (76% on average across OECD countries) would be able to explain why earthquakes occurred more frequently in some areas than in others. 57% of students in Estonia (64% on average across OECD countries) would be able to predict how changes in environment would affect the survival of certain species, etc. Over 64% of Estonian students (65% on average across OECD countries) responded that they were usually able to answer the questions in science tests well, but only 39% (47% on average across OECD countries) found school science topics easy.

69% of Estonian students said they were interested in learning human anatomy, but there was less interest in astronomy (64%), chemistry (49%), physics (53%) and botany (49%), and in the manner in which researchers plan their experiments (61%). Only 43% of students wanted to know what is required for scientific explanations.

It was also surveyed whether students enjoyed learning science. On average, 67% of students across OECD countries and 78% of students in Estonia said that they enjoyed acquiring new knowledge in science. 63% of students in Estonia found that they were interested in it. 50% of students in Estonia liked to read about science, but only 40% said that they enjoyed resolving scientific problems.

Students in Estonia are interested in learning science, but only a few of them expect to have a science-related career in the future. Most of students in OECD countries said that they were interested in learning science. 76% of Estonian students said that science was useful.

62% of Estonian students agreed that science was useful for further studies, but the percentage of students who see themselves engaged in science in the future is lower here than the average across OECD countries: only 14% of students in Estonia (21% on average across OECD countries) would like to spend their life doing advanced science and 26% of students in Estonia (37% on average across OECD countries) would like to work in a career involving science.

Only a small number of students in Estonia stated that they participated in activities involving science, even though they did some activities more frequently when compared to the average across OECD countries. For example, 26% of students in Estonia (21% on average across OECD countries) regularly watched television programmes about science; 22% (20% on average across OECD countries) read magazines or newspaper articles about science; 19% of students in Estonia (13% on average across OECD countries) said they regularly visited websites about science; 6% of students in Estonia (8% on average across OECD countries) borrowed books on science; 10% of Estonian students (7% on average across OECD countries) listened to radio programmes on science. However, only 7% of students in Estonia (4% on average across OECD countries) regularly participated in science clubs.

Estonian students feel responsibility for environmental issues. The PISA 2006 student questionnaire asked students how they felt about selected environmental issues. Students' awareness of environmental issues varied considerably according to the issue: 84% of students in Estonia (73% on average across OECD countries) were aware of the consequences of clearing forests for other land use; 73% (60% on average across OECD countries) were aware of acid rain. Students were not so aware of issues less associated with Estonia (such as radioactive waste).

Effects of students' and school's socio-economic background on student performance

In PISA the relationship between performance and socio-economic background was examined on three levels. Firstly, what can be predicted about the performance of every student in the country if their socio-economic background is known? Secondly, what can be predicted about a student's performance in this particular school? Thirdly, what can be predicted about the average performance of the school when the student's background is known?

When looking at the differences in student performance in all participating countries in PISA 2006, then it is noticeable that 26% of the differences are between countries, 27% between schools and 47% between students. The results show that in all countries, within-school differences are considerably bigger than between-school differences. In many countries, students' performance varied considerably also between different schools. On average across OECD countries, 33% of all variation in student performance was between schools. In Finland less than 5% of the overall performance variation among OECD countries lay between schools. In Iceland and Norway, this indicator was less than 10% and in Estonia 15.9%. Estonia belongs among countries where performance is largely independent of the school. Parents in these countries can rely on the high and consistent performance standards followed in all schools of the education system and they have less reason for concern when selecting a school for their children. In Estonia, within-school differences in the average performance of students are bigger than the differences between different schools.

PISA survey also assessed the impact of the socio-economic background on the students' performance. The information collected about the different aspects of the economic, social and cultural status of the students' families was summarised as the Index of Economic, Social and Cultural Status (ESCS). The relationships between students' performance and the PISA Index of Economic, Social and Cultural Status were described on the basis of international gradients. These gradients were the shallowest in Finland, Canada, Hong Kong-China and Estonia. Social context explained 9.3% of student performance variation in Estonia, the same figure in Finland was 8.3% (on average 14% across OECD countries). However, Estonia belongs among countries where the gradient is relatively shallow at the lower levels of socio-economic status, but becomes steeper at higher levels. This means that home background in the group of students living in better conditions caused bigger differences in the students' performance in science.

