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Quality of Education: International Comparison. Latvia in OECD Programme for International Student Assessment

Edited by Andris Kangro

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Andrejs Geske, Andris Grīnfelds, Andris Kangro, Rita Kiseļova, Linda Mihno. **Quality of Education: International Comparison. Latvia in OECD Programme for International Student Assessment.** Edited by Andris Kangro. Riga: University of Latvia, 2015. 336 pages.

The 8th monograph of the series "Educational Research in Latvia" aims to provide an analysis of the most recent indicators characterising the quality of education in Latvia, and the contextual characteristics thereof. The analysis is based on the research data obtained in OECD PISA and other universally recognised international programmes. The research addresses the relevant development issues in the Latvian education – ensuring the equal opportunities to obtain good quality education everywhere in Latvia, the impact of students' socio-economic status on their study performance, optimisation of the school network, increase in the relative number of high-performing students, the effect of ICT use, the methodologies of teaching mathematics, testing, etc. The monograph, by using the data of international comparison, shows the rising educational quality levels in mathematics, science and reading in the schools of Latvia over the entire period of the country's independence and the current status among the world's developed countries. The monograph is intended for researchers and practitioners of education, education policy makers and supervisors, teachers, the masters' and doctoral programme students of the relevant fields.

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INVESTING IN YOUR FUTURE

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CONTENT

Abbreviations

AHELO – Assessment of Higher Education Learning Outcomes
ALL – Adult Literacy and Life Skills Survey
CIMO – Centre for International Mobility and Cooperation
CIVED – Civic Education Study
CME – The centralized mathematics examination
COMPED – Computers in Education Study
EACEA – EC Education, Audiovisual and Culture Executive Agency
EC – European Commission
ECER – European Conference on Educational Research
ECES – International Early Childhood Education Study
EERA – European Educational Research Association
ESCS – Index of social, cultural and economic status
ESF – European Social Fund
ESLC – European Survey on Language Competences
ETLS – English Teaching and Learning Study
EU – European Union
FEPA – University of Latvia Faculty of Education, Psychology and Art
GDP – Gross Domestic Product
IALS – International Adult Literacy Survey
ICCS – International Civic and Citizenship Study
ICILS – International Computer and Information Literacy Study
ICT – Information and communication technologies
IEA – International Association for Evaluation of Educational Achievement
IER – University of Latvia Institute for Educational Reaserch
INES – Indicators of Education Systems
IRC – International Research Conference
IRT – Item Response Theory
ISCED – International Standard Classification of Education
ISEI – International Socio-Economic Index of Occupational Status
LES – Language Education Study
MoES – Republic of Latvia Ministry of Education and Science
NAEP – National Assessment of Educational Progress
NCE – National Centre for Education
NCEE – Network for Central/Eastern Europe
NDP – National Development Plan of Latvia
OECD – Organisation for Economic Cooperation and Development

PIAAC – Programme for the International Assessment of Adult Competencies
PIRLS – Progress in International Reading Literacy Study
PISA – Programme for International Student Assessment
RLS – Reading Literacy Study
SACMEQ – Southern Africa Consortium for Monitoring Educational Quality
SEDA – State Education Development Agency
SES – Socio-economic status
SITES – Second Information Technology in Education Study
TALIS – Teaching and Learning International Study
TEDS-M – Teacher Education and Development Study in Mathematics
TIMSS – Trends in International Mathematics and Science Study
UL – University of Latvia
UNDP – United Nations Development Programme
UNESCO – United Nations Educational, Scientific and Cultural Organization

INTRODUCTION

Today the welfare of a country greatly depends on its human resources, opportunities to obtain competitive knowledge and skills that can be effectively used in one's life. The education system should be of good quality, it should ensure a possibility to acquire the necessary proficiency, boost young people's motivation and academic strength to continue education after leaving school. All stakeholders – parents, students, teachers, education managers, education policy-makers, as well as the general public – should be informed about the potential of a specific education system to prepare young people for life. The European Union's (EU) Strategic Framework of Education and Training (ET 2020) has named the improving of the quality and efficiency of education as one of the four strategic objectives for education development until 2020 (*http://ec.europa.eu/education/policy/strategic-framework/index_en.htm*). One of the key education development policy documents in the Republic of Latvia is "Education Development Guidelines 2014–2020", and its main goal is "high-quality and inclusive education for personal development, human welfare, and sustainable national growth" (*http://polsis.mk.gov.lv/view.do?id=4781*).

Thus, the quality issues are of utmost importance in the development of national education systems. Indeed, the quality of education and its evaluation are constantly in the focus of attention of academic, practical and political circles (see Chapter 1.1). There is an issue emerging quite regularly in the political debate concerning education in Latvia, that, in the first place, an agreement is needed on the meaning of the concept 'quality of education', on the choice of its assessment methods, and only subsequently the appropriate steps in education policy and practice should be taken.

Currently the countries do not content themselves with resorting only to their national quality assessment. Usually, internationally recognized criteria, methods and assessments are taken into account, and Latvia is not an exception here. Since Latvia regained its independence in 1991, it has introduced and applied an education quality assessment method that was developed in 1958 and has gained extensive popularity all over the world, providing direct comparative assessment of students' knowledge and skills in different areas in a number of countries. International organizations – OECD (*Organisation for Economic Cooperation and Development, www.oecd.org*), IEA (*International Association for Evaluation of Educational Achievement, http://www.iea.nl*), EU – perform extensive organizational and research work: they develop scientifically justified education assessment programmes conforming to high standards and methodologies. Based on the assessment results, these institutions elaborate recommendations for education policy to assist governments in addressing the issues of education quality and enhancement of education system. In the modern globalized world, the results of regular international assessment programmes (OECD PISA (*Programme for International Student Assessment, www.pisa.oecd.org*), IEA TIMSS (*Trends in International Mathematics and Science Study*), IEA PIRLS (*Progress in International Reading Literacy Study, http://www.iea.nl/current_studies.html*), etc.) – involving about 80 countries in total, which include all the industrially developed countries, always cause an extensive response in the world; these results are being analysed and referred to by EU, OECD, UNESCO (*United Nations Educational, Scientific and Cultural Organization*), the World Bank and other institutions, as well as the participating countries.

Each of the countries taking part in the research programmes attach great importance to the performance level of its students in comparison to their peers all over the world, and, furthermore, benefits from the internationally evaluated comparative information, thereby enhancing its education system and undertaking required reforms. For example, the structural reforms of the education system are a very important aspect of policy in Latvia, the need of which has been widely discussed in recent years. A certain downsizing of the school system is also contemplated, as well as optimization of the school network due to the significant decrease in the number of students (approximately by half), caused both by demographic reasons and the migration of the population to other countries. The reforms of the school network should be linked to the quality of education provided by schools; many other indicators should be borrowed from the international education studies. In fact, already 15 years ago the researchers, basing their proposals on the results of international comparative assessments of education, suggested school network reforms in Latvia (see, e.g., A. Kangro (2000), A. Kangro (2002), A. Geske, A. Kangro (2004)), which only now (i.e., in 2014) are included in "Declaration of the Intended Activities of the Cabinet of Ministers Headed by Laimdota Straujuma" (*http://www.pkc.gov.lv/images/LS_MK_deklaracija.pdf*) and have become a subject of vigorous political debate.

Ultimately, it comes to evidence-based education policy decision making, which today is largely dependant on internationally generated data and analysis. All the developed countries work toward the improvement of their education systems and participate in the international comparative assessments of education, obtaining and accumulating internationally recognized and significant data about the quality of their education system and many of its contextual characteristics on a regular basis. Of course, implementing the research results in the education policy directly depends on the countries participating in the research, the same goes for an appropriate in-depth national analysis (i.e. secondary analysis of international research data).

All monographs of the series "Educational Research in Latvia", like many other publications of the monograph authors, are devoted to the analysis of Latvia's results in international comparative evaluation and assessment of education.

The 8th monograph of the series – "Quality of Education: International Comparison. Latvia in OECD Programme for International Student Assessment" is devoted to the analysis of the most recently obtained education quality indicators in Latvia and their contextual characteristics in international comparison, and their secondary analysis in order to address the current education development issues in Latvia, such as the access to the education of equal quality in Latvia, the impact of the students' socio-economic status on their learning achievements, optimisation of the school network, boosting of the number of students showing excellent results, the impact of ICT use, the maths teaching methods and tests, etc. Monograph No. 8 is translated into English from the revised edition of Monograph No. 7. It is necessary both for exchanging of information with the respective research groups and other interested parties abroad and for the postgraduate students at the University of Latvia whose study language is English. The publication mostly draws on the latest data (OECD PISA 2012), however, the researchers make full use of a major advantage of this cyclical research – the opportunity (and, simultaneously, the necessity) to compare the changes over time that have influenced any particular quality indicator or the factors affecting it. Consequently, many parameters have to be analysed in comparison with the data provided by PISA 2000, 2003, 2006, 2009. Thus, various trends are examined in the light of the entire OECD PISA data obtained within the previous cycles, as well as the data from IEA TIMSS and PIRLS cycles. The monograph is intended for researchers and practitioners in education, educational policymakers and education managers, teachers, graduate students, whose interests lie in the respective sphere.

Chapter 1 of the current monograph focuses on the education quality assessment and general characterisation of OECD PISA. At the beginning of the chapter, a whole set of quality assessment activities is highlighted – assessment of students, appraisal of teachers and school principals, evaluation of schools and education system in various countries in order to improve learning and to achieve the set targets. The important role of student assessment is discussed by showing international comparative student performance assessment origin and its place in quality assessment activities as a whole. A brief description of IEA (since 1958) and OECD (since 1998) activities is provided, both in the context of developing regular international comparative assessment in the countries worldwide, as well as the advancement of this research direction in Latvia since 1991. The problem of research result implementation in the education policy is given particular attention. The chapter provides a description of OECD PISA cycles and their main features.

Chapter 2 reflects the international comparative educational research methodology, describing the research sample selection and the research implementation process, performance scale and building proficiency levels, as well as the formation of the context indices by using the survey data. This chapter is intended to contribute to improved understanding of the analysis and its results in the subsequent chapters, which are based on rather complicated methodological approaches.

Chapters 3, 4 and 5 address mathematics, science and reading performance of 15-year-old students based on the data and results of the latest completed cycle (PISA 2012) of OECD PISA assessment, as well as those of the previous cycles. First of all, each chapter provides a definition of the respective proficiency and its six levels, the aspects of proficiency assessment and the types of test items with examples of particular items. Afterwards, PISA measurement results are presented, including the average student performance in the participating countries, the distribution of students according to the achieved level of proficiency in the test, the changes in results over time, etc. The analysis is mainly focussed on the performance of Latvian students in comparison to OECD and EU countries. These chapters outline the main PISA results and their evaluation with regard to Latvia in order to select the directions for secondary analyses of Latvia's results in the following chapters of the monograph.

Chapter 6.1 examines the changes in the trends of the Latvian student average performance in mathematics, reading and science over a rather long period of time. OECD PISA cycles enable the comparison of quality levels since the year 2000, using the assessment results obtained every three years. The results achieved by the Latvian students in mathematics, science and reading in OECD programme have generally improved. IEA TIMSS initiated in 90s of the 20th century and subsequently also IEA PIRLS cycles and their continuation simultaneously with PISA cycles in the following decade provide an opportunity to assess the trends of education quality level in 49 countries around the world from 1995 to 2009. The publications cited in Chapter 6.1 demonstrate that the average annual improvement of the education quality in Latvia is the highest among the 49 countries, taking into account the results of Latvia not only in OECD PISA, but also in IEA research. The results of Latvia in IEA TIMSS and PIRLS until 2009 (after that Latvia temporarily ceased to participate in IEA research, remaining only in OECD PISA) were significantly above the average level of the participating countries and with an upward trend. Thus, essentially, in a long-term perspective – throughout the entire period after Latvia regained its independence in 1991 – our education system has maintained a rising trend in education quality level.

Undoubtedly, this raises the question as to the currently attained level of education quality in Latvia in comparison to other countries. Chapter 6.1 provides an answer to this question by using the results, combining the data from PISA 2012 and TIMSS 2011 – Latvia ranks as the 24th among 76 countries. The analysis of Latvia's relative position in each OECD PISA cycle is performed, taking into account the total number of countries participating in the research. It is evident that Latvia takes a stable position on the average level among OECD countries or is close to it, while the performance of students in the new participating countries, whose number is growing, almost always is lower. Thus, the relative rank of Latvia among all the participating countries significantly improves.

Chapters 3, 4, 5 and 6.1 mainly provide the analysis of the Latvian students' performance in the international context – OECD PISA tests, in the particular content area, respectively, mathematics, reading and science, whereas the continuation of Chapter 6 is devoted to performance of Latvian students in relation to various contextual factors (e.g., socio-economic status of the family (SES), location of the school and type of school, school network, truancy, etc.), which, in essence, similarly affect student performance in any content area. Naturally, the most recent data are used for the purposes of illustration (i.e., PISA 2012 main content area – mathematics), although the analysis often deals also with other content areas and the previous PISA cycles.

Chapter 6.2 examines the generally known student performance relation with student SES in the context of Latvia. It is shown that the correlation of student performance and family's material well-being, educational and cultural resources available at home, education and profession of parents (i.e. family SES) in Latvia in recent years has become somewhat more pronounced, as our country from being in a higher position, according to international comparison, has reached the average level of OECD countries in the field of equal opportunities in education. Thus, it is necessary to monitor the situation and look for the ways to help the students from families with a lower SES, and especially the schools attended by greater number of these students to achieve a higher study performance.

To characterise the situation more precisely, Chapter 6.2 further explores the average level of school SES, as well as the average school performance in Latvia within an international comparison. The level of a school's SES is the particular factor that significantly influences student performance, comparing various schools in Latvia and also on the average in OECD countries. In this respect, the greatest attention should be directed toward the groups of schools with low SES and low performance, and average SES and low performance. There are 9.0% and 11.5% of students, respectively, studying in these schools in Latvia. The schools with low SES in Latvia are often located in the areas with a less developed socio-economic status, therefore, in this case the quality improvement is definitely also a matter of regional development. By contrast, in case of schools with low performance and average SES, the decisive improvement factor should be the analysis and advancement of the educational work. This topic is further addressed in Chapters 6.4, 6.5 and other chapters of the monograph by linking the previously described school performance and SES group with urbanization, type of school and other factors.

Chapter 6.3 provides a performance analysis of the students who have a very high family SES (10% of students with the highest level of SES) comparing the situation in nine countries of the Baltic Sea region: Finland, Estonia, Latvia, Lithuania, Russia, Poland, Germany, Denmark and Sweden. Analysing the relation between the performance in mathematics and reading, and the SES group, certain differences between the countries can be observed, especially the lowest group of SES – Latvia, Lithuania and Germany demonstrate a sharp decline in performance. The analysis shows that the increase in performance of the students with a high SES is positively related to the teachers' support in students' learning, discipline and interest in the study subject.

Chapter 6.4 commences with the analysis of Latvian student variation of performance distribution, which in Latvia has always been substantially below the average in OECD countries. Also, one of the components thereof – variance between schools – in Latvia is approximately two times smaller than the average in OECD. Thus, it can be concluded that the education system in Latvia generally provides an improved equity in education quality and students with different performance levels are studying in the same school more often than on the average in OECD countries. This analysis also shows that the relative number of students in Latvia in the lowest and the highest proficiency levels defined according to OECD countries' average distribution, will be below the average in OECD, since the average student performance in Latvia is close to the OECD average, but the variation of performance distribution is smaller.

Following the general review of performance distribution variation, Chapter 6.4 proceeds with analysis of the relationship between Latvian student performance and the location of the school, type of school and study programme, students' gender. Particular attention is dedicated to the relatively large differences between rural and urban school performance, exposing one of the causes – significantly lower SES of the rural students. A very significant difference between the students' SES in different types of schools in Latvia is found – from the highest level of SES in national gymnasiums to the lowest level in basic schools. Similar tendencies in differences can be observed with regard to the performance of students – the highest performance in gymnasiums, followed by secondary schools and the lowest performance in basic schools.

Chapter 6.5 examines the relation that the autonomy level of Latvian school management, the number of students at school and in classroom, the high competition among schools has with student performance and a particularly important issue in our country – the optimization of school network. For example, the number of fifteen year old students in Latvia has decreased by half over 10 years, the number of students in general education day schools in Latvia since 1998 has decreased by 42%, while the number of teachers and schools has decreased only by 25%.

It is a situation where, on average, a higher student performance in Latvia can be observed in schools and classes with a greater number of students, however, it should be noted that this is also related to urbanization, SES of schools and students, and student selection procedures in schools. The relatively free choice of schools in Latvia foster the impact of parent SES on the choice of school, the relative number of schools that are chosen by socio-economically most favourable families is rapidly decreasing (since 2006, the relative number of schools in Latvia chosen by families with very high SES has decreased from 75–77 % to 55%).

The optimization of the school network is considered as an issue of state administrative territorial division and the country's regional development, because it is not solely a matter of educational policy. The authors recommend during the school network optimization process, which includes merging, closure and transformation of schools, to take into account also the quality of education provided therein, and choosing appropriate methods for comparing the education quality level of individual schools – these are centralized exams, international comparative studies of education, particular quality monitoring activities in order to determine both the level of student performance and, possibly, its growth, etc., trying to take into account also the student SES and the overall SES of the school. With regard to research and implementation of the research results into the policy, it is interesting to look at the publications of the authors released 15 years ago. Therein, based on TIMSS of 90s and other international assessment programmes in Latvia, it was proposed to implement the school network optimization reforms that are currently included in the government declaration on the measures to be taken and are subject of vigorous political discussion. Thus, international comparative research of education quality in Latvia for at least 20 years has signalled the need to devote particular attention to the school network and to provide the education of equity in our country.

Chapter 6.6 investigates the impact of truancy on student performance in OECD PISA 2012 test. Truancy is a problem faced by most education systems in the world. Researchers admit that truancy significantly influences the student performance and the future life of each student, as well as causes damage to the society as a whole. One of the reasons for instigating such an analysis is the fact that student survey results in Latvia indicated a relatively high frequency of truancy in comparison to other countries. Impacts of different types of truancy on student performance were analysed (skipped day, arriving late for school, skipped classes). A possible link between student SES, type of school and study programme, urbanization and gender of students was also explored.

Based on the analysis, Chapter 6.6 provides recommendations of various levels, commencing with necessity of overall change in the attitude towards truancy that in Latvia usually is not regarded as something extraordinary, and continuing with more specific recommendations concerning schools and families. These results to some extent echo the opinion of the public in Latvia, that the most acute problem in our schools is the lack of discipline among the students. It was the view expressed by 57% to 62% of respondents for three successive years in the sociological survey "DNB Barometer of Latvia" (*https://www.dnb.lv/sites/default/files/dnb_latvian_barometer/documents/2015/dnb-latvijas-barometrs-petijums_nr82.pdf*). Certainly, the DNB survey does not reveal the details – how, according to the residents of Latvia, the lack of discipline among the students is mainly manifested, how to improve the discipline, and what could be the involvement of the school and the parents, because, obviously, the family also can have a major role in preventing truancy and being late for school.

Chapter 7 is mostly dedicated to the performance of Latvia's students and analysis of correlation of other factors with student skills and activities to ensure future career. Additional career module was included in student surveys in three PISA cycles, however, unfortunately it was not possible to perform a trend analysis, as the questions included in the module were different in each cycle. In PISA 2012 cycle, the answers of the Latvian students to the questions about their activities that would assist in the choice of their further education and career, signalled a relatively low student participation in different activities (for example, talks with career counsellors, shadow days, school and workplace visits, etc.). The exception was such activities as information search over the Internet about secondary school or university study programmes, general career opportunities and filling in surveys in order to find out one's interests and skills. This was done by 70–80% of students. These students, who apparently wanted to purposefully build their future education and career, showed higher performance in mathematics. On the other hand, it is alarming that only 14% of these students were from rural basic schools. Is not surprising, that, according to the opinion of the majority of students themselves, the skills required for online search of career-related information they have mastered outside school. At school they have dedicated more time to learn to write a summary of their qualifications and to prepare for a job interview. However, in this aspect, the result of analysis is particularly important, showing that students from the families with lower SES mostly have mastered all skills related to future careers at school rather than outside it, purposefully thinking about their future career.

Chapter 8 analyses the link of student performance with use of information and communication technologies (ICT) detected in OECD PISA. Including

ICT question group in OECD PISA survey of students and schools provides the opportunity to explore a variety of factors related to the use of ICT in education, to investigate, how they affect student performance, as well as to develop medium and long-term forecasts and recommendations regarding different aspects related to integration and use of ICT.

OECD PISA data also show that students are increasingly provided with computers at home, and Latvia has rapidly reached the average rate of OECD countries – 92%. Access to the Internet and using it, educational software, printers and other devices at home are positively associated with higher student performance, although, to some extent, it also reflects the influence of a student's SES.

On the other hand, analysis of OECD PISA participant progress in relation to the use of ICT in lessons in Latvia and other countries showed the opposite correlation – the use of ICT in lessons did not in any way contribute to higher performance, on the contrary, the correlation between the student performance in PISA test and the use of computer time during the lessons is negative. Consequently, PISA 2012 results again touch upon the problem that has to be tackled urgently. ICT is developing rapidly and enters all spheres of life, therefore it is a popular belief that teachers should use technologies more actively at the lessons, although, as it turns out, at our current teaching methodology development level it is not scientifically justified, since student performance is thereby declining.

Chapter 9 considers Latvian students with high performance, who have reached proficiency level 5 and 6 in reading, mathematics or science in OECD PISA tests. The beginning of the chapter is dedicated to the differences between the students with high performance and the gifted students. The issue addressed in this chapter arises from the results of PISA cycles – the proportion of students in Latvia who have high performance is lower than the average in OECD countries, although the overall student performance in Latvia coincides or is close to the average performance of students from OECD countries.

However, the fact that the proportion of students with low and high performance is lower, in Latvia is also determined by the smaller variation of performance distribution – less diversity in the quality of provided education (see Chapter 6.4), nevertheless, it is very important to look for factors associated with higher performance of our students, which could potentially improve the performance of students and proportion of students with high performance in Latvia.

Chapter 9 provides analysis using the binomial logistic regression method, to explore the factors (indices) that would allow students of Latvia with performance from 500 to 600 points in reading, mathematics and science to join the group with performance exceeding 600 points. The result allowed to identify both general factors, such as a higher education level of parents, and a number of factors specific to each content area, such as more frequent solving of formal mathematics tasks, overcoming unnecessary anxiety and insecurity in this subject, more frequent reading for pleasure, more correct learning strategy in order to comprehend and remember texts or write a text summary. High performance in science could be promoted by a number of specific factors, such as students being well-informed on environmental issues, confidence and satisfaction with their study results in science, a positive attitude about the role of science in people's lives and the development of society, and the possibility of finding their careers in science. The chapter also looks at the experience of the countries with a large number of students in the highest performance levels. The results allow to offer a number of recommendations to education policy makers, school principals, teachers, parents and students.

Chapter 10 is dedicated to the relationships between the results of PISA, student assessment results and the content of curricula in Latvia. Data used in the analysis include student performance in mathematics within PISA 2003, PISA 2009 and PISA 2012, results of Latvia's students in the mathematics' examination, and the 9th year students' final marks in mathematics in 2012, and the results of the centralized examination in mathematics of the 12th year students in 2012 and 2015.

First of all, the results of Latvian students in mathematics items in PISA 2003 and PISA 2012 cycles are compared in order to detect possible changes in student performance in this or that content area of mathematics. The following part of analysis is devoted to a detailed comparison of the results of Latvian students to the average performance in OECD countries in item groups classified according to different aspects – content area of mathematics, item type, item context and the proficiency required for solving the item.

The further analysis deals with the student assessment in mathematics at the final grade of basic schools in Latvia – grade 9 – and at the conclusion of secondary school – grade 12, comparing its results with the results of OECD PISA test. Students of grade 9 take examination in mathematics, its content is equal for all and developed centrally by the National Centre for Education (NCE), but it is marked at the specific school. Students of grade 12 take the mandatory centralized examination in mathematics, its content is being developed and the results marked in a centralised manner. For the purpose of analysis, the same students are chosen – the students of grade 9 who have participated in 2012 PISA test in 2012 and have taken the final exam in mathematics at a basic school (grade 9), or the students who in 2009, while in grade 9, participated in PISA 2012 test, and have taken the centralized examination in mathematics in 2012, while in grade 12, or the students who in 2012 participated in 2012 PISA test and took the centralized examination in mathematics for the grade 12 in 2015.

The method of analysis is the calculation of correlation and comparison of achievement distributions. High correlations have been obtained in all cases, however, it must be noted that students, whose performance in OECD PISA is low – below proficiency level 2, in grade 9 exam assessment have mostly received 6, 5, 4 points and also an assessment below 4 (17%). Latvian schools use a 10-point scale, where a score below 4 is unsatisfactory.

Chapter 11 provides a study of 15-year-old students' financial proficiency in the context of school, family and student level factors in Latvia, based on the data of OECD PISA 2012 financial literacy module. The financial module within OECD PISA was developed for the first time and offered to the countries participating in the research as an optional module. In the sphere of financial literacy, OECD PISA 2012 is the first large-scale international study dedicated to the students at the age of the end of the basic school. In PISA 2012, 18 countries chose to participate, and the first results were announced later than the results of the key content areas – on July 9, 2014. The obtained results showed that Latvian students in the financial module had achieved very similar results to those in science, mathematics and reading, for example, the average performance and its relation with the student SES index, variation in performance distribution and the relative number of students with low and high performance.

Analysing other contextual factors, in financial proficiency, significant differences appear in comparison with such 'classical' fields as mathematics, reading and science. For example, one of the results shows that student performance in the participating countries does not depend on the volume of the financial education in the curriculum estimated by school principals. In Latvia, the highest performance in the tests was achieved by the student group who claimed that they had not mastered these topics either at school, or in any organized way outside it. However, these students had demonstrated a good achievement in mathematics and reading, and they had a relatively high SES.

Consequently, financial education is one of the interdisciplinary spheres, where the nature of teaching and learning has changed most pronouncedly in the modern world – students can learn a lot by themselves, outside school, if they have acquired the key proficiencies and the adequate conditions have been created for them (which are likely to be better in the families with a higher SES). Thus, it in no way diminishes the role of the school, but rather calls for some changes in it, in this case, strengthening of interdisciplinary links, quality mastering of key proficiencies by all students, while the most efficient method, most likely, will not be introducing a new subject – financial education.

The monograph reflects the result of the shared, purposeful work of the authors, obtained in joint research and various seminars particularly during drafting of the monograph. *Dr. phys.*, Professor Andris Kangro has written the Introduction, Chapters 1, 6.2, 6.4, 6.5 and the Summary, *Dr. oec.*, professor Andrejs Geske – Chapters 2, 4, 5 and Chapter 6.1 (together with A. Grīnfelds), as well as Chapter 6.3, *Dr. admin.*, assistant professor Rita Kiseļova – Chapters 3, 7,10; *Dr. phys.*, professor

Andris Grīnfelds – Chapter 6.1 (together with A. Geske), Chapter 6.6 and Chapter 8, PhD student Linda Mihno – Chapters 9 and 11. The monograph has been developed under scientific editorship of A. Kangro.

In Latvia, the study of OECD PISA 2012 was supervised by the Republic of Latvia Ministry of Education and Science (MoES), its implementation and pre-financing was commenced by the University of Latvia (UL), and, since 2011, it has been implemented by the State Education Development Agency (SEDA) in close cooperation with the researchers of the University of Latvia, Faculty of Education, Psychology and Art, the Institute for Educational Research (director, *Dr. oec.,* professor A. Geske) in the framework of the project "Support to Education Studies" funded by European Social Fund, Agreement No. 2011/0011/1DP/1.2.2.3.2/11/IPIA/VIAA/001, UL Reg. No. ESS2011/123. The Advisory Council for supervision of the project delivery was established, chaired by the Director of *SEDA* Dita Traidās. PISA National project manager in Latvia is *Dr. phys*., professor Andris Kangro, leading researchers (group managers): *Dr. admin*., assist. professor Rita Kiseļova, *Dr. phys*., professor Andris Grīnfelds, *Dr. oec*., professor Andrejs Geske, and PhD student Linda Mihno. Latvian representatives on the OECD PISA 2012 Governing Board are Dita Traidās, Director of SEDA European Union Lifelong Learning Programme Department Ennata Kivriņa and Andris Kangro. Since 2014, Latvia is in accession process to OECD organization, therefore, currently there is a particularly pronounced interest in our country concerning participation in OECD programmes.

The results published in the monograph have been widely circulated and discussed with the key stakeholders – education policy makers and implementers, directors of education authorities, school principals, teachers, education researchers, representatives of parent organizations and journalists, postgraduate students of respective study directions – in several conferences with extensive participation of the parties involved. Thus, for example, the conference "Quality, Teaching and Learning in International Comparison. Latvia in OECD PISA and OECD TALIS programmes" held on 17.06.2015 in the *Aula Magna* of the University of Latvia brought together about 150 participants.

On the forum of directors of general and vocational education establishments and municipal education specialists "Education in Crossroads: Opportunities and Choices" held on 19.08.2015 with approximately one thousand participants, a report "Equity in Education of Latvia: International Comparison" was discussed, considering the international comparative research results and recommendations for Latvian education policy making. There have been other conferences where the results of the latest OECD PISA and other international studies were announced and discussed, press conferences, seminars at the School Boards and schools, regular meetings of project Advisory Council, special consultations with heads of MoES and with OECD representatives during Latvia's accession negotiations. Mass media have shown a great interest with regard to the results of OECD PISA data analysis, for example, the information about the equity issues and quality of education in Latvia, rural schools, necessity to optimise the network of education institutions, and other matters. The main daily news programme at Latvian National Television Channel 1 "*Panorāma*" dedicated 12 exclusively prepared news stories "School as Opportunity" (I. Springe), broadcasted in September 2015, organised the TV discussion "Direct Speech", and National Radio of Latvia, Programme 1, dedicated a radio broadcast "Family Studio" to the issues addressed in the research. Many publications appeared in newspapers and magazines of national and local level.

The results of the secondary analysis have been regularly reported in international scientific conferences, for example, the annual European Conference on Educational Research, organized by European Educational Research Association (EERA), as well as in the International Research Conference (IEA IRC) arranged by the International Association for Evaluation of Educational Achievement (IEA).

All the international comparative educational research comprehensive databases are available to researchers and interested parties globally (*http://www.oecd.org/pisa/pisaproducts/, http://www.iea.nl/data.html*). New instruments for more convenient use of the databases are being constantly developed and are available to all (*http://www.iea.nl/fileadmin/user_upload/IEA_Software/Installing_the_IDB_Analyzer__Version_3_0_.pdf*). A further joint database has been created (*Cross–Time, Cross–System–XTXS*), containing both IEA and OECD organized international comparative research data, as well as other UNESCO, World Bank, United Nations Development Programme (UNDP), Statistics Canada and other databases, encompassing 232 education systems (*http://www.iea.nl/data.html*). Currently, within the framework of the implemented OECD PISA 2015 cycle, student testing in most countries, including Latvia, is already fully computer-based, thus marking a new level in student assessment development.

The authors extend their gratitude to the tens of thousands of Latvian students, hundreds of teachers and school principals for participation in the research cycles, hoping that the achieved results in comparison with the most advanced countries of the world will yield satisfaction and strengthen their self-confidence, while bestowing new energy and ideas for future education development path.

The authors would particularly like to thank the reviewers *Dr. admin.* Ieva Johansone (Boston College, USA), *Dr. admin*. Andris Sarnovičs (BA School of Business and Finance (*Banku augstskola*), Latvia) and *Dr. admin.* Ināra Upmale (Rīga Stradiņš University (*Rīgas Stradiņa Universitāte*), Latvia) for the input in developing the monograph, to the staff of the Ministry of Education and Science for continuous interest in the progress of research and the obtained results, and to the colleagues from State Education Development Agency for their constructive cooperation on a daily basis.

1. EVALUATION OF THE QUALITY OF EDUCATION AND GENERAL CHARACTERISTICS OF OECD PISA

1.1. International assessment of students' educational achievement

In order to improve the learning and teaching process and to achieve the educational targets, a whole range of education quality evaluation activities and tools is being developed and used globally, including evaluation and assessment of students, teachers, school principals, education establishments and systems. Different countries choose different emphases and approaches (OECD, 2013d; Scheerens, Glas, Thomas, 2003; European Commission, 2015), determined by traditions, infrastructure, the capacity of human resources, assessment practices and political understandings. Overall, quality assessment has played an increasingly important role in the national education systems over the last 30 years. Naturally, a question arises of balanced, harmonized and efficient implementation of all the components of evaluation and assessment. A question of even greater importance concerns the purposeful use of the quality evaluation results in order to verify (through licensing, accreditation, certification procedures) the credibility of the defined and achieved quality levels and to demonstrate and actually improve the quality of the learning process, the teacher's work in the classroom, teachers' training and further education, development of the school system, etc.

Assessment of student performance, too, is diverse and essential (OECD, 2013d; OECD, 2005c; National Testing …, 2009; Fitz-Gibbon, 1996). On everyday basis, students are assessed in various subjects by their teachers, they take compulsory centralized exams with assignments developed and results evaluated outside school. Everyday classroom performance assessment (formative assessment) and the marks given by teachers are important for the learning process, and the most significant indicator of academic progress for an individual student and his/her parents, yet they are not applicable for the comparison of student performance on a national or international scale.

The international comparative education studies have been evolving worldwide already since 1958 (Ross, Genevois, 2006; Papanastasio, Plomp, Papanastasio, 2011); where the main methodological approach is comparative assessment of students' knowledge, skills and attitude to various curriculum areas, such as mathematics, science, reading, foreign language, information and communication technology, finance, civic education, etc., using standardized tests and questionnaires. In such studies, the student's test results cannot be used individually, but in an aggregated form, as the main object of the study ultimately is the overall national performance of students and also the performance of sizeable segments, such as urban and rural schools, various types of schools, different regions, families of different social and economic backgrounds, boys and girls, etc. Purposefully created questionnaires of students, school principals, teachers, parents, education experts provide an extensive characterisation of the education processes in various countries and allow implementing a comparative analysis of the common and different relations between the student performance and the contextual factors at the level of education system, school, family and student. Test items are developed with the focus on the modern framework structure assessing, for instance, the student's ability to apply the knowledge in real-life situations. The items are numerous, covering a wide range of content (different groups of students receive different sets of items, containing, however, a part that is common to all). Normally, at least a half of the items requires the student to demonstrate an appropriate solution rather than choose from a number of answers (see Chapter 2).

Thus, the founders of this direction have come up with the idea of "the world as an education laboratory" (Husen, Postlethwaite, 1996); we are able to compare and analyze education systems, processes, practices and policies in the countries with different student performance and, possibly, we can understand better, which methods and what education policy can ensure a higher student performance in our country. One of the reasons, why such comparative studies of education were initiated in the 1960s of the 20th century, was the upsurge of students from abroad at the universities of North America and Western Europe. Thus, a great disparity in the quality and level of secondary education in different countries and parts of the world could be observed. The development of research direction also has been triggered by recognizing the education as one of the factors ensuring a country's economic, technological and military progress. State governments and international organizations prepared many questions for the researchers, for example, what role was played by the quality of the education in the USSR as the country that launched the first artificial satellite into the Earth orbit in 1957, and in Taiwan's and Japan' spectacular technological breakthrough? Consequently, large scale comparative international studies of student performance were initiated in a wide context of education system, and the IEA was founded to develop and manage such studies.

Currently, 64 countries representing all continents are taking part in IEA activities and carrying out comparative international studies in education (*http://www.iea.nl/institutional_members.html*). IEA conducts the studies including PIRLS 2016, ICCS 2016 (*International Civic and Citizenship Study*), TIMSS 2015 and ECES (*International Early Childhood Education Study*), and prepares research like ICILS 2018 (*International Computer and Information Literacy Study*) and ETLS (*English Teaching and Learning Study*).

Since 1998, under the leadership of Andreas Schleicher, OECD has initiated the cycles of OECD PISA (*www.pisa.oecd.org*); at present already the 6th cycle (PISA 2015) and 7th cycle (PISA 2018) are taking place. Within PISA, OECD assesses to what extent fifteen year old students, who are about to finish lower secondary education (in Latvia – basic education), have acquired the knowledge and skills necessary for the full participation in civil society, and the ability of students to analyze the experience gained at school and apply it to different life situations outside school and in further education. The objectives of OECD PISA are set to help develop and introduce the evidence-based education policy and national education reforms while fostering labour market and competition. Therefore, the cycles of studies are regularly implemented, fully internationally verified, and comparable databases are created for analysis generating recommendations applicable to education.

OECD also conducts a study on teachers and learning environment: OECD TALIS 2013 (*Teaching and Learning International Study, http://www.oecd.org/edu/school/talis-2013-results.htm*) and a study on adult competencies: PIAAC (*Programme for the International Assessment of Adult Competencies*), etc. The European Union has accomplished a study on foreign language competencies: ESLC (*European Survey on Language Competences, http://ec.europa.eu/languages/policy/strategic-framework/documents/language-survey-final-report_en.pdf*). The African countries are engaged in similar studies within the framework of SACMEQ (*The Southern and Eastern Africa Consortium for Monitoring Education Quality*) (Ross, Genevois, 2006).

The studies mainly embrace the primary school students (grades 3 to 4) and those attending the last grades of the basic school (grades 8 to 9 or 15-year-olds), assuming that on these levels of education the best comparison of school education in different countries and continents can be achieved by measuring the basic competencies acquired in compulsory education. However, in several cases, analogical studies have been conducted in upper secondary schools (such as TIMSS Advanced), modified studies are carried out also for pre-school educational institutions (IEA ECES) and for adults OECD PIAAC, OECD IALS (*International Adult Literacy Survey*) and

OECD ALL (*Adult Literacy and Life Skills Survey*), based on surveys and testing at research participants' homes.

So far, the efforts to introduce such direct assessments of the quality of education in higher education have not been successful, although from 2009 to 2013 OECD has carried out a wide feasibility study AHELO (*Assessment of Higher Education Learning Outcomes*) (Tremblay, Lalancette, Roseveare, 2012), involving 248 higher education institutions, 23 000 students and 4800 academics from 17 countries. AHELO feasibility study included last year students of bachelor's level studies in economics, engineering or any other area, who had to complete computer based tests in economics or engineering, or take a test of generic skills. Large scale comparative studies to explore teachers' work also are carried out, which either give simultaneous assessment of student knowledge and skills (IEA TEDS-M (*Teacher Education and Development Study in Mathematics*) study on mathematics teachers), or do not (OECD TALIS 2013). However, OECD TALIS 2013 strives to connect teachers' work with the level of their students' performance, using data on student performance from OECD PISA 2012.