When we look at the impact of the socio-economic context on performance in science, then it is particularly clear in the case of Canada, Finland, Japan, Korea, Hong Kong-China, Estonia and Macao-China that students have achieved excellent performance in science and the impact of the socio-economic and cultural backgrounds is lower than the international average. Estonia belongs among the countries where the link between the socio-economic background and performance is weak.
When Estonia is compared to other countries, the average impact of the school's economic, social and cultural status on the students' performance is also insignificant. The impact of the school is the smallest in Finland and Iceland.

School environment and organisation

The questions that students and school principals were asked fell into three categories:

- learning opportunities, efficient use of time, measuring performance on the level of classes, approaches to teaching and differentiation traditions;
- internal climate of the school and class, focus on performance, school autonomy and educational management, evaluation methods and data, involvement of parents and staff development;
- school size, number of students and teachers, the e-infrastructure of schools and quality of study materials, experience, training and remuneration of teachers.

In order to assess the academic selectiveness of educational systems, school principals were asked about the extent in which they consider different criteria upon admitting students. On average across OECD countries, 47% of students aged 15 are admitted to schools on the basis of residence. This indicator was 42% Estonia. The students' academic record was the second important criteria in OECD countries (27%). The share of this criterion in Estonia was 44%. On average across OECD countries, 19% of schools proceed from the need of students to study according to a certain programme, with the relevant percentage in Estonia is 9%.

On average across OECD countries, 65% of 15-year-olds were enrolled in schools where performance data were tracked over time by an administrative authority. The survey showed that this exceeded 90% in many countries and 80% in Estonia.

On average across OECD countries, 43% of 15-year-olds were enrolled in schools where students' performance data is used in the evaluation of teacher performance. School principals reported that this percentage was 86% in Estonia, but only 14 in Finland.

On average across OECD countries, 59% of 15-year-olds were enrolled in schools where principals reported that the school took sole responsibility for appointment of teachers. This percentage in Estonia was 95.

Schools take significant responsibility for their methods of disciplining students, selection of textbooks and admittance policies. On average across OECD countries, 82%, 80% and 74% of students respectively were enrolled in schools where it was reported that the schools mainly take responsibility for the above. The relevant indicators in Estonia were 95%, 72% and 85%.

On average across OECD countries, 3% (also 3% in Estonia) of 15-year-olds were enrolled in schools where one or more science teacher positions were vacant.

Mathematics performance of Estonia in PISA 2006 in comparison to other countries

Mathematical literacy

PISA uses a concept of mathematical literacy related to students' capacity to analyse, reason and communicate effectively as they pose, solve and interpret mathematical problems in a variety of situations involving quantitative, spatial, probabilistic or other mathematical concepts. This means that the PISA concept of mathematical literacy differs somewhat from the traditional understanding of school mathematics. When schools generally teach and assess mathematical content out of context, then PISA tests look at everything within context. Therefore, mathematical literacy means the so-called functional learning of mathematics, acquiring knowledge in a certain context, for a certain purpose.

How does PISA measure mathematical literacy?

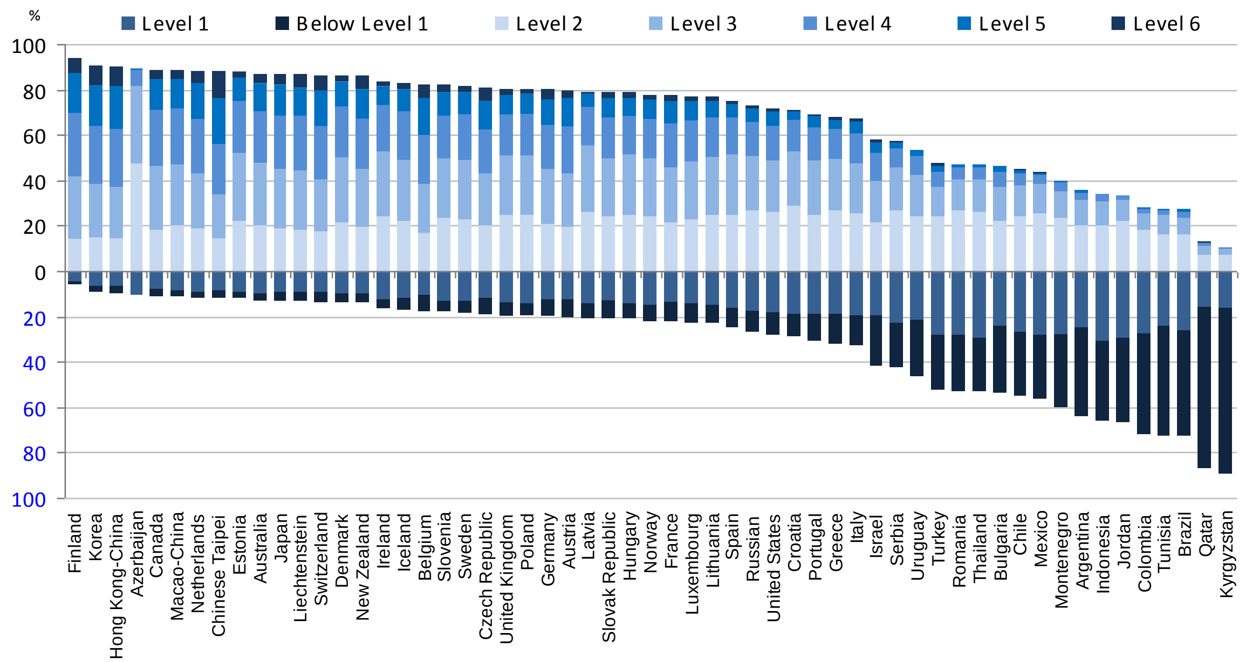
The PISA 2006 survey contained 48 mathematical tasks. They were divided between different test booklets in such a manner that when the booklets were distributed to students, the number of students solving each task was more or less the same. In order to facilitate interpretation of the students' scores, the PISA 2003 assessment scale was constructed in such a manner that the mean score would be 500 and approximately two-thirds of students would place between 400 and 600 points in the scale. The scale obtained in the PISA 2006 survey was tied to the 2003 scale with the tasks contained in both surveys. This way, the mean score in mathematics in PISA 2006 was 498 points. Similarly to previous PISA surveys, the scores achieved by students were again divided between six proficiency levels. These six levels represent the difficulty levels of the tasks with Level 6 being the highest (over 669.3 points) and Level 1 the lowest level of difficulty (357.8-420.1 points). Every such proficiency level covers 62.3 points and has also been described in the survey with the competencies that students need in order to achieve the level.

Division of students in Estonia according to PISA 2006 proficiency levels in comparison to other countries

12.5% of students in Estonia reached ***at least Level 5*** (students who are able to solve difficult tasks). This percentage puts us slightly below the average across OECD countries **(13.4%).** However, it must be added that other countries originating from the same cultural space as Estonia are significantly behind us: Lithuania 9.1%, Russia 7.4%, Latvia 6.6% (Figure 7). Such European countries as France, United Kingdom, Slovakia, Poland, Luxembourg, Norway, Hungary, Italy, Spain, Portugal, Greece, etc., are also behind Estonia with their scores. The percentage of students on Level 5 or higher in the United States was also remarkably lower than in Estonia – only 7.6%. The percentage of students on Level 5 or 6 higher than in Estonia are in the following countries: Sweden, Iceland, Slovenia, Denmark, Germany, Austria, Australia, Canada, Czech Republic, Liechtenstein, New Zealand, Holland, Belgium, Switzerland and Asian countries. *In total, Estonian rank among all countries on the basis of this indicator is 21st (16th if Asian countries are not considered).*