The rather complicated methodology of comparative international studies in education is being continuously developed, involving the best experts, particularly the complicated mathematical data procession methods. ICT development opportunities are used more widely, including the ongoing transition to computer-based assessment, where students receive and complete tests on computer (OECD PISA, IEA ICILS, IEA PIRLS, IEA TIMSS, etc.).

When debating about the quality of education and searching for a suitable policy solution for education, in most countries globally the results from comparative international studies, such as OECD PISA, IEA PIRLS, IEA TIMSS etc., are used. International organizations in their analysis widely use education indicators derived from the comparative international studies (OECD (*Education at a Glance, Education Today, etc.*), EU (*Key data on Education, Education and Training Monitor, Eurydice reports, etc.*), UNESCO (*Education for All, etc.*), analytical reports of the World Bank). Europe 2020 strategy lays down EU targets in education for 2020, such as the relative number of students (less than 15%), who have low performance in mathematics, reading and science, data acquired within the framework of OECD PISA (*http://ec.europa.eu/education/policy/strategic-framework/index_en.htm*). The results of Latvia in OECD PISA cycles have been included in OECD's annual editions of *Education at a Glance. Education Indicators* encompassing all cycles of the programme, and commencing with the edition of 2014, contain even more extensive data on Latvia, because Latvia has become involved in OECD INES (Indicators of Education Systems) programme. Naturally, the indicators obtained within OECD PISA assessment have been included in the main strategic documents of Latvia; for example, the *National Development Plan of Latvia for 2014–2020,* strategic objective

"Development of Competencies" establishes that by 2020 the number of 15-year-old students with low reading literacy (the 1st level or below within OECD PISA), will be reduced by up to 13%, simultaneously increasing the number of students with higher levels of literacy: levels 4 and 5, by up to 9%.

Participation in comparative international studies on the quality of education and acquiring their implementation methodology provides an opportunity and stimulates countries to develop somewhat similar assessments on national level that are carried out by most of the OECD countries (Synergies for Better Learning: an International Perspective on Evaluation and Assessment, 2013). Objectives of such national studies can differ: to explore the impact of concrete reforms on the quality of education, to compare performance among different regions of a country, separate groups of schools or individual schools, etc. Such studies do not intend to use results of individual students, but the studies can be compulsory and results are assessed centrally. Methodology can be very similar to the methodology of comparative international studies, but it can also differ, for example, studies can use all students in the selected grade group, not the statistical sample. Latvia has not carried out such national assessments.

Naturally, the extension and evolving of comparative international studies and the great attention paid to these matters (particularly to OECD PISA) by politicians, also raises a scientific debate on various aspects of assessment and on alternative explanations to the results achieved, and on the practical contribution of study results as regards education policy, and on the dominance of OECD PISA that is also referred to as emergence of global education governance (Meyer, Benavot, 2013; Nordin, Sundberg, 2014; Sahlgren, 2015; Wyatt-Smith, Cumming, 2009, Smith, 2016).

The issue of the development of evidence-based practical recommendations and its concurrent contribution to policy has always been topical, and comparative international studies in education are not unique in this context. Such principles of policy development are usually recognized both by researchers and policy-makers. However, we can often hear discontent from policy-makers regarding insufficient contribution of studies, but researchers are discontent because their recommendations aren't implemented. The connection between study results and their implementation in education policy is not direct and immediate. In order to promote a more complete understanding of the situation and a better cooperation among researchers and policy-makers, it is useful to take into consideration interaction of several powerful factors (Nordin, Sundberg, 2014, Ross, Genevois, 2006, pp. 265–275).

Evidence to be used for political decisions can be derived not only from the research results provided by studies, but also from other evaluation (such as accreditation, etc.), practical experience, potentially also from scientific theories that have not been applied in the concrete studies. On the other hand, in order to implement

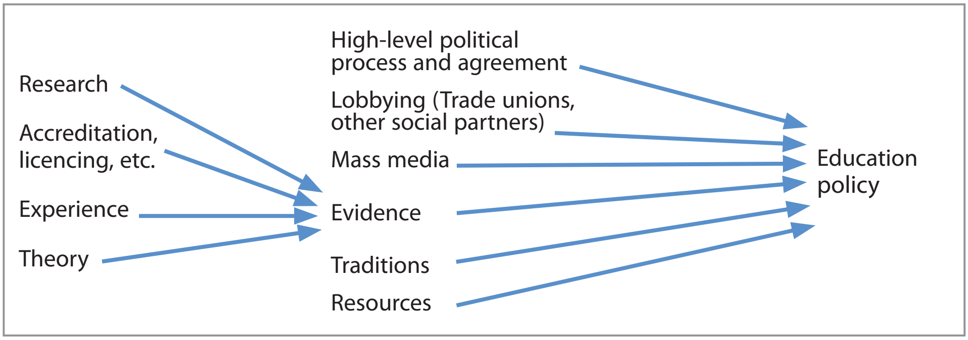


Figure 1.1 Interrelation between research and policy (Hegarty, 2014, p. 54)

results in real life, besides the evidence politicians must also take into account the policy defined by their parties or coalitions (for example, in Latvia they must consider the content of government declaration and decisions by the Coalition Council), the resources available, opinions and traditions of media and various actors, which uphold rather influential positions in the education system.

Latvia gained an opportunity to take part in comparative international studies only after its independence was restored, as the USSR or its republics did not participate, ignoring invitations from IEA. The independent Latvia immediately accepted the invitation from IEA, because the newly sovereign state was interested to compare its education quality to other countries, to acquire internationally acknowledged comparative data characterising the strengths and weaknesses of Latvian education system, to obtain evidence-based insights for reforms. The Ministry of Education and Science entrusted the University of Latvia (UL) with this task. Consequently, the researchers from UL began to implement the relevant studies after state sovereignty was restored, in 1991–1992. Latvian researchers, using the advice from international experts, had to leap in the study programmes that had already begun, acquiring study methodology and carrying out research under pressing time constraints. This was the case with the IEA studies RLS (Reading Literacy Study) (national coordinator of the study was I. Dedze), COMPED (Computers in Education Study) (A. Grīnfelds) and TIMSS (A. Geske).

Figure 1.2 depicts the time scale when Latvia joined the studies described above (coloured bars). Naturally, at first all the international contacts and initial study materials were in English, the allocated finances were rather limited, therefore, for example, participation in international study conferences for UL researchers was possible only with the financial support from the Soros Foundation Latvia or international study centres.

Soon after that, the first rather optimistic results were received: the last-year-students from the Latvian upper secondary schools took the 2nd place in the COMPED study, running up with the Austrian students, and just above the students

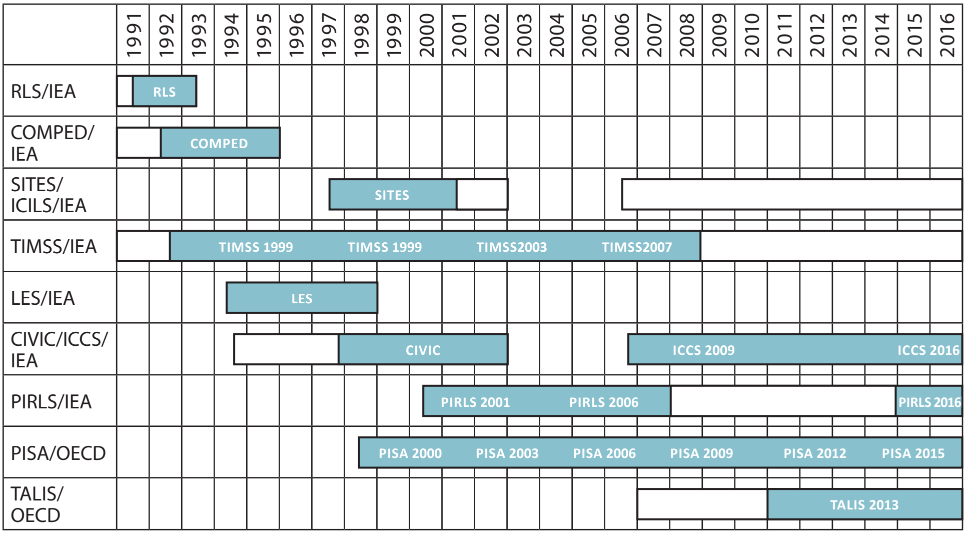


Figure 1.2 Latvia's participation in international studies of the quality of education

from the USA and Slovenia. Thus, the initial introduction of informatics to the Latvian education system gave benefits to the international comparison (Grīnfelds, Kangro, 1996). Importantly, the experience and results from this international study were promptly used for the development of education in Latvia. MES invited researchers from UL (A. Kangro, A. Grīnfelds, etc.) to develop a standard for informatics, which was also one of the first standards in the newly created system of standards for study subjects in secondary schools of Latvia. The standard included many internationally acknowledged approaches of that time, for example, that students of informatics should acquire computer skills working with various data (text and graphic editors, databases, spreadsheets). On the other hand, COMPED study showed that Latvian teachers of informatics often focused on the basics of programming, therefore it was necessary to foster a further education of teachers in other directions and provide school computers with a corresponding software to be able to fully implement the new standard.

UL researchers, with the support from MES (Minister A. Piebalgs, Department Director J. Bokāns, etc.), became involved in comparative international studies of education very actively. In 1993, Latvia became an official member state of IEA, and A. Kangro represented Latvia at the General Assembly of IEA. UL in 1993, by the decision of its Senate and the recommendation of the Minister, formed the national institution of IEA in Latvia, the IEA National Research Center (headed by A. Kangro), and its opening ceremony was attended by Bill Loxley, Executive Director of the IEA, and researchers from Sweden, University of Latvia, officials from MES. In 1995, IEA entrusted UL with organizing the 36th General Assembly of the IEA, attended by education researchers, experts and ministry representatives from approximately 60 countries. Latvia and nine other countries learned the best global practice in comparative international studies of education with the help of a special IEA's project – IEA NCEE or IEA Network for Central/Eastern Europe (1993–1997), which included an extensive international learning programme, development of scientific collaboration, information exchange and creation of a specialized ICT basis.

The University of Latvia continued its intensive participation in international research programmes (see Figure 1.2.), which increased the necessity to develop, as regards theory, methodology and infrastructure, the efforts of Latvia in scientific studies of comparative international education assessment as a part of education management science, based on internationally approved criteria and methods. Within institutional development, the next step after the foundation of the IEA National Research Center was to establish the Institute for Educational Research (IER) in 1996. The first director of the Institute was professor J. Zaķis, rector of the University of Latvia at that time (1996–1999), succeeded by professors A. Kangro and A. Geske (since 2013).

Involvement in the OECD's projects marks an exceptional time in the development of comparative international studies in Latvia. In 1998, the researchers from UL IER were already invited to represent Latvia and take part in the Programme for International Student Assessment (OECD PISA 2000). In 1998, Thomas J. Alexander, Director for the OECD's Education, Employment, Labour and Social Affairs Directorate, had a meeting with the scientific representatives from Latvia, Russia and China, explaining that they were representing the very few non-members of the OECD which, together will all the 30 member countries, were invited join the new programme in order to express the determination of our state and researchers, the capacity and ability to acquire the latest methods and carry out the complicated studies. T. Alexander also explained that, for Latvia, one of the selection criteria was the successful participation in the IEA studies since 1991.

As a result, Latvia (UL IER) successfully took part not only in OECD PISA 2000, but also in all the subsequent cycles of the programme: PISA 2003, 2006, 2009, 2012, and now is participating in the study cycles PISA 2015 and PISA 2018 (the National project manager of OECD PISA is A. Kangro). Russia successfully participated in the first cycle of OECD PISA, as well as the next cycles, but China has not yet completed any of the cycles, however, the students from Shanghai are achieving top results. Today, OECD PISA includes all the OECD, EU and other countries of the world, encompassing 80–90 countries.

We can conclude that the successful participation of IER researchers in all cycles of OECD PISA created our scientific capacity and provided comparative results on the quality of our education among the most developed countries of the world, and, furthermore, brought Latvia nearer to full OECD membership. At this time, Latvia is under accession process to the OECD, and Latvia's results in OECD PISA cycles are being analysed.

Currently UL IER represents Latvia at OECD PISA and OECD TALIS (*Teaching and Learning International Study*) programmes, as well as at IEA and the studies thereof – ICCS 2016 and PIRLS 2016.

The total number of international studies and programmes performed by UL researchers already exceeds 20. Study results are regularly discussed with policy makers and implementers, school principals and teachers. They are published as monographs and books (for example, the series of monographs "Educational Research in Latvia" and books about particular study results), and international scientific magazines. Dissemination includes articles, scientific conferences, congresses and other events in Latvia and abroad.

Advancement of human resources, i.e., educating researchers how to work in the international comparative education research projects and to develop a suitable analytic potential for the Latvian education system, as well as up-to-date university programs in Latvia, is doubtlessly a very important issue. Learning from international experience, Faculty of Education, Psychology and Arts (FEPA) created a professional master's programme "Educational Management" (director A. Geske), a doctorate programme "Educational Management" (director A. Kangro), and other bachelor's and master's programmes including education research methods, education quality assessment, education management, etc. Professors A. Geske, A. Grīnfelds and A. Kangro are actively conducting the cycles of international studies, heading groups of researchers and supervising doctorate papers. I. Johansone, R. Kiseļova, R. Kalvāns, A. Ozola, R. Geske and I. Čekse, the former doctoral students of educational management, today – doctors of science, have elaborated their doctorate theses in the area of comparative international studies of education. They continue their academic work and international research at FEPA and IER, working at the TIMSS and PIRLS International Study Center at Boston College (USA) (I. Johansone), or contributing to education policy at MES (R. Kalvāns).

The successful involvement in IEA's studies for 25 years since Latvia regained its independence in 1991, and in entire OECD PISA for the duration of 18 years, since the programme was opened, undoubtedly has brought Latvia nearer to understanding globally highest standards and approaches to education quality assessment and improvement, simultaneously gathering the corresponding scientific potential, experience and internationally acknowledged basis of data and knowledge to enable making informed decisions in education management. Moreover, the collected data demonstrate, for example, that the quality of education in Latvia ascends. The most recent data analysis (OECD, 2015b) shows that, according to the data from TIMSS, PIRLS of the IEA and OECD PISA for a period from 1995 to 2009, Latvia has the highest growth in education quality compared to other countries that have participated in these cycles of international education quality assessment. International assessments show Latvia as a country that has successfully managed to reform its education system (*PISA in FOCUS 2013/11*), and a place where students' performance level, based on the data of OECD PISA and IEA TIMSS, has risen from "fair" to "good" thanks to many concrete reforms in education system (Mourshed, Chijioke, Barber, 2010). These reforms are summarized and analysed internationally and involved introduction of student and school assessment and evaluation (centralized examinations, comparative international studies, accreditation, licensing, etc.), re-structuring the management – the organizational and financial basis of education system (development of school management and financing mechanisms, to some extent their decentralization, etc.), and revising the pedagogical foundation of education system (reforms in curriculum, education standards, textbooks, etc.). This set of reforms has been the basis for increasing the education quality in Latvia and other countries (for example, in Poland, Lithuania, Hong Kong (China), Singapore) during particular periods of their education system's development, generally achieving a good level of education quality in line with the international criteria. At the same time, naturally, the data from OECD PISA and other studies and their analysis reveal many aspects that require a further improvement.

Thus, it is necessary to ensure a systematic and full participation of Latvia in global processes of education evaluation and improvement, maintaining and developing a corresponding international level of scientific potential in our country, taking part in respective research and development programmes of OECD, EU and IEA, thereby acquiring comprehensive, credible and internationally-comparable information and up-to-date knowledge about Latvian education system and its developmental trends, which would help evolving and adopting evidence-based decisions in education management and policy.

Summary

In order to improve student learning and to achieve the planned results, a whole set of education quality assessment instruments is being developed and used globally, including the evaluation and assessment of students, teachers, school principals, school systems and education systems.

The assessment of student performance is one of the main components forming the evaluation of education quality, which is being internationally reviewed on a comparative basis already since 1958, and in Latvia starting from 1991.

Latvia needs internationally comparable and internationally acknowledged data characterising the knowledge of the students, their skills and the related characteristics of education system, school, student and his or her family. Such data can only be acquired with the help of the regular cycles of comparative international studies such as OECD PISA and the wide range of IEA's studies (PIRLS, TIMSS, ICCS, etc.). This data and its analysis is included in all the main education editions issued by OECD, EU, UNESCO and the World Bank, for example, *Education at a Glance, Key data on Education in Europe*, and many others. They form the main international set of data for the evidence-based education system improvement and development.

The results of studies should always be communicated and discussed with a wide range of stakeholders. The connection between study results and their implementation in education policy is not direct and immediate. Interaction of several important factors must be considered – the evidence basis for political decisions is derived not only from research results, but also from other evaluations (for example, accreditation, etc.) and the practical experience. On the other hand, in order to apply the research results in real life, politicians must take into account not only the evidence basis, but also the policy defined by their parties or coalitions, available resources, the opinions and traditions maintained by media and various actors, which are rather strongly represented in the education system.

Latvia, a developed country that is devoted to the improvement of its education system, needs to ensure a systematic and full participation in global processes of education assessment and improvement, maintaining and developing a corresponding international level of scientific potential, taking part in the respective research and development programmes of OECD, EU and IEA, thereby acquiring comprehensive, credible and internationally-comparable information and new knowledge about Latvian education system and its developmental trends, which would help to elaborate and adopt well-founded decisions in education management and policy.

1.2. OECD PISA cycles and their main features

The international student assessment programmes are cyclic, because it is thereby possible to track the changes in education quality, assessing the impact of varying factors, including the impact of different education policy decisions and reforms on student performance.