Two-thirds of students in Estonia **(66%)** reached ***at least Level 3*** (students who are able to solve tasks on the average or higher levels of difficulty). In this respect, we significantly exceed the average across OECD countries **(56.8%).** Lithuania (52.0%), Latvia (53%) and Russia (46.4%) are all behind Estonia. Only Finland, Canada, Holland, Switzerland, Liechtenstein, Japan, Australia, New Zealand and Asian countries were more successful than Estonia with respect to this indicator. *In total, Estonian rank among all countries with respect to students who achieved Level 3 or higher is 13th (8th if Asian countries are not considered) and as high as 5th among European countries.*

Level 2 is the so-called baseline level of skills on the PISA survey scale. In the opinion of the PISA framework creators, this is the level from which students are able to demonstrate their skills of using mathematics in a manner necessary in their everyday life in the future. On average across OECD countries, **78.7%** of students exceeded this so-called zero level. The relevant percentage in Estonia was remarkably higher, i.e. **87.9%.** This was the ***fourth-highest score in Europe*** and the only countries to score higher were Finland, Azerbaijan and Holland, where the share of students who achieved at least Level 2 was 94% and 88.5% respectively. Korea, Hong Kong-China, Canada, Macao-China and China Taipei also scored higher than Estonia. *In total, Estonian rank among all countries that took part in the PISA survey on the basis of this indicator is 9th (5th if Asian countries are not considered).* This means that Estonia has been able to give at least elementary mathematical literacy to a relatively large number of students when compared to countries across OECD.



Countries are ranked in descending order of percentage of 15-year-olds in Levels 2, 3, 4, 5 and 6.

Source: OECD PISA database 2006, Table 7.2a.

Figure 7. Percentage of students at each level of proficiency on the mathematics scale

Rank of countries on the basis of mean scores achieved in mathematics tests

Only the scores that are statistically significant are differentiated. The PISA survey showed that:

- the mean scores of four countries were statistically significantly above the scores of all PISA 2006 countries in mathematics. They were OECD countries Finland and Korea and OECD partner countries Chinese Taipei and Hong Kong-China.
- the top four countries were followed by a group of six countries, where the differences in scores were statistically insignificant. This group consisted of Holland, Switzerland, Canada, Macao-China, Liechtenstein and Japan.
- Estonia belongs to the third group of countries that scored higher than the OECD average. The differences in the scores of different countries in this group were bigger than in the previous ones. Besides Estonia, this group also included New Zealand, Belgium, Australia, Denmark, Czech Republic, Iceland, Austria and Slovenia.
- The following countries form a group where the average performance of students was similar to the OECD average and was not statistically significantly different from the OECD average. These countries were Germany, Sweden, Ireland, France, United Kingdom and Poland.

Estonia ranked 14th and its result was statistically significantly below the result of just 11 countries (Appendix 1, Table 2). Only four of these 11 are European countries. We ranked fifth among European countries with similar performance. The only countries whose performance is statistically significantly above Estonia were ***Liechtenstein, Holland and Finland.***

Opportunities to improve the position of Estonia in the rank of PISA countries

When mathematical achievements of males and females were compared, then it became evident that whilst males performed significantly ahead of females in most countries, then such difference was almost non-existent in Estonia. On the one hand, this is a positive result. On the other hand, we could reason that the better performance of males might have been caused by PISA tasks corresponding more to the interests and abilities of males. This assumption allows us to conclude that the relevant abilities and interests of males have not been sufficiently developed in Estonian schools. Maybe this potential will allow Estonia to perform even better in future PISA surveys.

Another circumstance, which gives reason for concern, appeared in the comparison of students' performance in Estonian-language and Russian-language schools. It appeared that the mean score of Russian-language schools was almost 40 points less than the score of Estonian-language schools (in the TIMSS survey, Russian-language schools scored 17 points less than Estonian-language schools). This result is even more surprising considering that the same textbooks are used for teaching mathematics in both Estonian and Russian-language schools. It shows that the reasons for this difference may lie in teachers, their teaching style and methods.