The first cycle of Programme for International Student Assessment of the OECD (PISA 2000) with reading as the main content area, took place from 1998 to 2001. This cycle involved 32 countries (including 28 OECD countries and four partner

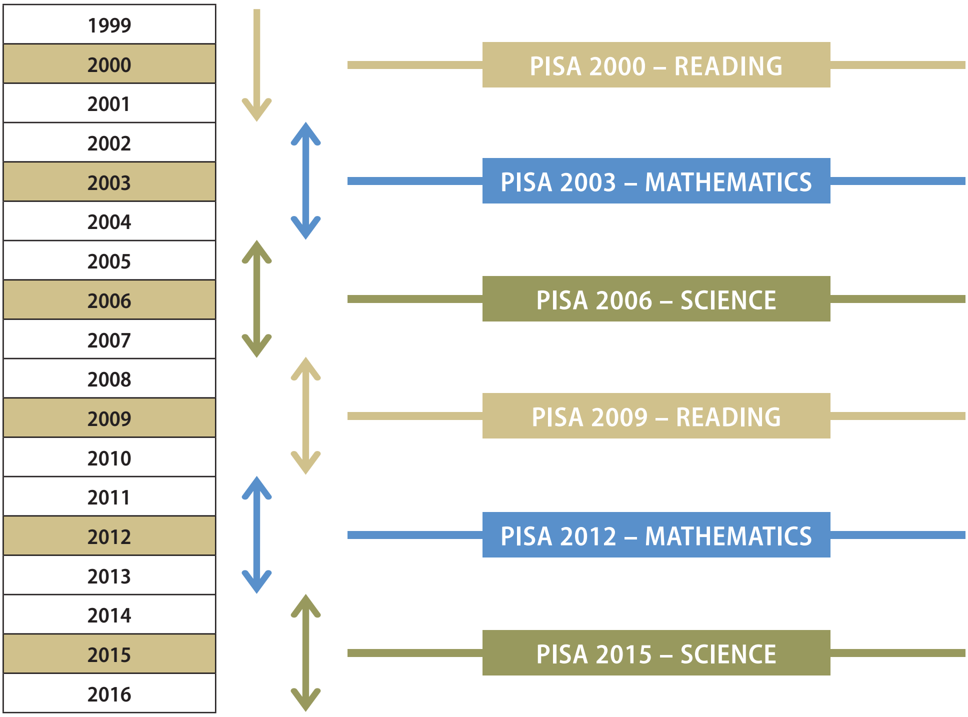


Figure 1.3 *Cycles of the OECD Programme for International Student Assessment (OECD PISA)*

countries: Brazil, Russian Federation, Latvia, Liechtenstein), but PISA 2000 data was collected in 11 more partner countries in 2002.

The second cycle of OECD PISA (PISA 2003) with mathematics as the main content area took place from 2001 to 2004. PISA 2003 involved 41 countries: 30 OECD countries and 11 partner countries.

The third cycle of OECD PISA (PISA 2006) with science as the main content area took place from 2004 to 2007. This study cycle involved 57 countries: all the OECD countries and 26 partner countries. In PISA 2006, for the first time, the participants included our neighbouring countries – Lithuania and Estonia.

The fourth cycle of OECD PISA (PISA 2009) was carried out from 2007 to 2010. Its main content area was reading. The study involved 65 countries, including 34 OECD countries and 31 partner countries, but nine more countries participated in the 2nd phase of PISA 2009.

The fifth cycle of OECD PISA (PISA 2012) was carried out from 2010 to 2013. Its main content area was mathematics. The study involved 65 countries, including 34 OECD countries and 31 partner countries.

The current, 6th OECD PISA cycle (PISA 2015) has concluded the phase of gathering the main data; its core content area was science. It involved a computer based assessment of students, and 73 countries participated therein (34 OECD countries and 39 partner countries). Announcing of the first results of PISA 2015 will take place in December, 2016.

The preparatory work for the 7th cycle of OECD PISA (PISA 2018) has already begun, and its main content area will be reading.

Figure 1.3 shows the timeframe of OECD PISA. Only the main content area of each cycle is provided. The years when the main data of the respective cycle have been collected in schools are marked in colour (see also Chapter 2). A year before collecting the main data (for example, for PISA 2012 – in 2011) all countries participating in the study carry out field trial (pilot studies), whereby the suitability of items and research procedures at schools and national and international study centres are verified. Two years beforehand (for PISA 2012 – in 2010) the research procedures and instruments (tests, questionnaires, marking guides, etc.) are developed, including the necessary translation and verification. In the next year after the collection of the main data, it is analysed internationally and nationally, and the announcement of the first results is possible only by the end of the year (for PISA 2012 – on December 3, 2013). Thus, a study cycle lasts at least 4 years, but the collection of the main data for the next cycle is carried out every 3 years. At least for a year, an intensive work is carried out for two study cycles simultaneously: analysis of the data from the previous study cycle to acquire the first results, and a rather intensive developing of study instruments for the next cycle. Such a tight schedule of OECD PISA originates in its main characteristic – the focus on education policy, which often requires obtaining results and recommendations as soon as possible. Naturally, an in-depth analysis of data (i.e., the secondary analysis) is possible only after the four year cycle described above. Such analysis is carried out both in the countries participating in the study and internationally; for example, both extensive full OECD thematic reports on particular subjects and short reports, such as *PISA in Focus*, etc., are prepared.

The OECD Programme for International Student Assessment is characterized by the following features:

- focusing on the needs for defining and improving education policy;
- theoretic improvement of the term “literacy” and its application in practice, referring to the ability of students to use their knowledge in basic subjects in real life, to analyse, reason logically and communicate skilfully by defining, interpreting and solving problems in various situations;
- relevance to lifelong learning: PISA is not limited to assessment of student literacy in individual subjects, students are asked to report on their motivation to learn, their beliefs about themselves, and their learning strategies;

- regularity: assessment cycle repeats every three years, which enables the countries to monitor the achieved improvement of education quality;
- extent of coverage: for example, more than 80 countries plan to participate in PISA 2018.

Further on, a complete list of countries and education systems from the latest completed OECD PISA cycle (PISA 2012), is provided, as well as the diagram of their geographic location, characteristics of the study, because the data and results of this cycle will be widely analysed in this monograph.

Table 1.1 Countries participating in OECD PISA 2012

OECD member countries		OECD partner countries		Countries that have participated in the previous cycles
Australia	Japan	Albania	Malaysia	Azerbaijan
Austria	Korea	Argentina	Montenegro	Georgia
Belgium	Luxembourg	Brazil	Peru	Himachal (India)
Canada	Mexico	Bulgaria	Qatar	Kyrgyzstan
Chile	Netherlands	Colombia	Romania	Macedonia
Czech Republic	New Zealand	Costa Rica	Russian Federation	Malta
Denmark	Norway	Croatia	Serbia	Mauritius
Estonia	Poland	Cyprus	Shanghai (China)	Miranda (Venezuela)
Finland	Portugal	Hong Kong (China)	Singapore	Moldova
France	Slovakia	Indonesia	Taiwan (China)	Panama
Germany	Slovenia	Jordan	Thailand	Tamil Nadu (India)
Greece	Spain	Kazakhstan	Tunisia	Trinidad and Tobago
Hungary	Sweden	Latvia	United Arab Emirates	
Iceland	Switzerland	Liechtenstein	Uruguay	
Ireland	Turkey	Lithuania	Viet Nam	
Israel	United Kingdom	Macao (China)		
Italy	Unites States			

The main content area in PISA 2012 was mathematics, but, naturally, the study also encompassed reading and science. PISA 2012, for the first time ever, included a module for testing the financial literacy of students. In this study, the student knowledge was assessed in close connection with their skills to reflect on the material acquired, the aim was to evaluate the students' own knowledge and experience, and also the application of these in real-life situations.

PISA 2012 involved approximately 510 000 students who represented around 28 million 15-year-old students from 65 participating countries.

Figure 1.4 Map of OECD PISA 2012

Each student had to complete the written tasks in 90 minutes. PISA items included both questions with selection options and questions, where students had to provide their own answer. Questions were grouped according to a concrete real-life situation.

Approximately 40 minutes were dedicated by students to fill a survey questionnaire, answering questions about themselves, their learning habits, attitudes towards mathematics, motivation, skills in ICT usage and the performance at school.

The school principals of the participating schools filled a survey questionnaire about their schools, providing demographic characterization and evaluating the quality of education environment at their school.

The results of the study cycle:

- detailed information on literacy of 15-year-old students in mathematics, reading and science;
- contextual indicators that connect student performance to characteristics of the student, family, school and country;
- trends of performance shown by the students and their contextual parameters.

Starting with PISA 2015, most of the participating countries used only computer-based tests and surveys, thus reflecting the great significance of information technology in modern life.

2. RESEARCH METHODOLOGY

In order to ensure a high level of validity and reliability and to achieve high measurement standards, it is necessary to develop an appropriate research methodology, and to strictly observe it throughout the research. The methodology in each cycle of the study must ensure that the results are comparable with the previous cycles. The major research stages are, as follows: (1) elaboration of a research conception, (2) selection of a students' sample, (3) test task development, (4) formulation of survey questions, (5) conducting of tests and surveys in schools, (6) definition of the performance scale and proficiency levels, (7) definition of contextual indicators.

2.1. Selection of a sample

OECD PISA target group is formed of the students aged between 15 years and three full months to 16 years and two full months during testing, and enrolled in any type of educational institution, grade seventh or above, within the boundaries of the respective country. This age group is chosen in order to make it relatively easier to include students in the sample, taking into account only their year of birth, but ignoring the month of birth. It is also related to the fact that the study took place in schools within six weeks in March and April. The target population of PISA 2012 consisted of the students born in 1996.

Selecting the sample of research participants, it is important to ensure that it encompasses the students from all regions of Latvia, and from all types and sizes of schools. For example, student performance in big schools differ from that of small-school students – on average, in Latvia the performance of students from bigger schools is higher, whereas in other countries it could be the other way around. To ensure accurate measurement results, the sample should include an appropriate proportion of students from big and small schools. It cannot be done by selecting a simple random sample.

The statistical sample of participants for PISA 2012 main study was established in two phases. In the first phase, using systematic sampling, which is proportional to the size of the schools, 221 participating schools were selected, including into the general group not only the general education schools, but also vocational and technical schools, where there are fifteen-year-old students. Random selection is never used in this type of research. Instead, stratified sampling is always applied. It provides more accurate measurements and lowers the research costs. In practical terms, this means that all schools according to particular parameters are divided into several groups (the explicit strata) and a separate sampling is carried out in each group. In case of Latvia's schools, in all PISA cycles the size of school was chosen as the explicit stratification variable.

The schools were divided into three groups: large schools (the schools with more than 35 fifteen-year-old students), small schools (schools with less than 35 but more than 18 fifteen-year-old students), very small schools (schools with less than 18 fifteen-year-old students). The chosen implicit strata variables are urbanization and the type of school. Urbanization was considered at four levels: Riga schools, schools of large cities (Daugavpils, Jelgava, Jēkabpils, Jūrmala, Liepāja, Rēzekne, Valmiera, Ventspils), town schools, rural schools. The schools were grouped according to several types: state gymnasiums and gymnasiums, secondary schools, basic schools, as well as other educational institutions (vocational schools, technical schools, art schools, evening schools, etc.).

In the second phase, using random selection, from all the fifteen-year-old students of each of the participating schools, 43 PISA participants were chosen. If there were less students of the appropriate age in a school, all of the students were included in the PISA sample. Overall, the main study sample included 5922 students who represent Latvia's fifteen-year-old students. The sample did not include the students from special schools, and the students studying according to special programs at their school.

Of 5922 students included in the sample, 5279 students participated in testing, but after data cleaning and checking the information about 5276 students, i.e., 89% of students, were entered in the international database. A part of the students included in the sample participated in the Sub-study of Financial Education. PISA 2012 main study included the data about 4306 students of Latvia. The division of schools and students among the strata is shown in Table 2.1, and the distribution of students according to grades (classes) is reflected in Table 2.2. The stratum "Russian language of instruction at school" includes educational institutions, which implement national minority (Russian) education programmes. The stratum "Latvian and Russian language of instruction at school" includes the educational institutions, where education can be obtained in the official national language (Latvian) or an ethnic minority language (Russian) education programme or in both types of programmes. Students who are studying in the minority (Russian) education programmes, performed the test and survey in the Russian language. The distribution of schools and pupils in the strata shown in Table 2.1 will be further used in the data analysis of the study.

Table 2.1 Distribution of PISA 2012 main study participants by strata

Title of strata	Strata	Number of schools	Number of students	Distribution of the number of students (%)
Urbanisation	Riga	58	1407	33
	Cities*	36	926	22
	Towns**	45	1046	24
	Rural areas	76	927	21
Type of school	State gymnasiums and gymnasiums	27	794	18
	Secondary schools	125	2907	68
	Basic schools	58	593	14
	Other (vocational schools, technical schools, art schools, etc.)	5	12	0,3
Language of instruction at school	Latvian	167	3096	72
	Russian	36	962	22
	Latvian and Russian***	12	248	6
Total			4306	

*Daugavpils, Jelgava, Jēkabpils, Jūrmala, Liepāja, Rēzekne, Valmiera, Ventspils
** Remaining 67 towns of Latvia.
*** Schools implementing education programmes in Latvian and Russian languages.

Table 2.2 Distribution of students (%) by grades (classes), OECD PISA 2000, 2003, 2006, 2009 and 2012

Grade \ Year	2000	2003	2006	2009	2012
Grade 7	2	2	2	2	1
Grade 8	8	17	15	14	13
Grade 9	39	76	78	81	83
Grade 10	50	6	3	3	3
Other grades	1	0	2	1	0,3

Since the 90s of the last century, the education system underwent reforms related to the age when school had to be started. The fifteen-year-old student division among the grades (class groups) in the year 2000 was different from the distribution of students in 2003, 2006, 2009 and 2012 (Table 2.2).

2.2. Test administration at schools

Preparation for OECD PISA fifth cycle (PISA 2012) began as early as in 2010. Overall, 62 new mathematics items with 172 questions were prepared for the pilot study.

The pilot study was carried out in March and April of 2011, involving 1627 fifteen-year-old students from 49 schools of Latvia and 49 principals of these schools.

After the analysis of pilot study results at the end of 2011, the toolkit of the main study was fully completed – 13 test booklets, three different student surveys and a survey of schools. Tests for mathematical literacy measurement included 36 items from the previous study cycle, ensuring measurement of changes in performance, as well as 74 items of those tested during the pilot study (OECD, 2014a). The test booklets and student surveys were prepared both in Latvian and Russian, and the other study materials – in Latvian. All study materials were translated from the original English and French texts, and the layout was approved by the international study management group.

In Latvia, the study took place at schools from March 19 to April 27, 2012. The administration of testing and surveys (involving students and principals) was conducted by 21 specially prepared test administrators – UL FPPA researchers, doctoral and master's students. In total, 226 testing sessions were conducted.

The responses to the test items were reviewed by a specially created panel according to strictly defined instructions. Most of the brochures were evaluated once, while a portion of them – four times. This a procedure is necessary to carry out the evaluation as coherently and objectively as possible. The data were processed both in the international research centre and in Latvia.

2.3. Performance scale formation

Student performance was calculated using the Item Response Theory (IRT) enabling the administrator to adequately assess each student's performance, regardless of which test booklet the student had worked with. Similarly, the IRT allows for an accurate evaluation of student performance should in any participating country an item be removed from the test (for example, because of a rough translation or a layout error, or if the item does not comply with the country's cultural or geographical context). In PISA 2012, none of the items prepared in Latvia was removed, while in Estonia one item of the Russian-language test was removed, and in the German version, which was used in a number of countries, two items were removed. Within the IRT framework there are a whole lot of models, differing by mathematical expressions and a number of parameters included in the model. Each model must contain at least one parameter that characterizes the item, and at least one parameter, which characterizes the examinee. In OECD PISA study, one-parameter model in dichotomous tasks is used for scale formation, and a partial credit model – in the tasks, which are evaluated with several points.

The results of the test in the framework of the study are not given in the above-mentioned IRT scale, but in further data processing the so-called plausible values are obtained. These include random variance of components and are not applicable to individual evaluation, yet they are suitable for the mutual comparison of large groups (e.g., national, regional, school groups). Each student is given five plausible values, and, when processing personal data, each operation must be repeated five times, at the end calculating the average value. The calculation of the plausible values takes into account not only the students' answers to the test questions, but also the answers to the survey questions (OECD, 2009).

The major domain of PISA 2000 was reading. Student performance in mathematics and science was also measured, however, the number of these tasks was insufficient to form stable scales in these subjects. The mathematics scale was constructed in the 2003 survey, in which the emphasis was laid on mathematics. The scale was formed, taking into account solely the OECD countries' student performance. The mean value of the scale was set at 500 points, the standard deviation – at 100 points. This means that 64% of the students' results were between 400 and 600 points, while 95% of the students' results were between 300 and 700 points. This mathematics scale in subsequent cycles of study has not been changed, therefore it is possible to assess the changes in mathematics performance over the period from 2003 to 2012. Similarly, in 2006, the science scale was constructed (OECD, 2012a; OECD 2014).

2.4. Formation of proficiency levels

On the basis of the students' answers to the test questions, each student obtains a certain number of points in the PISA scale. Using this scale, it can be easily determined, whether a country's student performance is higher or lower than the OECD average performance, higher or lower than another country's average student performance. Similarly, such comparisons can be made between individual schools or school groups (such as rural and urban schools). However, it does not provide any information about the performance in mathematics (or other areas) of a student having the respective number of points. If a student has, for example, 700 or 400 points, what is his or her mathematical proficiency? To answer this question, the levels of proficiency are established, in which the obtained points are linked to certain knowledge and skills. Such a practice for publishing and interpretation of extensive educational research results has existed since the last century, the early 1980s.

The basis of proficiency level formation is the calculation of overall results of the test, using the item response theory. It is based on the assumption that the students with higher proficiency (ability in the respective test) are more likely to provide a correct answer to an item. In this case, a single scale displays both the student performance and the difficulty level of each item. If a student's proficiency coincides with the difficulty level of the item, then the probability that his or her reply will be correct, is 50%. Schematically it is shown in Figure 2.1.

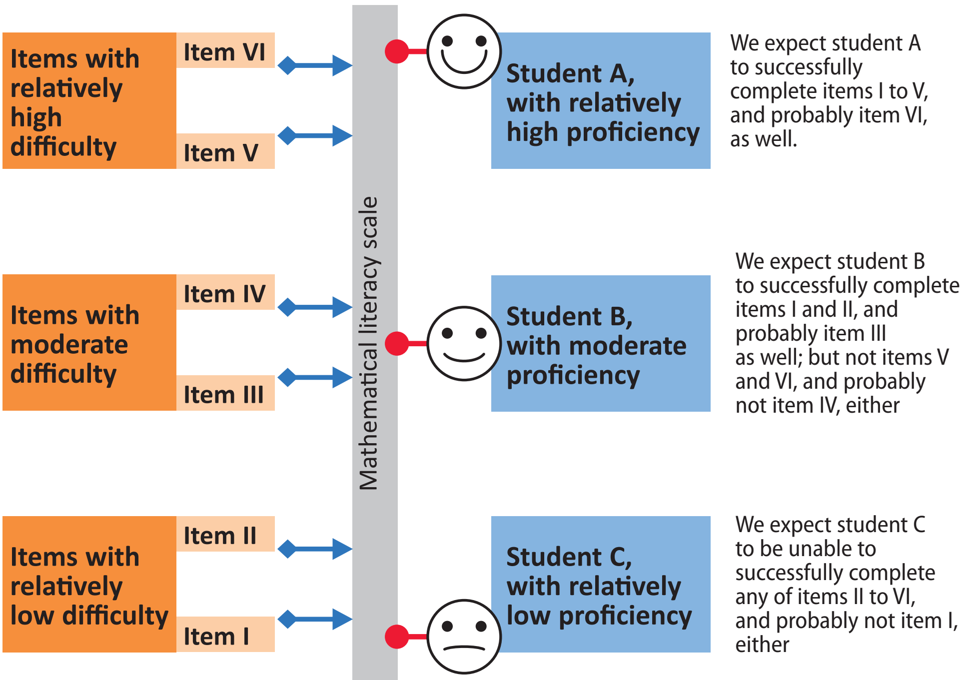


Figure 2.1 ***Relationship between student performance and the difficulty level of items (OECD, 2014a, p. 289)***

If a student C has a proficiency (see Figure 2.1) that is slightly lower than the difficulty level of the first item, then the probability that he or she will respond correctly to this item will be slightly below 50%. The probability that he or she will provide the right answer to the second item is already lower, but the probability that the correct answer will be found to the sixth item is very small, but still greater than 0. The student B with a relatively high probability will provide a correct answer to the first item, with less probability (but more than 50%) will correctly answer the second and third items. Also, he has a certain probability (below 50%) to correctly answer items with a higher level of difficulty (4, 5 and 6), but as the task difficulty level increases, this probability decreases.