We have to admit that due to the language barrier, mathematics teachers in Russian-language schools have been unable to participate in contemporary subject didactics trainings for mathematics teachers that have been available in Estonia (events for mathematics teachers, special trainings, research work courses, etc.). It is certainly clear that by improving the situation in Russian-language schools, Estonia will improve its position in the next PISA surveys as well.

Reading performance of Estonia in PISA 2006 in comparison to other countries

What were the reading tasks of PISA survey like and how did Estonian students perform?

Reading tasks focused on understanding texts, including both coherent traditional texts and diagrams, schemes and multi-layered texts that combined all of the aforementioned means of expression. One of the most complicated tasks was a tree diagram that showed the division of the working-age population of a notional country between different areas of work. This diagram was characterised by the use of numerous footnotes. Footnotes turned a text into a multi-layered one, which made understanding of the text fully relatively complicated. The difficulty and structure of the text meant it was the type of text adults are likely to encounter in their working lives and must be able to read. In addition to understanding complicated texts, there were also tasks where students had to compare short texts of the same type (opinions posted on the Internet) with respect to their argumentation, style and expression and decide which of the texts was better. There were other simpler tasks where students had to find the factual information requested in the task on a textbook page that was typically illustrated with schemes. The simplest questions asked about the main idea of a text. Questions of different difficulty levels differentiated between five reading proficiency levels.

The following scores were used for different reading proficiency levels in the PISA 2006 survey:

Proficiency Level 5 – the student scored more than **625.6** points;
Proficiency Level 4 – the score exceeds **552.9** points and is smaller than or equal to **625.6;**
Proficiency Level 3 – the score exceeds **480.2** points and is smaller than or equal to **552.9;**
Proficiency Level 2 – the score exceeds **407.5** points and is smaller than or equal to **480.2;**
Proficiency Level 1 – the score exceeds **334.8** points and is smaller than or equal to **407.5;**

Reading skills of Estonian students in PISA 2006 in comparison to other countries

- Estonia ranked 13th among OECD countries in reading literacy if we proceed from the number of students who achieved Levels 3, 4 or 5. This means that Estonia belongs among countries whose performance was statistically significantly above the OECD average. The best-scoring countries among the neighbours of Estonia were Finland (2nd place), Poland (9th) and Sweden (10th). The performance of Latvia, Lithuania and Russia was statistically significantly below the average of all countries (Appendix 1, Table 3).
- If we consider the number of students whose knowledge reached or exceeded Level 2, then Estonia ranked 8th. This shows that Estonia ranks high where students at very low levels are concerned, but Estonian place in the rank drops immediately (12th) when a slightly higher level is used for comparison. A very high number of students have acquired baseline level of competencies in reading, but the number of students with higher reading skills is smaller.
- 6% of Estonian students achieved the highest- the fifth level in reading and this result gives us the 22nd position. Even though there are relatively few students in Estonia with very low reading literacy skills, and it gives us a rather high position in the rank, we still have room for improvement as far as the reading skills of Estonian students are concerned.
- Females in all countries performed significantly ahead of males in reading. When we compare the results, we can say that Estonian males were about half a year behind females in the development of their reading literacy skills.
- If we look at the results on the basis of the test language, i.e. compare Estonian-language and Russian-language schools, then the difference is quite significant – the performance of Russian-language schools was significantly below the performance of Estonian-language schools.

APPENDIX 1

Table 1. Range of rank of countries on the different combined science scale

Science scale						
	Mean score	S.E.	Range of rank			
			OECD countries		All countries/economies	
			Upper Rank	Lower Rank	Upper Rank	Lower Rank
Finland	563	(2,0)	1	1	1	1
Hong Kong-China	542	(2,5)			2	2
Canada	534	(2,0)	2	3	3	6
Chinese Taipei	532	(3,6)			3	8
Estonia	531	(2,5)			3	8
Japan	531	(3,4)	2	5	3	9
New Zealand	530	(2,7)	2	5	3	9
Australia	527	(2,3)	4	7	5	10
Netherlands	525	(2,7)	4	7	6	11
Liechtenstein	522	(4,1)			6	14
Korea	522	(3,4)	5	9	7	13
Slovenia	519	(1,1)			10	13
Germany	516	(3,8)	7	13	10	19
United Kingdom	515	(2,3)	8	12	12	18
Czech Republic	513	(3,5)	8	14	12	20
Switzerland	512	(3,2)	8	14	13	20
Macao-China	511	(1,1)			15	20
Austria	511	(3,9)	8	15	12	21
Belgium	510	(2,5)	9	14	14	20
Ireland	508	(3,2)	10	16	15	22
Hungary	504	(2,7)	13	17	19	23
Sweden	503	(2,4)	14	17	20	23
Poland	498	(2,3)	16	19	22	26
Denmark	496	(3,1)	16	21	22	28
France	495	(3,4)	16	21	22	29
Croatia	493	(2,4)			23	30
Iceland	491	(1,6)	19	23	25	31
Latvia	490	(3,0)			25	34
United States	489	(4,2)	18	25	24	35
Slovak Republic	488	(2,6)	20	25	26	34
Spain	488	(2,6)	20	25	26	34
Lithuania	488	(2,8)			26	34
Norway	487	(3,1)	20	25	27	35
Luxembourg	486	(1,1)	22	25	30	34
Russian Federation	479	(3,7)			33	38
Italy	475	(2,0)	26	28	35	38
Portugal	474	(3,0)	26	28	35	38
Greece	473	(3,2)	26	28	35	38
Israel	454	(3,7)			39	39
Chile	438	(4,3)			40	42
Serbia	436	(3,0)			40	42
Bulgaria	434	(6,1)			40	44
Uruguay	428	(2,7)			42	45
Turkey	424	(3,8)	29	29	43	47
Jordan	422	(2,8)			43	47
Thailand	421	(2,1)			44	47
Romania	418	(4,2)			44	48
Montenegro	412	(1,1)			47	49
Mexico	410	(2,7)	30	30	48	49
Indonesia	393	(5,7)			50	54
Argentina	391	(6,1)			50	55
Brazil	390	(2,8)			50	54
Colombia	388	(3,4)			50	55
Tunisia	386	(3,0)			52	55
Azerbaijan	382	(2,8)			53	55
Qatar	349	(0,9)			56	56
Kyrgyzstan	322	(2,9)			57	57

Statistically significantly above the OECD average
Not statistically significantly different from the OECD average
Statistically significantly below the OECD average