Using the continuous literacy scale and analyzing the test items, the scale can be divided into several sections (proficiency levels) and each section can be provided with the corresponding proficiency characterizing descriptions. Implementing the quantitative data analysis (both the psychometric analysis of items and the analysis of student performance), it is possible to determine each item's degree of difficulty. The qualitative analysis of each item allows us to determine the knowledge and skills that are necessary for the student to provide the correct answer. Such analyses use both pilot research and main research data, which provides a large number of students for each item, and a relatively great number of items.

Each proficiency level scale is constructed, previously determining 1) the potential likelihood of a student from this level to provide a correct answer to the items of this level, 2) the level width, 3) the probability of a student from the mid-level to respond correctly to the item of medium difficulty. The scheme of PISA proficiency levels is shown in Figure 2.2.

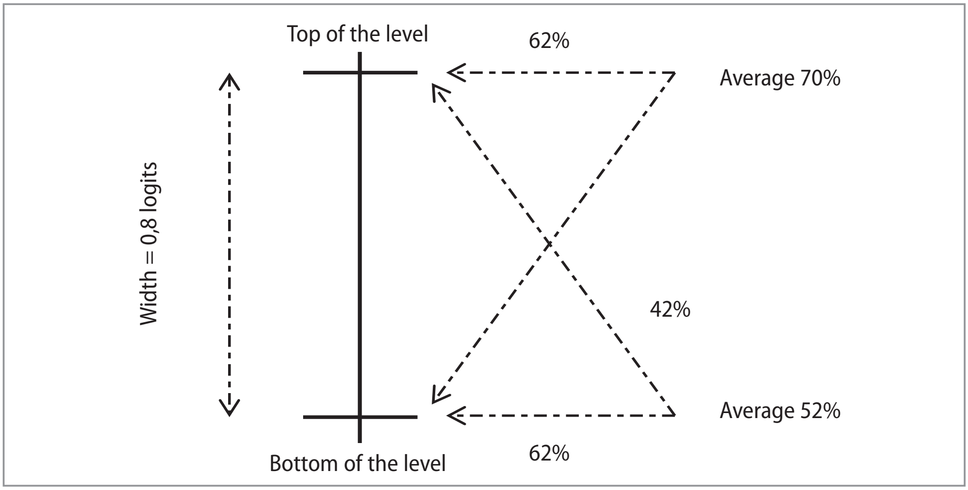


Figure 2.2 Scheme of determining PISA proficiency levels (OECD, 2014a, p. 293)

The selected level width is 0.8 logits (logit is a measurement unit of both item difficulty and the ability of students within the item response theory). In PISA mathematics scale it is about 62 points. A student whose proficiency corresponds to the top of the level, has a 62% chance to correctly answer the most difficult item of this level, 70% probability of correctly answering all of the items of the level, and 78% probability to correctly respond to the easiest item of the level. A student whose proficiency corresponds to the bottom of the level, has a 62% probability to provide a correct answer to the easiest item of the level, 52% probability to answer correctly all items within the level, and a 42% probability of correct answer to the hardest task of the level.

For constructing and describing the mathematics proficiency levels, the data about 290 items from the pilot study of 2011 and the data about 150 items from the main study of 2012 were used. The test items had very different degrees of difficulty to enable measuring both the low and the high proficiency. For example, the difficulty of item PM995Q02 was 840 points, and the correct answer was provided only by 3.47% of all students in all countries, to whom this item was assigned. The difficulty of item PM985Q01 was 328, and correct answers were given by 81% of all students. In 2012, the entire set of mathematics items was analyzed independently, but subsequently, using shared items, calibrated according to the scale defined in 2003. Since the definition of the levels in 2012 was the same as in 2003, it is possible to compare the two studies, using the proficiency levels.

Table 2.3 Mathematics proficiency level definitions according to PISA mathematics scale (OECD, 2014a, p. 297)

Level	Score points on the PISA scale
6	Above 669.3
5	From 607.0 to less than 669.3
4	From 544.7 to less than 607.0
3	From 482.4 to less than 544.7
2	From 420.1 to less than 482.4
1	From 357.8 to less than 420.1
Below 1	Below 357.8

The description of overall mathematics scale proficiency levels is given in the chapter on students' mathematical performance, and the definition of level division is shown in Table 2.3. Here it should be noted that both the top (sixth) level, and the bottom (below level 1) are not clearly defined, they are open (unrestricted) levels. If a student is on the sixth level, he or she is able to perform at least according to the description of the level, but possibly his or her mathematics performance is much higher, and can no longer be measured by the PISA test. If a student performs according to the lowest level, then his or her mathematical performance can be very, very low, even so poor that they cannot be measured by the PISA test (OECD, 2014a).

2.5. Questionnaires and contextual indices

Background data in PISA study are necessary for two important reasons – firstly, to gather information about the students' families, attitude toward school and mathematics, learning habits, process of lessons and other factors possibly related to performance. The second reason is obtaining the information necessary for the formation of the performance scale. The students' performance is expressed as plausible values. The survey data are necessary to generate these variables.

The survey participants were students and school principals. Since the selection of students in the school is made up of all 15-year-olds who are studying in grades 7 to 10, they do not have the same teachers, and teacher surveys are not carried out. The students in about 30 minutes completed the questionnaire, answering the questions about themselves, their learning habits, attitudes towards mathematics, motivation. Each principal of a participating school completed a questionnaire about his or her school, giving its demographic characteristics, the assessment of the learning environment quality at the school, existing resources.

In the educational research, it is very important to determine the social, economic and cultural status of the students' families. A long time ago, it has been found to be linked to the student performance and achievements, and the effect is relatively very high. Seeking the factors that influence student achievement, one should always take into account the students' family status, because the significant effect of this factor may interfere with noticing the influence of other factors.

Therefore, within the PISA study, the student surveys contain a series of questions about the students themselves and their families. The students' answers are used to form several indexes characterizing a student's family. The first to be mentioned is the International Socio-Economic Index of Occupational Status (ISEI). It characterizes both the prestige of a profession and the work complexity. The index values range from 1 to 99. Students had to answer two open questions about their parents' occupation: "What is your mother's (father's) main job?" And "What does your mother (father) do in her (his) main job?" Student responses to these two questions were coded according to the International Standard Classification of Occupations (ISCO-2008). The resulting code was then recoded to obtain the ISEI value.

The students were also asked to provide information on their parents' education – what kind of education has been obtained by parents at school and at other educational institutions after graduation. Indexes of parental education were prepared according to ISCED (International Standard Classification of Education) levels.

The survey included questions about the use of a language at home (the extent to which it corresponds to the test language), and the family structure. A series of questions were about the things owned by the family – which of the things listed in the survey were at the student's home and at his or her disposal, such as a desk to study at, a room of one's own, a computer, internet access, classic literature, poetry, etc. There were also questions about how many of the following were owned by the family – books, mobile phones, television sets, computers, cars and bathrooms. From the responses of the students, three indexes were created: Family wealth index, Index of cultural possessions and Index of home educational resources. Combining these three indices, the overall index of home possessions was established.

By combining all of the previously reviewed indices characterising a student's family, the PISA index of social, cultural and economic status (ESCS) was formed. This is the main index characterising the students' families. Like most other indices, ESCS for OECD countries is calibrated to the normal scale – the average value of 0, standard deviation – 1 (OECD, 2014a).

In all OECD PISA cycles, starting from the year 2000, student performance in mathematics, science and reading was also evaluated in the context of the indices characterising the socioeconomic status of a family and a school. The index helps to explain a great number of differences in student and school performance, however, it must be taken into account that the index is not a panacea for explaining all the differences. For the purposes of the study, it was assumed that the student is in a socio-economically advantageous position, if he or she is among the 25% of the students enjoying the highest social, cultural and economic status index in the country, and the student is socio-economically disadvantaged, if he or she is a part of the 25% of students having the lowest social, cultural and economic status index in the country. OECD PISA enables to compare the average performance in mathematics and SES impact on this performance in each country participating in the study. On average, in OECD countries, 15% of the performance variance can be explained by the impact of the SES (OECD, 2013c).

To explore the impact of other factors (attitudes, schools, teachers) on student performance, a number of other indices were developed – Mathematics interest, Index of anxiety regarding mathematics, Index of mathematics self-concept, etc.

3. MATHEMATICAL LITERACY OF STUDENTS

3.1. Definition of mathematical literacy and its proficiency levels

Everyone, not just the adults whose careers are of technical or scientific nature, requires an adequate knowledge of mathematics for personal growth, work and full participation in society, therefore it is important that parents and teachers know the extent to which young people graduating from basic school are prepared to use the knowledge of mathematics for problem solving in everyday life.

PISA mathematical literacy is defined as

- an individual's capacity to formulate, employ, and interpret mathematics in a variety of contexts;
- an individual's ability to reason mathematically and use mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena;
- an individual's capacity to recognise the role that mathematics plays in the world and to make well-founded judgments and decisions needed by constructive, engaged and reflective citizens.

This definition emphasizes the role of mathematics as a subject taught at school, where the processes related to problem-solving in real-life context, by using mathematical analysis, applying appropriate mathematical literacy and evaluating the solution in the context of the problem are particularly emphasized. The items of mathematics are composed pursuant to the knowledge and skills required to solve them, observing the particular context and content. Mathematical literacy, just like science and reading proficiency, is expressed in points or in six proficiency levels.

In PISA 2012, as well as in PISA 2003, mathematics was the main content area and mathematics literacy assesment results were first aggregated into one combined mathematics scale. In 2012, the OECD average was 494 points with a standard deviation of 92 (in 2003 – 500 and 100 points, respectively). Besides the combined mathematical literacy scale, the student performance is also reflected in the seven subscales: three Process subscales (formulating, employing and interpreting) and four Content subscales (Quantity, Space and shape, Change and relationships, Uncertainty and data). These seven subscales provide an opportunity to compare the students' average results and their distribution according to different mathematical literacy assessment elements.

Table 3.1 Levels of proficiency in mathematics in PISA 2012 (OECD 2014d, p. 61)

Level (lower score limit)	What students can typically do
Level 6 (669 points)	Students can conceptualise, generalise and utilise information based on their investigations and modelling of complex problem situations, and can use their knowledge in relatively non-standard contexts. They can link different information sources and representations and flexibly translate among them. Students at this level are capable of advanced mathematical thinking and reasoning. These students can apply this insight and understanding, along with a mastery of symbolic and formal mathematical operations and relationships, to develop new approaches and strategies for attacking novel situations. Students at this level can reflect on their actions, and can formulate and precisely communicate their actions and reflections regarding their findings, interpretations, arguments, and the appropriateness of these to the original situation.
Level 5 (607 points)	Students can develop and work with models for complex situations, identifying constraints and specifying assumptions. They can select, compare, and evaluate appropriate problem-solving strategies for dealing with complex problems related to these models. Students at this level can work strategically using broad, well-developed thinking and reasoning skills, appropriate linked representations, symbolic and formal characterisations, and insight pertaining to these situations. They begin to reflect on their work and can formulate and communicate their interpretations and reasoning.
Level 4 (545 points)	Students can work effectively with explicit models for complex concrete situations that may involve constraints or call for making assumptions. They can select and integrate different representations, including symbolic, linking them directly to aspects of real-world situations. Students at this level can utilise their limited range of skills and can reason with some insight, in straightforward contexts. They can construct and communicate explanations and arguments based on their interpretations, arguments, and actions.
Level 3 (482 points)	Students can execute clearly described procedures, including those that require sequential decisions. Their interpretations are sufficiently sound to be a base for building a simple model or for selecting and applying simple problem solving strategies. Students at this level can interpret and use representations based on different information sources and reason directly from them. They typically show some ability to handle percentages, fractions and decimal numbers, and to work with proportional relationships. Their solutions reflect that they have engaged in basic interpretation and reasoning.

Level (lower score limit)	What students can typically do
Level 2 (420 points)	Students can interpret and recognise situations in contexts that require no more than direct inference. They can extract relevant information from a single source and make use of a single representational mode. Students at this level can employ basic algorithms, formulae, procedures, or conventions to solve problems involving whole numbers. They are capable of making literal interpretations of the results.
Level 1 (358 points)	Students can respond to articulate questions about the well-known context, which contains the relevant information. They are able to identify information and to carry out routine operations in accordance with clearly pronounced indications in explicit situations. They are able to carry out self-explanatory operation and immediately follow the given proposal.

An essential feature of PISA is the provision of information to policy makers about trends in education. Comparability of the data is ensured by the combined scale structure that is entirely based on mathematics link items, which have remained unchanged in all PISA cycles, and therefore PISA 2000, 2003, 2006, 2009 and 2012 results are comparable.

In PISA 2003, six difficulty levels were defined for mathematical literacy assessment proficiency level scales. The description of mathematics proficiency levels in the combined mathematics scale is shown in Table 3.1.

3.2. Types of mathematics items in PISA 2012

PISA 2012 mathematics tests included items developed in accordance with the following elements: context, content, process. Each test item is special in its content, a certain area of skills and knowledge. Item content is provided in stimulating material, which is usually a fragment of a text, table, diagram, photograph, scheme, etc. Each of these items contains several questions (in total 109 items).

Similarly to the previous PISA cycles, PISA 2012 also contained various response formats of items:

- elaborated constructed response items – a student must enter a reply and show or explain the process of solving the item or providing the proof;
- simple constructed response items – a student must enter a brief response (usually, a number or a word) without an explanation;
- simple multiple choice items – a student must select one correct answer from the provided options;

- complex multiple choice items – a student must select one correct answer from the options provided for several questions of the item.

Table 3.2 shows distribution of PISA 2012 mathematics items according to content, context format, aspect and situation, as well as the type of item.

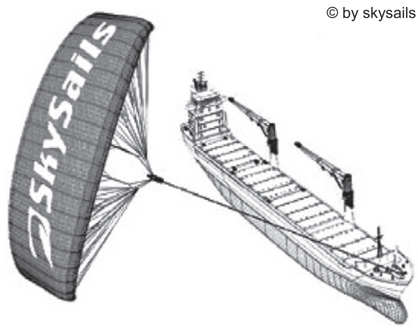
Table 3.2 Distribution of PISA 2012 mathematics items

	Total number of items	Simple multiple choice items	Complex multiple choice items	Elaborated constructed response items	Simple constructed response items
Mathematics items according to content					
Quantity	28	10	3	5	10
Space and shape	27	6	4	10	7
Change and relationships	29	5	3	14	7
Uncertainty and data	25	11	3	5	6
Total	109	32	13	34	30
Mathematics items according to process					
Formulating situations mathematically	35	7	3	16	9
Employing mathematical concepts, facts, procedures, and reasoning	47	13	5	11	18
Interpreting, applying and evaluating mathematical outcomes	27	12	5	7	3
Total	109	32	13	34	30
Mathematics items according to context					
Personal	21	7	3	3	8
Societal	36	16	3	7	10
Occupational	24	3	4	11	6
Scientific	28	6	3	13	6
Total	109	32	13	34	30

3.3. Examples of PISA 2012 mathematics items

In the studies like PISA that are carried out every three years, it is important to establish a group of link items, which is not published, to enable a safe and reliable measurement of changes in student performance in time. Other items are publishable after the end of the study, and they illustrate, how the students' mathematical literacy is measured. This chapter provides two examples of mathematics items to illustrate the different types of assignments.

SAILING SHIPS



Ninety-five percent of world trade is moved by sea, by roughly 50 000 tankers, bulk carriers and container ships. Most of these ships use diesel fuel.

Engineers are planning to develop wind power support for ships. Their proposal is to attach kite sails to ships and use the wind's power to help reduce diesel consumption and the fuel's impact on the environment.

Question 1

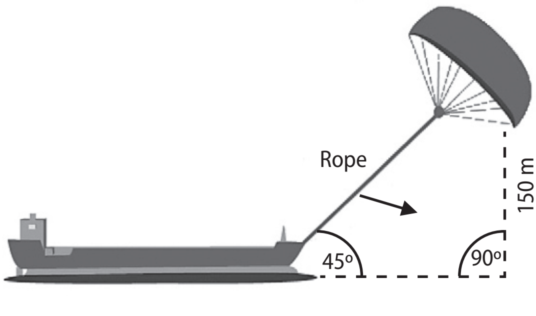
One advantage of using a kite sail is that it flies at a height of 150 m. There, the wind speed is approximately 25% higher than down on the deck of the ship.

At what approximate speed does the wind blow into a kite sail when a wind speed of 24 km/h is measured on the deck of the ship?

A. 6 km/h
B. 18 km/h
C. 25 km/h
D. 30 km/h
E. 49 km/h

Question 2

Approximately what is the length of the rope for the kite sail, in order to pull the ship at an angle of 45° and be at a vertical height of 150 m, as shown in the diagram opposite?



Note: Drawing not to scale.© by skysails

A. 173 m

B. 212 m
C. 285 m
D. 300 m

Question 3

Due to high diesel fuel costs of 0.42 zeds per litre, the owners of the ship NewWave are thinking about equipping their ship with a kite sail.

It is estimated that a kite sail like this has the potential to reduce the diesel consumption by about 20% overall.

Name: NewWave
Type: freighter
Length: 117 metres
Breadth: 18 metres
Load capacity: 12 000 tons
Maximum speed: 19 knots
Diesel consumption per year without a kite sail: approximately 3 500 000 litres

The cost of equipping the NewWave with a kite sail is 2 500 000 zeds.

After about how many years would the diesel fuel savings cover the cost of the kite sail? Give calculations to support your answer.

Number of years: … … …

Item scoring:

Scoring of question 1

A student must calculate percentage in a specific real-life situation. This is a multiple-choice, Quantity area item, and in its solution process student must be able to apply mathematical knowledge. The item has a scientific context.

<u>Correct answer:</u> D 30 km/h

Scoring of question 2:

The student must apply Pythagorean theorem in real geometrical situation. This is a multiple-choice, Space and shape area item, and in its solution process a student must be able to use mathematical knowledge. The item has a scientific context.

<u>Correct answer:</u> B 212 m

Scoring of question 3:

The student must find a solution to a real-life situation, which includes the cost savings and fuel consumption. This is a constructed response, Change and relationships area item, and its solution requires an ability to formulate a mathematical problem. The item has a scientific context.

Correct answer: responses from 8 to 9 years with correct (mathematical) calculations.

Yearly diesel fuel consumption without a kite: 3,5 million litres costing 0,42 zeds per litre, diesel fuel costs without a kite: 1 470 000 zeds. If a kite allows to save 20% of energy, that is 1 470 000 zeds × 0,2 = 294 000 zeds per year. Consequently, 2 500 000 ÷ 294 000 8,5: kite becomes (financially) profitable after 8 to 9 years.

Table 3.3 provides the international comparison of different countries' students' performance in solving this item (percentage of students who gave correct answers).