APPENDIX 1

Table 2. Range of rank of countries on the mathematics scale

Mathematics scale						
			Range of rank			
	Mean score	S.E.	OECD countries		All countries	
			Upper Rank	Lower Rank	Upper Rank	Lower Rank
Chinese Taipei	549	(4,1)			1	4
Finland	548	(2,3)	1	2	1	4
Hong Kong-China	547	(2,7)			1	4
Korea	547	(3,8)	1	2	1	4
Netherlands	531	(2,6)	3	5	5	8
Switzerland	530	(3,2)	3	6	5	9
Canada	527	(2,0)	3	6	5	10
Macao-China	525	(1,3)			7	11
Liechtenstein	525	(4,2)			5	13
Japan	523	(3,3)	4	9	6	13
New Zealand	522	(2,4)	5	9	8	13
Belgium	520	(3,0)	6	10	8	14
Australia	520	(2,2)	6	9	10	14
Estonia	515	(2,7)			12	16
Denmark	513	(2,6)	9	11	13	16
Czech Republic	510	(3,6)	10	14	14	20
Iceland	506	(1,8)	11	15	16	21
Austria	505	(3,7)	10	16	15	22
Slovenia	504	(1,0)			17	21
Germany	504	(3,9)	11	17	16	23
Sweden	502	(2,4)	12	17	17	23
Ireland	501	(2,8)	12	17	17	23
France	496	(3,2)	15	22	21	28
United Kingdom	495	(2,1)	16	21	22	27
Poland	495	(2,4)	16	21	22	27
Slovak Republic	492	(2,8)	17	23	23	30
Hungary	491	(2,9)	18	23	24	31
Luxembourg	490	(1,1)	20	23	26	30
Norway	490	(2,6)	19	23	25	31
Lithuania	486	(2,9)			27	32
Latvia	486	(3,0)			27	32
Spain	480	(2,3)	24	25	31	34
Azerbaijan	476	(2,3)			32	35
Russian Federation	476	(3,9)			32	36
United States	474	(4,0)	24	26	32	36
Croatia	467	(2,4)			35	38
Portugal	466	(3,1)	25	27	35	38
Italy	462	(2,3)	26	28	37	39
Greece	459	(3,0)	27	28	38	39
Israel	442	(4,3)			40	41
Serbia	435	(3,5)			40	41
Uruguay	427	(2,6)			42	43
Turkey	424	(4,9)	29	29	41	45
Thailand	417	(2,3)			43	46
Romania	415	(4,2)			43	47
Bulgaria	413	(6,1)			43	48
Chile	411	(4,6)			44	48
Mexico	406	(2,9)	30	30	46	48
Montenegro	399	(1,4)			49	50
Indonesia	391	(5,6)			49	52
Jordan	384	(3,3)			50	52
Argentina	381	(6,2)			50	53
Colombia	370	(3,8)			52	55
Brazil	370	(2,9)			53	55
Tunisia	365	(4,0)			53	55
Qatar	318	(1,0)			56	56
Kyrgyzstan	311	(3,4)			57	57

Statistically significantly above the OECD average

Not statistically significantly different from the OECD average

Statistically significantly below the OECD average

Source: OECD PISA 2006 database.

APPENDIX 1

Table 3. Range of rank of countries on the reading scale

Reading scale						
	Mean score	S.E.	Range of rank			
			OECD countries		All countries	
			Upper Rank	Lower Rank	Upper Rank	Lower Rank
Korea	556	(3,8)	1	1	1	1
Finland	547	(2,1)	2	2	2	2
Hong Kong-China	536	(2,4)			3	3
Canada	527	(2,4)	3	4	4	5
New Zealand	521	(3,0)	3	5	4	6
Ireland	517	(3,5)	4	6	5	8
Australia	513	(2,1)	5	7	6	9
Liechtenstein	510	(3,9)			6	11
Poland	508	(2,8)	6	10	7	12
Sweden	507	(3,4)	6	10	7	13
Netherlands	507	(2,9)	6	10	8	13
Belgium	501	(3,0)	8	13	10	17
Estonia	501	(2,9)			10	17
Switzerland	499	(3,1)	9	14	11	19
Japan	498	(3,6)	9	16	11	21
Chinese Taipei	496	(3,4)			12	22
United Kingdom	495	(2,3)	11	16	14	22
Germany	495	(4,4)	10	17	12	23
Denmark	494	(3,2)	11	17	14	23
Slovenia	494	(1,0)			16	21
Macao-China	492	(1,1)			18	22
Austria	490	(4,1)	12	20	15	26
France	488	(4,1)	14	21	18	28
Iceland	484	(1,9)	17	21	23	28
Norway	484	(3,2)	16	22	22	29
Czech Republic	483	(4,2)	16	22	22	30
Hungary	482	(3,3)	17	22	23	30
Latvia	479	(3,7)			24	31
Luxembourg	479	(1,3)	20	22	26	30
Croatia	477	(2,8)			26	31
Portugal	472	(3,6)	22	25	29	34
Lithuania	470	(3,0)			30	34
Italy	469	(2,4)	23	25	31	34
Slovak Republic	466	(3,1)	23	26	31	35
Spain	461	(2,2)	25	27	34	36
Greece	460	(4,0)	25	27	34	36
Turkey	447	(4,2)	28	28	37	39
Chile	442	(5,0)			37	40
Russian Federation	440	(4,3)			37	40
Israel	439	(4,6)			38	40
Thailand	417	(2,6)			41	42
Uruguay	413	(3,4)			41	44
Mexico	410	(3,1)	29	29	41	44
Bulgaria	402	(6,9)			42	50
Serbia	401	(3,5)			44	48
Jordan	401	(3,3)			44	48
Romania	396	(4,7)			44	50
Indonesia	393	(5,9)			44	51
Brazil	393	(3,7)			46	51
Montenegro	392	(1,2)			47	50
Colombia	385	(5,1)			48	53
Tunisia	380	(4,0)			51	53
Argentina	374	(7,2)			51	53
Azerbaijan	353	(3,1)			54	54
Qatar	312	(1,2)			55	55
Kyrgyzstan	285	(3,5)			56	56
Kyrgyzstan	322	(2,9)			57	57

Statistically significantly above the OECD average

Not statistically significantly different from the OECD average

Statistically significantly below the OECD average

Source: OECD PISA 2006 database.

APPENDIX 1

Table 4. Summary of the assessment areas in PISA 2006

	Science	**Reading**	**Mathematics**
Definition and its distinctive features	The extent to which an individual: -Possesses scientific knowledge and uses that knowledge to identify questions, acquire new knowledge, explain scientific phenomena and draw evidence-based conclusions about science-related issues. -Understands the characteristic features of science as a form of human knowledge and enquiry. -Shows awareness of how science and technology shape our material, intellectual and cultural environments. -Engages in science-related issues and with the ideas of science, as a reflective citizen. *Scientific literacy* requires an understanding of scientific concepts, as well as the ability to apply a scientific perspective and to think scientifically about evidence.	The capacity of an individual to understand, use and reflect on written texts in order to achieve one's goals, to develop one's knowledge and potential, and to participate in society. In addition to decoding and literal comprehension, *reading literacy* also involves interpretation and reflection, and the ability to use reading to fulfil one's goals in life. The focus of PISA is on reading to learn rather than learning to read, and hence students are not assessed on the most basic reading skills.	The capacity of an individual to identify and understand the role that mathematics plays in the world, to make well-founded judgements and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen. *Mathematical literacy* is related to wider, functional use of mathematics; engagement includes the ability to recognise and formulate mathematical problems in various situations.
Knowledge domain	*Knowledge of science*, such as: • "Physical systems" • "Living systems" • "Earth and space systems" • "Technology systems" *Knowledge about science*, such as:	The form of reading materials: • *Continuous texts:* including different kinds of prose such as narration, exposition, argumentation • *Non-continuous texts:* including graphs,	Clusters of relevant mathematical areas and concepts: • *Quantity* • *Space and shape* • *Change and relationships* • *Uncertainty*

	• "Scientific enquiry" "Scientific explanations"	forms and lists	
Competencies involved	Type of scientific task or process: • *Identifying scientific issues* • *Explaining scientific phenomena* • *Using scientific evidence*	Type of reading task or process: • Retrieving information • Interpreting texts • Reflecting and evaluating of texts	Competency clusters define skills needed for mathematics: • *Reproduction* (simple mathematical operations) • *Connections* (bringing together ideas to solve straightforward problems) • *Reflection* (wider mathematical thinking)
Context and situation	The area of application of science, focusing on uses in relation to personal, social and global settings such as: • "Health" • "Natural resources" • "Environment" • "Hazard" • "Frontiers of science and technology"	The use for which the text is constructed: • *Private* (*e.g.* a personal letter) • *Public* (*e.g.* an official document) • *Occupational* (*e.g.* a report) • *Educational* (*e.g.* school-related reading)	The area of application of mathematics, focusing on uses in relation to personal, social and global settings such as: • *Personal* • *Educational and occupational* • *Public* *Scientific*