Table 3.3 ***International comparison of different countries' students' performance in solving this item (percentage of students who gave correct answers)***

	Latvia	OECD countries' average	Estonia	Finland	Korea	Poland	USA	Lithuania	Russia
Q 1	56	60	65	73	69	67	50	55	57
Q 2	43	50	54	50	56	53	44	47	45
Q 3	13	15	18	16	21	19	12	14	16

DRIP RATE

Infusions (or intravenous drips) are used to deliver fluids and drugs to patients.
Nurses need to calculate the drip rate, ***D***, in drops per minute for infusions.

They use the formula $D = \frac{dv}{60n}$, where

d is the drop factor measured in drops per millilitre (mL)
v is the volume in mL of the infusion
n is the number of hours the infusion is required to run.

Question 1

A nurse wants to double the time an infusion runs for.
Describe precisely how D changes if n is **doubled** but d and v do not change.

....

....

Question 2

Nurses also need to calculate the volume of the infusion, v, from the drip rate, ***D***.

An infusion with a drip rate of 50 drops per minute has to be given to a patient for 3 hours. For this infusion the drop factor is 25 drops per millilitre.

What is the volume in mL of the infusion?

Volume of the infusion: … … … mL

Scoring of the item:

Scoring of question 1:

The student must understand and be able to explain how the change of one variable in the formula affects the result, if all other variables remain the same. This is a constructed response, Change and relationships area item, and its solution requires to be able to apply mathematical knowledge. The item has a societal context.

Correct answer: The answer **simultane**ously explains the **process** and the **impact** on value.

- it is divisible by two
- it is a half
- D decreases by 50%
- D will be twice less.

Partially correct answer: incomplete answer, gives correctly ONLY process OR only changes in value, but not BOTH.

- D decreases [no value]
- change 50% [no process]
- D increases by 50% [incorrect direction, but a correct value]

Scoring of question 2:

The student must be able to transpose the equation and replace the two variables with the given figures. This is a simple constructed response, Change and relationships area item, and its resolution process requires the ability to apply mathematical knowledge. The item has an occupational context.

Correct answer: 360 or a correct solution, inserting and replacing values:

- 360
- (60 × 3 × 50) ÷ 25 [correctly inserted and replaced values]

Table 3.4 provides the international comparison of different countries' students' performance in solving this item (percentage of students who gave correct answers).

Table 3.4 *International comparison of different countries' students' performance in solving this item (percentage of students who gave correct answers)*

	Latvia	OECD countries' average	Estonia	Finland	Korea	Poland	USA	Lithuania	Russia
Q 1	29	22	31	24	43	23	19	25	33
Q 2	23	26	26	24	46	31	30	24	36

3.4. Division of student mathematics performance in proficiency levels

Mathematical proficiency levels are detailed in Table 3.1. PISA Level 2 is set as the basic level, where students begin to demonstrate the mathematical literacy that allows for a successful use of mathematical knowledge and skills to achieve any goal and in the future to be able to become incorporated into the life of society and to compete in the labour market. Table 3.1 shows the percentage of students below level 2 (level 1 and below) in 2012 and the comparison with the year 2003. In Latvia, the proportion of these students has dropped from 24% to 20%. These changes are statistically significant at the 95% confidence level and it is the fifth largest decrease among European Union countries.

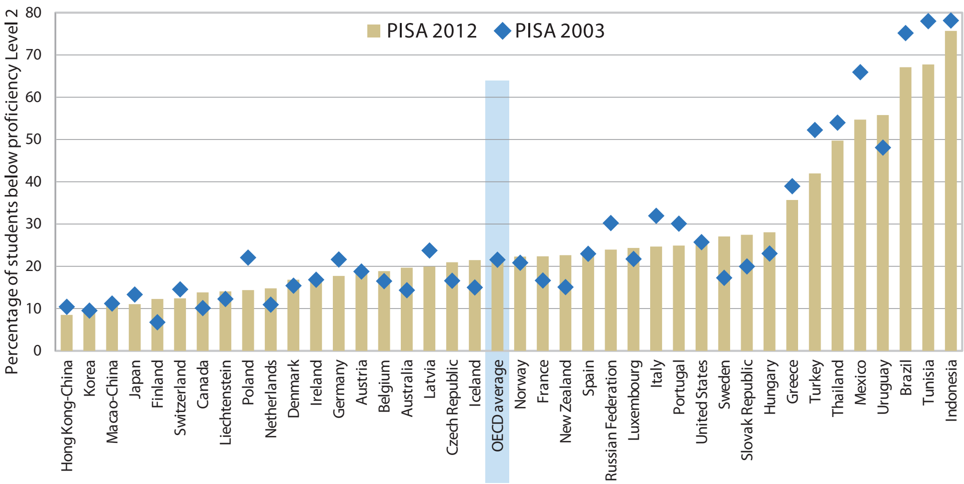


Figure 3.1 Percentage of students below proficiency level 2 in PISA 2012 and PISA 2003

On the other hand, the percentage of the Latvian students who are able to solve items in the higher difficulty levels (items of proficiency levels 5 and 6), in 2012 is the same as in 2003 (see Figure 3.2) – 8%.

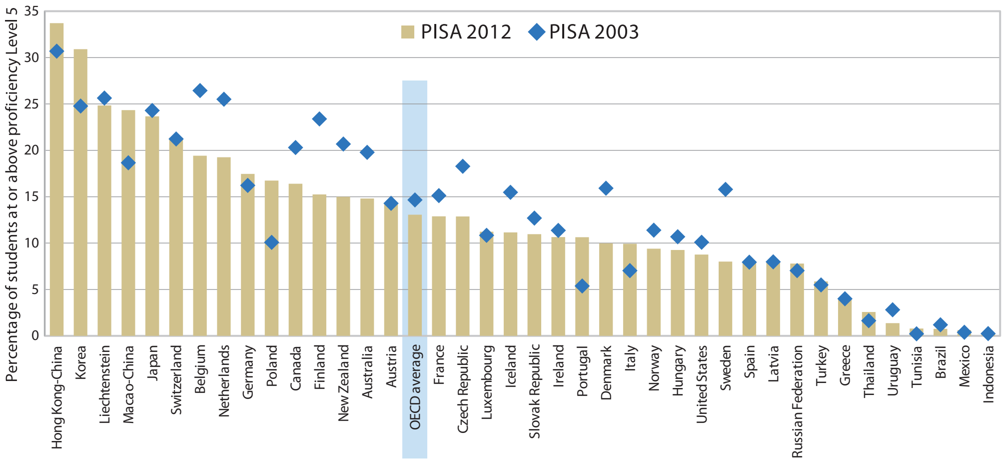


Figure 3.2 Percentage of students in proficiency level 5 and above in PISA 2012 and PISA 2003

Overall, comparing the distribution of the number of students in proficiency levels, it can be observed that there are relatively few students in Latvia who can solve the items of the highest difficulty level, and their number in comparison with 2003 has not changed. Then again, the number of students in Latvia whose knowledge is evaluated below PISA level 2 is lower than the OECD average, yet compared to PISA 2003 it has decreased, consequently – the number of those doing poorly in mathematics has declined. The comparison with neighbouring countries is shown in Table 3.5.

Table 3.5 Estonian, Latvian, Lithuanian and Russian student percentage comparison in the respective levels of mathematical proficiency

Country	Below level 1	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
Estonia	2.0	8.6	22.0	29.4	23.4	11.0	3.6
Latvia	4.8	15.1	26.6	27.8	17.6	6.5	1.5
Lithuania	8.7	17.3	25.9	24.6	15.4	6.6	1.4
Russia	7.5	16.5	26.6	26.0	15.7	6.3	1.5
OECD countries' average	8.0	15.0	22.5	23.7	18.2	9.3	3.3

Note. Countries are arranged in descending order according to the average performance in the combined mathematics scale.

3.5. A reflection of student performance in the combined mathematics scale

Student performance differences among the countries can be analyzed, comparing the average performance of each participating country's students both with other participating countries and with the OECD countries' average. The average student performance in PISA 2012 OECD mathematics is 494 points with a standard deviation of 92 points, which is the reference point for each participating country's student mathematics performance comparison.

Table 3.6 provides a summary of PISA 2012 participating countries' average student performance in mathematics. The countries in the table are arranged in descending order according to the average performance, indicating the countries whose performance does not differ statistically significantly.

Table 3.6 Average student performance assessed within the combined mathematics scale (OECD, 2014d, p. 47)

Mean score	Comparison country/ economy	Countries/economies whose mean score is NOT statistically significantly different from that comparison country's/economy's score
613	Shanghai-China	
573	Singapore	
561	Hong Kong-China	Chinese Taipei, Korea
560	Chinese Taipei	Hong Kong-China, Korea
554	Korea	Hong Kong-China, Chinese Taipei
538	Macao-China	Japan, Liechtenstein
536	Japan	Macao-China, Liechtenstein, Switzerland
535	Liechtenstein	Macao-China, Japan, Switzerland
531	Switzerland	Japan, Liechtenstein, Netherlands
523	Netherlands	Switzerland, Estonia, Finland, Canada, Poland, Viet Nam
521	Estonia	Netherlands, Finland, Canada, Poland, Viet Nam
519	Finland	Netherlands, Estonia, Canada, Poland, Belgium, Germany, Viet Nam
518	Canada	Netherlands, Estonia, Finland, Poland, Belgium, Germany, Viet Nam
518	Poland	Netherlands, Estonia, Finland, Canada, Belgium, Germany, Viet Nam
515	Belgium	Finland, Canada, Poland, Germany, Viet Nam
514	Germany	Finland, Canada, Poland, Belgium, Viet Nam

Mean score	Comparison country/ economy	Countries/economies whose mean score is NOT statistically significantly different from that comparison country's/economy's score
511	Viet Nam	Netherlands, Estonia, Finland, Canada, Poland, Belgium, Germany, Austria, Australia, Ireland
506	Austria	Viet Nam, Australia, Ireland, Slovenia, Denmark, New Zealand, Czech Republic
504	Australia	Viet Nam, Austria, Ireland, Slovenia, Denmark, New Zealand, Czech Republic
501	Ireland	Viet Nam, Austria, Australia, Slovenia, Denmark, New Zealand, Czech Republic, France, United Kingdom
501	Slovenia	Austria, Australia, Ireland, Denmark, New Zealand, Czech Republic
500	Denmark	Austria, Australia, Ireland, Slovenia, New Zealand, Czech Republic, France, United Kingdom
500	New Zealand	Austria, Australia, Ireland, Slovenia, Denmark, Czech Republic, France, United Kingdom
499	Czech Republic	Austria, Australia, Ireland, Slovenia, Denmark, New Zealand, France, United Kingdom, Iceland
495	France	Ireland, Denmark, New Zealand, Czech Republic, United Kingdom, Iceland, Latvia, Luxembourg, Norway, Portugal
494	United Kingdom	Ireland, Denmark, New Zealand, Czech Republic, France, Iceland, Latvia, Luxembourg, Norway, Portugal
493	Iceland	Czech Republic, France, United Kingdom, Latvia, Luxembourg, Norway, Portugal
491	Latvia	France, United Kingdom, Iceland, Luxembourg, Norway, Portugal, Italy, Spain
490	Luxembourg	France, United Kingdom, Iceland, Latvia, Norway, Portugal
489	Norway	France, United Kingdom, Iceland, Latvia, Luxembourg, Portugal, Italy, Spain, Russian Federation, Slovak Republic, United States
487	Portugal	France, United Kingdom, Iceland, Latvia, Luxembourg, Norway, Italy, Spain, Russian Federation, Slovak Republic, United States, Lithuania
485	Italy	Latvia, Norway, Portugal, Spain, Russian Federation, Slovak Republic, United States, Lithuania
484	Spain	Latvia, Norway, Portugal, Italy, Russian Federation, Slovak Republic, United States, Lithuania, Hungary
482	Russian Federation	Norway, Portugal, Italy, Spain, Slovak Republic, United States, Lithuania, Sweden, Hungary
482	Slovak Republic	Norway, Portugal, Italy, Spain, Russian Federation, United States, Lithuania, Sweden, Hungary
481	United States	Norway, Portugal, Italy, Spain, Russian Federation, Slovak Republic, Lithuania, Sweden, Hungary
479	Lithuania	Portugal, Italy, Spain, Russian Federation, Slovak Republic, United States, Sweden, Hungary, Croatia
478	Sweden	Russian Federation, Slovak Republic, United States, Lithuania, Hungary, Croatia
477	Hungary	Spain, Russian Federation, Slovak Republic, United States, Lithuania, Sweden, Croatia, Israel

Mean score	Comparison country/ economy	Countries/economies whose mean score is NOT statistically significantly different from that comparison country's/economy's score
471	Croatia	Lithuania, Sweden, Hungary, Israel
466	Israel	Hungary, Croatia
453	Greece	Serbia, Turkey, Romania
449	Serbia	Greece, Turkey, Romania, Bulgaria
448	Turkey	Greece, Serbia, Romania, Cyprus, Bulgaria
445	Romania	Greece, Serbia, Turkey, Cyprus, Bulgaria
440	Cyprus	Turkey, Romania, Bulgaria
439	Bulgaria	Serbia, Turkey, Romania, Cyprus, United Arab Emirates, Kazakhstan
434	United Arab Emirates	Bulgaria, Kazakhstan, Thailand
432	Kazakhstan	Bulgaria, United Arab Emirates, Thailand
427	Thailand	United Arab Emirates, Kazakhstan, Chile, Malaysia
423	Chile	Thailand, Malaysia
421	Malaysia	Thailand, Chile
413	Mexico	Uruguay, Costa Rica
410	Montenegro	Uruguay, Costa Rica
409	Uruguay	Mexico, Montenegro, Costa Rica
407	Costa Rica	Mexico, Montenegro, Uruguay
394	Albania	Brazil, Argentina, Tunisia
391	Brazil	Albania, Argentina, Tunisia, Jordan
388	Argentina	Albania, Brazil, Tunisia, Jordan
388	Tunisia	Albania, Brazil, Argentina, Jordan
386	Jordan	Brazil, Argentina, Tunisia
376	Colombia	Qatar, Indonesia, Peru
376	Qatar	Colombia, Indonesia
375	Indonesia	Colombia, Qatar, Peru
368	Peru	Colombia, Indonesia
	Average performance of students is statistically significantly above the OECD average.	
	Average performance of students is not statistically significantly different from the OECD average – 494 points.	
	Average performance of students is statistically significantly below the OECD average.	

The highest average performance is shown by Shanghai (China) students – 613 points, which is more than one standard deviation higher result than the OECD average (494 points) and confidently holds the first place in the table. The second place is taken by the Singaporean students – 573 points, while the third to fifth places are shared by three countries – Hong Kong (China), Taiwan (China) and Korea, with 561, 560 and 554 points respectively. From European countries the highest performance is shown by the students from Liechtenstein, Switzerland and the Netherlands – eighth to tenth place.

The Latvian students' average performance – 491 points – does not statistically significantly differ from the OECD average, and also from the average student performance of France, Great Britain, Iceland, Luxembourg, Norway, Portugal, Italy and Spain.

3.6. Average student performance in various mathematical literacy assessment scales

A more detailed assessment of mathematics literacy can be made by using a variety of mathematical competence subscales in the analysis of student performance.

In Table 3.7, the countries are arranged in descending order according to the average performance in the combined mathematics scale. The table shows the average performance difference between each subscale and the combined mathematics scale.

According to the OECD average there are no significant differences between the students' performance in various mathematical literacy assessment subscales, yet there are countries, where students' average performance in a particular mathematics literacy aspect assessment scale significantly differs from both the national average and other scales (see Table 3.7). For example, in six PISA 2012 participating countries (including the countries with the highest results), the average performance in different mathematics item content area scales differ by more than 20 points, accounting for more than one-fifth of the standard deviation. For example, in the strongest group of countries, the students had significantly better performance particularly in Space and shape content area, but showed a worse performance in Uncertainty and data, as well as Quantity scales.

The Latvian students showed the lowest performance in Uncertainty and data area (about 12 points lower than the average), and a slightly higher performance (5–6 points) in the areas of Space and shape, as well as Change and relationships. Similar distribution of the Latvian students' performance in the content areas subscales was observed also in the 2003 survey, but those differences were smaller.

Most countries do not have significant differences in mathematics item solving process subscales, in comparison with the average performance in the combined mathematics scale. As shown in Table 3.7, the students of the strongest countries have significantly higher skills in the formulation of a mathematical problem, but significantly lower – in the interpretation of the results. The Latvian students show a higher performance in solving the items, which require mathematical knowledge, and a little lower – in mathematical formulation of the problem and interpretation of results.

Table 3.7 Comparison of average student performance in mathematics literacy subscale

Participating countries	The differences between the average performance in mathematical literacy subscales and the combined mathematical literacy scale							
	Average performance in mathematics	Quantity	Space and shape	Change and relationships	Uncertainty and data	Formulate	Employ	Interpret
Shanghai-China	613	-22	36	11	-21	12	0	-34
Singapore	573	-4	7	7	-14	8	1	-18
Hong Kong-China	561	5	6	3	-8	7	-3	-10
Chinese Taipei	560	-17	32	1	-11	19	-11	-11
Korea	554	-17	19	5	-16	8	-1	-14
Macao-China	538	-7	20	4	-13	7	-2	-9
Japan	536	-18	22	6	-8	18	-6	-5
Liechtenstein	535	3	4	7	-9	0	1	5
Switzerland	531	0	13	-1	-9	7	-2	-2
Netherlands	523	9	-16	-5	9	4	-4	3
Estonia	521	4	-8	9	-11	-3	4	-8
Finland	519	8	-12	1	0	0	-3	9
Canada	518	-3	-8	7	-2	-2	-2	3
Poland	518	1	6	-9	-1	-2	1	-3
Belgium	515	4	-6	-2	-7	-2	1	-2
Germany	514	3	-7	2	-5	-3	2	3
Viet Nam	511	-2	-4	-2	8	-14	12	-15
Austria	506	4	-5	0	-7	-6	4	3
Australia	504	-4	-7	5	4	-6	-4	10
Ireland	501	4	-23	0	8	-9	1	5
Slovenia	501	3	2	-2	-5	-9	4	-3
Denmark	500	2	-3	-6	5	2	-5	8
New Zealand	500	-1	-9	1	6	-4	-5	11
Czech Republic	499	6	0	0	-11	-4	5	-5
France	495	1	-6	2	-3	-12	1	16
United Kingdom	494	0	-19	2	8	-5	-2	7

Participating countries	The differences between the average performance in mathematical literacy subscales and the combined mathematical literacy scale							
	Average performance in mathematics	Quantity	Space and shape	Change and relationships	Uncertainty and data	Formulate	Employ	Interpret
Iceland	493	3	-4	-6	3	7	-3	0
Latvia	491	-4	6	5	-12	-3	5	-4
Luxembourg	490	5	-4	-2	-7	-8	3	5
Norway	489	3	-9	-11	8	0	-3	9
Portugal	487	-6	4	-1	-1	-8	2	3
Italy	485	6	2	-8	-3	-10	0	13
Spain	484	7	-7	-2	3	-8	-3	11
Russian Federation	482	-4	14	9	-19	-1	5	-11
Slovak Republic	482	4	8	-8	-10	-1	4	-8
United States	481	-3	-18	7	7	-6	-1	8
Lithuania	479	4	-7	0	-5	-1	3	-8
Sweden	478	4	-9	-9	5	1	-4	7
Hungary	477	-1	-3	4	-1	-8	4	0
Croatia	471	9	-11	-3	-3	-19	6	6
Israel	466	14	-17	-4	-1	-2	2	-5
Greece	453	2	-17	-7	7	-5	-4	14
Serbia	449	7	-3	-7	-1	-2	2	-3
Turkey	448	-6	-5	0	-1	1	0	-2
Romania	445	-2	2	1	-8	0	1	-6
Cyprus	440	-1	-4	0	2	-3	3	-4
Bulgaria	439	4	3	-5	-7	-2	0	2
United Arab Emirates	434	-3	-9	8	-2	-8	6	-6
Kazakhstan	432	-4	18	1	-18	10	1	-12
Thailand	427	-8	5	-13	6	-11	-1	5
Chile	423	-2	-4	-12	7	-3	-6	10
Malaysia	421	-12	13	-20	1	-15	2	-3
Mexico	413	1	0	-8	0	-4	0	0
Montenegro	410	-1	2	-11	5	-6	0	4
Uruguay	409	2	4	-8	-2	-3	-2	0
Costa Rica	407	-1	-10	-5	7	-8	-6	11

Participating countries	The differences between the average performance in mathematical literacy subscales and the combined mathematical literacy scale							
	Average performance in mathematics	Quantity	Space and shape	Change and relationships	Uncertainty and data	Formulate	Employ	Interpret
Albania	394	-8	24	-6	-8	4	3	-16
Brazil	391	2	-10	-19	11	-16	-4	10
Argentina	388	3	-3	-9	1	-5	-1	1
Tunisia	388	-10	-6	-9	11	-15	2	-3
Jordan	386	-19	-1	1	8	4	-2	-3
Colombia	376	-1	-7	-19	12	-2	-9	11
Qatar	376	-5	4	-13	6	1	-3	-1
Indonesia	375	-13	8	-11	9	-7	-6	4
Peru	368	-3	2	-19	5	2	0	0

Note. The countries are arranged in descending order according to average student performance in the combined mathematics scale.

3.7. Average mathematics performance in European Union countries

Table 3.8 shows average performance in mathematics literacy achieved by the 25 European Union countries in 2006, 2009 and 2012. Consistently the highest performers are the Finnish and Dutch students, the lowest – the Greek, Bulgarian and Romanian students. Latvian students' performance in 2012 is higher than the results of the previous studies, the average level of the EU countries has been achieved, surpassing the countries like Sweden, Portugal, Luxembourg, Italy and Hungary.

Table 3.8 ***Average performance in mathematics literacy by students of EU countries, PISA 2006–2009–2012***

Country	PISA 2006	Country	PISA 2009	Country	PISA 2012
Finland	548	Finland	541	The Netherlands	523
The Netherlands	531	The Netherlands	526	Estonia	521
Belgium	520	Belgium	515	Finland	519

Country	PISA 2006
Estonia	515
Denmark	513
Czech Republic	510
Austria	505
Germany	504
Slovenia	504
Sweden	502
Ireland	501
France	496
Poland	495
Great Britain	495
Slovakia	492
Hungary	491
Luxembourg	490
Latvia	486
Lithuania	486
Spain	480
Portugal	466
Italy	462
Greece	459
Romania	415
Bulgaria	413
OECD countries' average	491

Country	PISA 2009
Germany	513
Estonia	512
Denmark	503
Slovenia	501
Slovakia	497
France	497
Austria	496
Poland	495
Sweden	494
Czech Republic	493
Great Britain	492
Hungary	490
Luxembourg	489
Portugal	487
Ireland	487
Italy	483
Spain	483
Latvia	482
Lithuania	477
Greece	466
Bulgaria	428
Romania	427
OECD countries' average	491

Country	PISA 2012
Poland	518
Belgium	515
Germany	514
Austria	506
Slovenia	501
Ireland	501
Denmark	500
Czech Republic	499
France	495
Great Britain	494
Latvia	491
Luxembourg	490
Portugal	487
Italy	485
Spain	484
Slovakia	482
Sweden	478
Hungary	477
Lithuania	476
Greece	453
Romania	445
Bulgaria	439
OECD countries' average	492

Summary

In OECD PISA, mathematical literacy is defined as

- an individual's capacity to formulate, employ, and interpret mathematics in a variety of contexts;
- an individual's ability to reason mathematically and use mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena;

- an individual's capacity to recognise the role that mathematics plays in the world and to make well-founded judgments and decisions needed by constructive, engaged and reflective citizens.

This definition emphasizes the role of mathematics as a subject taught in school, where the processes related to problem-solving in real-life context, by using mathematical analysis, applying appropriate mathematical literacy and evaluating the solution in the context of the problem are particularly emphasized. Items of mathematics are composed pursuant to the knowledge and skills required to solve them, observing the particular context and content. Mathematical literacy is expressed in points or in six proficiency levels.

The average performance of students in PISA 2012 OECD mathematics is 494 points with a standard deviation of 92 points. The highest average performance is shown by Shanghai (China) students – 613 points, followed by the students of Singapore (573 points), Hong Kong (China) (561 points), Taiwan (China) (560 points) and Korea (554 points). Among the European countries, the highest performance was achieved by the students from Liechtenstein (535 points), Switzerland (531 points) and the Netherlands (523 points).

The average performance of the Latvian students – 491 points – is not statistically significantly different from the OECD average, and it can be seen as a very good achievement of our education system. The Latvian students' performance is on the same level as the average performance of students in France, Great Britain, Iceland, Luxembourg, Norway, Portugal, Italy and Spain.

In comparison with the study of 2003, in 2012 there was a decrease in the number of those students in Latvia who did not reach level 2 of mathematics proficiency – it is considered the basic level, where the students begin to demonstrate the mathematical competence that allows successful use of mathematical knowledge and skills to achieve any objectives, and in the future to become involved in public life and compete in the labour market. This reduction is statistically significant at the 95% confidence level and it is the fifth largest among the European Union countries. On the other hand, the percentage of the Latvian students who were able to solve the items of the highest difficulty levels in 2012 remained the same as in 2003 and was one of the lowest among the European Union countries.

Invariably, the highest performance among the European Union countries is shown by the Finnish and Dutch students, the lowest – by the Greek, Bulgarian and Romanian students. The Latvian students' performance in 2012 was higher than the results of the previous studies, and the average level of the EU countries had been reached, surpassing the countries like Sweden, Portugal, Luxembourg, Italy and Hungary.

4. SCIENTIFIC LITERACY OF STUDENTS

4.1. Definition of science literacy and its proficiency levels

The study defines scientific literacy as an individual's scientific knowledge and use of that knowledge to identify questions, acquire new knowledge, to explain scientific phenomena and to draw evidence-based conclusions about science related issues; their understanding of the characteristic features of science as a form of human knowledge and enquiry; their awareness of how science and technology shape our material, intellectual and cultural environments; and their willingness to engage with science-related issues, and with the ideas of science, as a reflective citizen (OECD, 2006).

Science was the major assessment domain of OECD PISA 2006, and then the science proficiency scale was defined. It was developed for the OECD student average performance to correspond to 500 points with a standard deviation of 100. This scale was also used in the studies of 2009 and 2012, in which science was not the main content area. A joint scale usage allows to see the changes in student performance over the years. In 2012, the OECD average performance was 501 points, which has also been adopted as a reference point in the PISA 2012 study cycle.

Proficiency levels are an important indicator of student performance. Science literacy is assessed at six levels in the study. The science proficiency levels correspond to the groups of items of increasing difficulty, where 6 is the highest level, and 1 – the lowest. They are defined to indicate what knowledge and skills are required to solve the items of each level. The students whose score is below 334.9 points, are allocated to the group "below the level 1." One level corresponds to 74.7 points. Table 4.1 provides a description of knowledge and skills necessary to solve the items of each level of difficulty. The students are expected to correctly solve at least half of the items of the respective level. Student's allocation to a particular level means that he or she is able to solve at least half of the items of the respective level, as well as lower-level items. For example, students at level 4 proficiency are able to solve most of the items in level 1, 2 and 3, but not all of them.

Table 4.1 Science proficiency levels (OECD, 2009c, p. 294)

Level (lower score limit)	What students can typically do
Level 6 (708 points)	At level 6, students can consistently identify, explain and apply scientific knowledge and knowledge about science in a variety of complex life situations. They can link different information sources and explanations and use evidence from those sources to justify decisions. They clearly and consistently demonstrate advanced scientific thinking and reasoning, and they demonstrate willingness to use their scientific understanding in support of solutions to unfamiliar scientific and technological situations. Students at this level can use scientific knowledge and develop arguments in support of recommendations and decisions that centre on personal, social or global situations.
Level 5 (633 points)	At level 5, students can identify the scientific components of many complex life situations, apply both scientific concepts and knowledge about science to these situations, and can compare, select and evaluate appropriate scientific evidence for responding to life situations. Students at this level can use well-developed inquiry abilities, link knowledge appropriately and bring critical insights to situations. They can construct explanations based on evidence and arguments based on their critical analysis.
Level 4 (559 points)	At level 4, students can work effectively with situations and issues that may involve explicit phenomena requiring them to make inferences about the role of science or technology. They can select and integrate explanations from different disciplines of science or technology and link those explanations directly to aspects of life situations. Students at this level can reflect on their actions and they can communicate decisions using scientific knowledge and evidence.
Level 3 (484 points)	At level 3, students can identify clearly described scientific issues in a range of contexts. They can select facts and knowledge to explain phenomena and apply simple models or inquiry strategies. Students at this level can interpret and use scientific concepts from different disciplines and can apply them directly. They can develop short statements using facts and make decisions based on scientific knowledge.
Level 2 (410 points)	At level 2, students have adequate scientific knowledge to provide possible explanations in familiar contexts or draw conclusions based on simple investigations. They are capable of direct reasoning and making literal interpretations of the results of scientific inquiry or technological problem solving.
Level 1 (335 points)	At level 1, students have such a limited scientific knowledge that it can only be applied to a few, familiar situations. They can present scientific explanations that are obvious and that follow explicitly from given evidence.
Below Level 1 (less than 335 points)	Students cannot use the required knowledge and skills in situations that are included in the simplest PISA items.

4.2. Types of PISA 2012 science items

Areas of application and context of the situations used in scientific literacy assessment

According to the definition of scientific literacy and PISA conceptual framework, the science items are multifaceted, they cover a variety of life and scientific aspects. Different situations are used therein, associated with the three main contexts:

- personal – self, family and peer groups,
- social – the community,
- global – life across the world.

The science items involve a variety of life situations related to science and technology. The situations and environment used in the item content are chosen in the light of public interest in solving these problems, their topicality in both students' and adults' life, i.e., care of one's own health, protection of the environment, use of natural resources, prevention of potential disasters, rapid development of technology, and other problems. Table 4.2 shows the explanation of the areas of application and contexts with the real life situation examples.

Table 4.2 Contexts and areas of application for the PISA 2006 science assessment (OECD, 2006, p. 27)

Context / Area of application	Personal	Social	Global
Health	Maintenance of health, accidents, nutrition	Control of disease, food choices, community health	Epidemics, spread of infectious diseases
Natural resources	Personal consumption of materials and energy	Maintenance of human populations, quality of life, security, production and distribution of food, energy supply	Renewable and non-renewable energy sources, natural systems, population growth
Environment	Environmentally friendly behaviour, use and disposal of materials	Population distribution, disposal of waste, environmental impact, local weather	Biodiversity, ecological sustainability, control of pollution, production and loss of soil

Context / Area of application	Personal	Social	Global
Hazard	Natural and human-induced hazards, decisions about housing	Rapid climate changes (earthquakes, severe weather), slow and progressive changes (coastal erosion, sedimentation), risk assessment	Climate change, impact of modern warfare
Frontiers of science and technology	Interest in science's explanations of natural phenomena, science-based hobbies, sport and leisure, music and personal technology	New materials, devices and processes, genetic modification, weapons technology, transport	Extinction of species, exploration of space, origin and structure of the universe

To solve the science items, the students require the following competencies: (1) Identifying scientific issues, (2) Explaining phenomena scientifically, (3) Using scientific evidence.

These three competencies were chosen because of their importance to the practice of science and their connection to key cognitive abilities such as inductive and deductive reasoning, systems-based thinking, critical decision-making, transformation of information (e.g. creating tables or graphs out of raw data), evidence-based, substantiated discussion and explanations, conceptual thinking, use of mathematics. In general, these competencies characterize both the student's knowledge in science and his or her attitude towards science.

Identifying scientific issues:

- Recognising issues that are possible to investigate scientifically;
- Identifying keywords to search for scientific information;
- Recognising the key features of a scientific investigation.

Explaining phenomena scientifically:

- Applying knowledge of science in a given situation;
- Describing or interpreting phenomena scientifically and predicting possible changes;
- Identifying appropriate descriptions, explanations, and predictions.

Using scientific evidence:

- Interpreting scientific evidence and making and communicating conclusions;
- Identifying the assumptions, evidence and reasoning behind conclusions;
- Reflecting on the societal implications of science and technological developments.

Scientific knowledge and competency refers to both knowledge of science (knowledge about the natural world) and knowledge about science itself. To assess students' knowledge of science, PISA test questions encompass the major fields of physics, chemistry, biology, Earth and space science, and technology, according to the following criteria: (1) relevance to real life situations, (2) representativeness of important scientific concepts (fundamental meaning of science), (3) appropriateness to the developmental level of 15-year-old students

Traditionally, the science programmes examine the terms that emphasize specific knowledge in physics, chemistry or biology. It is the opposite of how most people gain experience in natural sciences, because scientific problems often involve a number of areas. For example, the analysis of the nuclear power plant operation problems deals with the physical and biological components of the Earth system, as well as the impact of energy consumption on the economy and society.

Knowledge of science can be classified, as follows:

Physical systems:

- Structure of matter (e.g., particle models, bonds),
- Properties of matter (e.g., changes of state, thermal and electrical conductivity),
- Chemical changes of matter (e.g., reactions, energy transfer, acids/bases),
- Motions and forces (e.g., velocity, friction),
- Energy and its transformation (e.g., conservation, dissipation, chemical reactions),
- Interactions of energy and matter (e.g., light and radio waves, sound and seismic waves).

Living systems:

- Cells (e.g., structures and functions, DNA, plants and animals),
- Humans (e.g., health, nutrition, disease, reproduction, subsystems (i.e., digestion, respiration, circulation, excretion, and their relationship)),
- Populations (e.g., species, evolution, biodiversity, genetic variation),
- Ecosystems (e.g., food chains, matter and energy flow),
- Biosphere (e.g., ecosystem preservation, sustainability).

Earth and space systems:

- Structures of Earth systems (e.g., lithosphere, atmosphere, hydrosphere),
- Energy in Earth systems (e.g., sources, global climate),
- Change in Earth systems (e.g., plate tectonics, geochemical cycles, constructive and destructive forces),

- Earth's history (e.g., fossils, origin and evolution),
- Earth in space (e.g., gravity, solar systems).

Technology systems:
- Role of science-based technology (e.g., solve problems, help humans meet needs and wants, design and conduct investigations)
- Relationships between science and technology (e.g., technologies contribute to scientific advancement)
- Concepts (e.g., optimisation, trade-offs, risk, cost, benefit)
- Important principles (e.g., criteria, constraints, costs, innovation, invention, problem solving).

Knowledge about science is divided into two categories.

Scientific enquiry:
- Origin (scientific question)
- Purpose (e.g., to produce evidence that helps answer scientific question, what current ideas/models/theories guide enquiries)
- Experiments (e.g., different questions and results may suggest new scientific investigations)
- Data (e.g., quantitative (measurements), qualitative (observations))
- Measurement (e.g., probability, inherent uncertainty, credibility, replicability, variation, accuracy/precision in equipment and procedures)
- Characteristics of results (e.g., empirical, tentative (first results), testable, falsified, corrected).

Scientific explanations:
- Types (e.g., hypothesis, theory, model, scientific law),
- Formation (e.g., existing knowledge and new evidence, creativity and imagination, logic),
- Rules (e.g., logically consistent, based on evidence, based on historical and current knowledge),
- Outcomes (e.g., new knowledge, new methods, new technologies, new investigations).

4.3. Example of PISA 2012 science item

An example of science item is provided below, illustrating different levels of difficulty, expertise and knowledge required to solve the item.

SUNSCREENS

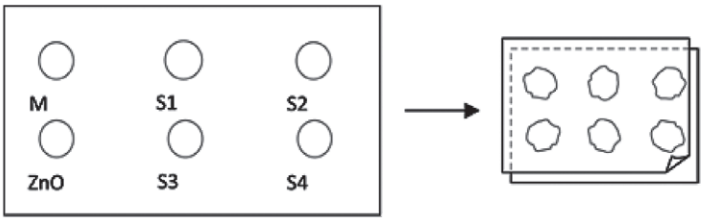
Mimi and Dean wondered which sunscreen product provides the best protection for their skin. Sunscreen products have a Sun Protection Factor (SPF) that shows how well each product absorbs the ultraviolet radiation component of sunlight. A high SPF sunscreen protects skin for longer than a low SPF sunscreen.

Mimi thought of a way to compare some different sunscreen products. She and Dean collected the following:

- two sheets of clear plastic that do not absorb sunlight;
- one sheet of light-sensitive paper;
- mineral oil (M) and a cream containing zinc oxide (ZnO); and
- four different sunscreens that they called S1, S2, S3, and S4.

Mimi and Dean included mineral oil because it lets most of the sunlight through, and zinc oxide because it almost completely blocks sunlight.

Dean placed a drop of each substance inside a circle marked on one sheet of plastic, then put the second plastic sheet over the top. He placed a large book on top of both sheets and pressed down.

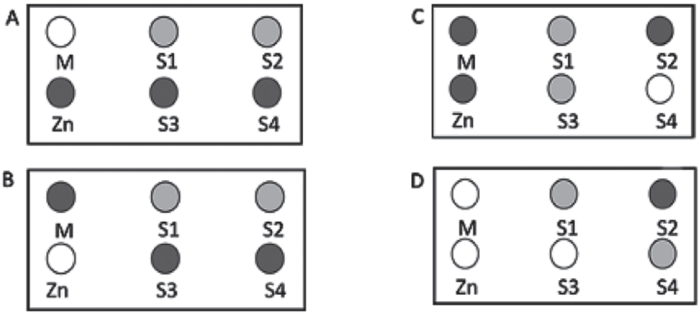


Mimi then put the plastic sheets on top of the sheet of light-sensitive paper. Light-sensitive paper changes from dark grey to white (or very light grey), depending on how long it is exposed to sunlight. Finally, Dean placed the sheets in a sunny place.

The light-sensitive paper is a dark grey and fades to a lighter grey when it is exposed to some sunlight, and to white when exposed to a lot of sunlight.

Which one of these diagrams shows a pattern that might occur? Explain why you chose it.

Answer:



Explanation:

Sunscreens scoring:

Correct answer: A

- With explanation that the ZnO spot has stayed dark grey (because it blocks sunlight) and the M spot has gone white (because mineral oil absorbs very little sunlight). [It is not necessary (though it is sufficient) to include the further explanations that are shown in parentheses.]
- A. ZnO has blocked the sunlight as it should and M has let it through.
- I chose A because the mineral oil needs to be the lightest shade while the zinc oxide is the darkest.

Partially correct answer:

- A. Gives a correct explanation for either the ZnO spot or the M spot, but not both, and does not give an incorrect explanation for the other spot.
- A. Mineral oil provides the lowest resistance against UVL. So with other substances the paper would not be white.
- A. Zinc oxide absorbs practically all rays and the diagram shows this.

Table 4.3 International comparison of different countries' students' performance in solving SUNSCREENS item (percentage of students who gave correct or partially correct answers)

	Latvia	OECD countries' average	Estonia	Finland	Korea	Mexico	Poland	USA	Lithuania	Russia
Correct answer	17	25	21	37	43	8	11	24	13	22
Partially correct answer	4	3	5	4	4	3	1	4	3	2

4.4. Performance of Latvian students in science literacy: international context

In science, just like in reading, students' performance in different countries is not so diverse as in mathematics. The average student performance in science in various countries ranges from 580 to 373 points (in mathematics – from 613 to 368 points). The average performance of all the participating countries' students involved in the study is shown in Table 4.4. Shanghai (China) students' performance is statistically above all the other participating countries' student performance. With a relatively large difference in performance follows Hong Kong (China), Singapore and Japan. The highest performance among the European countries is shown by Finnish, Estonian and Polish students. Performance statistically significantly above the OECD average is shown by Liechtenstein, Germany, the Netherlands, Ireland, Switzerland, Slovenia, Great Britain, Czech and Belgian students.

Latvia, along with Austria, France, Denmark and the United States is in the group of five countries where the average performance of students is no different from the average performance of OECD countries' students.

Very poor performance in science is observed in Peru, Indonesia, Qatar, Tunisia and Albania. Among the European countries, the lowest performance is shown by the Albanian and Montenegrin students. Slightly better performance is achieved by the students of Cyprus, Romania, Serbia and Bulgaria.

The Latvian mean score is not statistically significantly different from Czech Republic, Austria, Belgium, France, Denmark, the USA, Spain, Lithuania, Norway and Hungary. Among all the participating countries, Latvian rank is between 23 and 29.

Table 4.4 Comparison of different countries' student performance in science literacy (OECD, 2014d, p. 217)

Mean score	Comparison country	Countries, whose mean score is not statistically significantly different from that comparison country's score
580	Shanghai (China)	
555	Hong Kong (China)	Singapore, Japan
551	Singapore	Hong Kong (China), Japan
547	Japan	Hong Kong (China), Singapore, Finland, Estonia, Korea
545	Finland	Japan, Estonia, Korea
541	Estonia	Japan, Finland, Korea

Mean score	Comparison country	Countries, whose mean score is not statistically significantly different from that comparison country's score
538	Korea	Japan, Finland, Estonia, Viet Nam
528	Viet Nam	Korea, Poland, Canada, Liechtenstein, Germany, Taiwan (China), Netherlands, Ireland, Australia, Macao (China)
526	Poland	Viet Nam, Canada, Liechtenstein, Germany, Taiwan (China), the Netherlands, Ireland, Australia, Macao (China)
525	Canada	Viet Nam, Poland, Liechtenstein, Germany, Taiwan (China), the Netherlands, Ireland, Australia
525	Liechtenstein	Viet Nam, Poland, Canada, Germany, Taiwan (China), the Netherlands, Ireland, Australia, Macao (China)
524	Germany	Viet Nam, Poland, Canada, Liechtenstein, Taiwan (China), the Netherlands, Ireland, Australia, Macao (China)
523	Taiwan (China)	Viet Nam, Poland, Canada, Liechtenstein, Germany, the Netherlands, Ireland, Australia, Macao (China)
522	Netherlands	Viet Nam, Poland, Canada, Liechtenstein, Germany, Taiwan (China), Ireland, Australia, Macao (China), New Zealand
522	Ireland	Viet Nam, Poland, Canada, Liechtenstein, Germany, Taiwan (China), the Netherlands, Australia, Macao (China), New Zealand
521	Australia	Viet Nam, Poland, Canada, Liechtenstein, Germany, Taiwan (China), the Netherlands, Ireland, Macao (China), Switzerland
521	Macao (China)	Viet Nam, Poland, Liechtenstein, Germany, Taiwan (China), the Netherlands, Ireland, Australia, Switzerland, United Kingdom
516	New Zealand	Netherlands, Ireland, Switzerland, Slovenia, United Kingdom
515	Switzerland	Netherlands, Ireland, Australia, Macao (China), New Zealand, Slovenia, United Kingdom, Czech Republic
514	Slovenia	New Zealand, Switzerland, United Kingdom, Czech Republic
514	Great Britain	Netherlands, Ireland, Australia, Macao (China), New Zealand, Switzerland, Slovakia, Czech Republic, Austria
508	Czech Republic	Switzerland, Slovenia, United Kingdom, Austria, Belgium, Latvia
506	Austria	United Kingdom, Czech Republic, Belgium, Latvia, France, Denmark, USA
505	Belgium	Czech Republic, Austria, Latvia, France, USA
502	Latvia	Czech Republic, Austria, Belgium, France, Denmark, the USA, Spain, Lithuania, Norway, Hungary
499	France	Austria, Belgium, Latvia, Denmark, the USA, Spain, Lithuania, Norway, Hungary, Italy, Croatia
498	Denmark	Austria, Latvia, France, USA, Spain, Lithuania, Norway, Hungary, Italy, Croatia
497	USA	Austria, Belgium, Latvia, France, Denmark, Spain, Lithuania, Norway, Hungary, Italy, Croatia, Luxembourg
496	Spain	Latvia, France, Denmark, USA, Lithuania, Norway, Hungary, Italy, Croatia, Portugal

Mean score	Comparison country	Countries, whose mean score is not statistically significantly different from that comparison country's score
496	Lithuania	Latvia, France, Denmark, USA, Spain, Norway, Hungary, Italy, Croatia, Luxembourg, Portugal
495	Norway	Latvia, France, Denmark, USA, Spain, Lithuania, Hungary, Italy, Croatia, Luxembourg, Portugal, Russia
494	Hungary	Latvia, France, Denmark, USA, Spain, Lithuania, Norway, Italy, Croatia, Luxembourg, Portugal, Russia
494	Italy	France, Denmark, USA, Spain, Lithuania, Norway, Hungary, Croatia, Luxembourg, Portugal
491	Croatia	France, Denmark, USA, Spain, Lithuania, Norway, Hungary, Italy, Luxembourg, Portugal, Russia
491	Luxembourg	USA, Lithuania, Norway, Hungary, Italy, Croatia, Portugal, Russia
489	Portugal	USA, Spain, Lithuania, Norway, Hungary, Italy, Croatia, Luxembourg, Russia, Sweden
486	Russia	Norway, Hungary, Croatia, Luxembourg, Portugal, Sweden
485	Sweden	Croatia, Portugal, Russia, Iceland
478	Iceland	Sweden, Slovakia, Israel
471	Slovakia	Iceland, Israel, Greece, Turkey
470	Israel	Iceland, Slovakia, Greece, Turkey
467	Greece	Slovakia, Israel, Turkey
463	Turkey	Slovakia, Israel, Greece
448	UAE	Bulgaria, Chile, Serbia, Thailand
446	Bulgaria	United Arab Emirates, Chile, Serbia, Thailand, Romania, Cyprus
445	Chile	United Arab Emirates, Bulgaria, Serbia, Thailand, Romania
445	Serbia	United Arab Emirates, Bulgaria, Chile, Thailand, Romania
444	Thailand	United Arab Emirates, Bulgaria, Chile, Serbia, Romania
439	Romania	Bulgaria, Chile, Serbia, Thailand, Cyprus
438	Cyprus	Bulgaria, Romania
429	Costa Rica	Kazakhstan
425	Kazakhstan	Costa Rica, Malaysia
420	Malaysia	Kazakhstan, Uruguay, Mexico
416	Uruguay	Malaysia, Mexico, Montenegro, Jordan
415	Mexico	Malaysia, Uruguay, Jordan
410	Montenegro	Uruguay, Jordan, Argentina
409	Jordan	Uruguay, Mexico, Montenegro, Argentina, Brazil

Mean score	Comparison country	Countries, whose mean score is not statistically significantly different from that comparison country's score
406	Argentina	Montenegro, Jordan, Brazil, Colombia, Tunisia, Albania
405	Brazil	Jordan, Argentina, Colombia, Tunisia
399	Columbia	Argentina, Brazil, Tunisia, Albania
398	Tunisia	Argentina, Brazil, Colombia, Albania
397	Albania	Argentina, Colombia, Tunisia
384	Qatar	Indonesia
382	Indonesia	Qatar, Peru
373	Peru	Indonesia
	The average performance of students is statistically significantly higher than the OECD countries' students' average performance.	
	The average performance of students statistically does not significantly differ from the OECD countries' students' average performance – 501 point.	
	The average performance of students is statistically significantly lower than the OECD countries' students' average performance.	

Table 4.5. shows the breakdown of the science proficiency levels in all the countries participating in the study. Information in the table is arranged according to the number of students in level 6, although on average in OECD countries only 1% of the students belong to that level. Significantly more students at this level are in Singapore (5.8%), Shanghai (China) (4.2%), Japan (3.4%) and Finland (3.2%). In these countries, there is also the greatest number of students in Levels 5 and 6 combined. In Latvia, these levels have a total of 4.3% of the students, while Level 6 – 0.3%. In Estonia, at both levels together, there are 12.8% of students (three times more than in Latvia), while the highest – 1.7% (six times more than in Latvia). In Lithuania, at both highest levels there are 5.1% of the students, in Russia – 4.3%.

The comparison of proficiency groups shows that Latvia has too few students whose literacy corresponds to the highest level of performance, consequently, in this respect, our education system is in need of significant improvements.

Table 4.5 ***Percentage of students at each level of science proficiency (OECD, 2014d, p. 392)***

Level / Country	Below level 1	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
Singapore	2.2	7.4	16.7	24.0	27.0	16.9	5.8
Shanghai (China)	0.3	2.4	10.0	24.6	35.5	23.0	4.2
Japan	2.0	6.4	16.3	27.5	29.5	14.8	3.4

Country \ Level	Below level 1	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
Finland	1.8	5.9	16.8	29.6	28.8	13.9	3.2
New Zealand	4.7	11.6	21.7	26.4	22.3	10.7	2.7
Australia	3.4	10.2	21.5	28.5	22.8	10.9	2.6
Canada	2.4	8.0	21.0	32.0	25.3	9.5	1.8
Great Britain	4.3	10.7	22.4	28.4	23.0	9.3	1.8
Hong Kong (China)	1.2	4.4	13.0	29.8	34.9	14.9	1.8
Estonia	0.5	4.5	19.0	34.5	28.7	11.1	1.7
Poland	1.3	7.7	22.5	33.1	24.5	9.1	1.7
Germany	2.9	9.3	20.5	28.9	26.2	10.6	1.6
Ireland	2.6	8.5	22.0	31.1	25.0	9.3	1.5
Netherlands	3.1	10.1	20.1	29.1	25.8	10.5	1.3
Slovenia	2.4	10.4	24.5	30.0	23.0	8.4	1.2
Luxembourg	7.2	15.1	24.2	26.2	19.2	7.0	1.2
OECD average	4.8	13.0	24.5	28.8	20.5	7.2	1.2
USA	4.2	14.0	26.7	28.9	18.8	6.3	1.1
Norway	6.0	13.6	24.8	28.9	19.0	6.4	1.1
Korea	1.2	5.5	18.0	33.6	30.1	10.6	1.1
Liechtenstein	0.8	9.6	22.0	30.8	26.7	9.1	1.0
Belgium	5.8	11.8	21.5	28.7	22.9	8.3	1.0
Switzerland	3.0	9.8	22.8	31.3	23.7	8.3	1.0
Viet Nam	0.9	5.8	20.7	37.5	27.0	7.1	1.0
France	6.1	12.6	22.9	29.2	21.3	6.9	1.0
Czech Republic	3.3	10.5	24.7	31.7	22.2	6.7	0.9
Austria	3.6	12.2	24.3	30.1	21.9	7.0	0.8
Sweden	7.3	15.0	26.2	28.0	17.2	5.6	0.7
Denmark	4.7	12.0	25.7	31.3	19.6	6.1	0.7
Iceland	8.0	16.0	27.5	27.2	16.2	4.6	0.6
Israel	11.2	17.7	24.8	24.4	16.1	5.2	0.6
Italy	4.9	13.8	26.0	30.1	19.1	5.5	0.6
Slovakia	9.2	17.6	27.0	26.2	15.0	4.3	0.6
Taiwan (China)	1.6	8.2	20.8	33.7	27.3	7.8	0.6
Hungary	4.1	14.0	26.4	30.9	18.7	5.5	0.5
Macao (China)	1.4	7.4	22.2	36.2	26.2	6.2	0.4
Lithuania	3.4	12.7	27.6	32.9	18.3	4.7	0.4

Level / Country	Below level 1	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
Spain	3.7	12.0	27.3	32.8	19.4	4.5	0.3
Russia	3.6	15.1	30.1	31.2	15.7	3.9	0.3
Latvia	1.8	10.5	28.2	35.1	20.0	4.0	0.3
Croatia	3.2	14.0	29.1	31.4	17.6	4.3	0.3
Portugal	4.7	14.3	27.3	31.4	17.8	4.2	0.3
Bulgaria	14.4	22.5	26.3	22.5	11.2	2.8	0.3
UAE	11.3	23.8	29.9	22.3	10.1	2.3	0.3
Geece	7.4	18.1	31.0	28.8	12.2	2.3	0.2
Cyprus	14.4	23.7	30.3	21.3	8.4	1.8	0.2
Qatar	34.6	28.0	19.6	11.2	5.1	1.3	0.1
Serbia	10.3	24.7	32.4	22.8	8.1	1.6	0.1
Thailand	7.0	26.6	37.5	21.6	6.4	0.9	0.1
Uruguay	19.7	27.2	29.3	17.1	5.6	1.0	0.0
Romania	8.7	28.7	34.6	21.0	6.2	0.9	0.0
Chile	8.1	26.3	34.6	22.4	7.5	1.0	0.0
Turkey	4.4	21.9	35.4	25.1	11.3	1.8	0.0
Albania	23.5	29.6	28.5	14.4	3.6	0.4	0.0
Costa Rica	8.6	30.7	39.2	17.8	3.4	0.2	0.0
Malaysia	14.5	31.0	33.9	16.5	3.7	0.3	0.0
Jordan	18.2	31.4	32.2	15.0	3.0	0.2	0.0
Argentina	19.8	31.0	31.1	14.8	3.0	0.2	0.0
Brazil	18.6	35.1	30.7	12.5	2.8	0.3	0.0
Columbia	19.8	36.3	30.8	11.0	1.9	0.1	0.0
Mexico	12.6	34.4	37.0	13.8	2.1	0.1	0.0
Indonesia	24.7	41.9	26.3	6.5	0.6	0.0	0.0
Kazakhstan	11.3	30.7	36.8	17.8	3.3	0.2	0.0
Peru	31.5	37.0	23.5	7.0	1.0	0.0	0.0
Montenegro	18.7	32.0	29.7	15.4	3.8	0.4	0.0
Tunisia	21.3	34.0	31.1	11.7	1.8	0.1	0.0

Table 4.6 shows the changes in students' science proficiency since 2006. The greatest growth of performance compared to 2006 was observed in Turkey, Qatar, Romania and Thailand, however, these countries are still far from the medium and high performance. Among the countries with relatively high performance, there is a significant improvement in Poland, Italy, Korea, Japan and also in Latvia. The decline in performance is observed in the European countries with a relatively high level of

education – Finland, Hungary, Sweden, Slovakia, Iceland. In 2006, Latvian students' performance in science was lower than the Swedish students' performance, in 2009 – the same, but in 2012 – statistically significantly higher.

Table 4.6 Average student performance in science literacy and the changes since 2006 (OECD, 2014d, p. 399)

Score / Country	Average in 2006		Average in 2009		Average in 2012		Changes between 2006 and 2012		Changes between 2009 and 2012	
Shanghai (China)	m		575	(2.3)	580	(3.0)	m		6	(4.1)
Hong Kong (China)	542	(2.5)	549	(2.8)	555	(2.6)	13	(4.1)	6	(4.0)
Singapore	m		542	(1.4)	551	(1.5)	m		10	(2.5)
Japan	531	(3.4)	539	(3.4)	547	(3.6)	15	(5.3)	7	(5.2)
Finland	563	(2.0)	554	(2.3)	545	(2.2)	-18	(3.5)	-9	(3.5)
Estonia	531	(2.5)	528	(2.7)	541	(1.9)	10	(3.7)	14	(3.6)
Korea	522	(3.4)	538	(3.4)	538	(3.7)	16	(5.3)	0	(5.2)
Poland	498	(2.3)	508	(2.4)	526	(3.1)	28	(4.3)	18	(4.2)
Canada	534	(2.0)	529	(1.6)	525	(1.9)	-9	(3.4)	-3	(2.9)
Liechtenstein	522	(4.1)	520	(3.4)	525	(3.5)	3	(5.7)	5	(5.1)
Germany	516	(3.8)	520	(2.8)	524	(3.0)	8	(5.2)	4	(4.3)
Taiwan (China)	532	(3.6)	520	(2.6)	523	(2.3)	-9	(4.7)	3	(3.8)
Netherlands	525	(2.7)	522	(5.4)	522	(3.5)	-3	(4.8)	0	(6.6)
Ireland	508	(3.2)	508	(3.3)	522	(2.5)	14	(4.4)	14	(4.3)
Australia	527	(2.3)	527	(2.5)	521	(1.8)	-5	(3.4)	-6	(3.4)
Macao (China)	511	(1.1)	511	(1.0)	521	(0.8)	10	(2.3)	10	(1.9)
New Zealand	530	(2.7)	532	(2.6)	516	(2.1)	-15	(3.9)	-16	(3.6)
Switzerland	512	(3.2)	517	(2.8)	515	(2.7)	4	(4.6)	-1	(4.2)
Slovenia	519	(1.1)	512	(1.1)	514	(1.3)	-5	(2.5)	2	(2.2)
Great Britain	515	(2.3)	514	(2.5)	514	(3.4)	-1	(4.5)	0	(4.4)
Czech Republic	513	(3.5)	500	(3.0)	508	(3.0)	-5	(4.9)	8	(4.4)
Austria	511	(3.9)	m		506	(2.7)	-5	(5.1)	m	
Belgium	510	(2.5)	507	(2.5)	505	(2.1)	-5	(3.7)	-1	(3.6)
Latvia	490	(3.0)	494	(3.1)	502	(2.8)	13	(4.5)	8	(4.4)
France	495	(3.4)	498	(3.6)	499	(2.6)	4	(4.6)	1	(4.7)
Denmark	496	(3.1)	499	(2.5)	498	(2.7)	3	(4.5)	-1	(4.0)
USA	489	(4.2)	502	(3.6)	497	(3.8)	9	(6.0)	-5	(5.4)
Spain	488	(2.6)	488	(2.1)	496	(1.8)	8	(3.7)	8	(3.1)

Score / Country	Average in 2006		Average in 2009		Average in 2012		Changes between 2006 and 2012		Changes between 2009 and 2012	
Lithuania	488	(2.8)	491	(2.9)	496	(2.6)	8	(4.2)	4	(4.1)
Norway	487	(3.1)	500	(2.6)	495	(3.1)	8	(4.8)	-5	(4.3)
Hungary	504	(2.7)	503	(3.1)	494	(2.9)	-10	(4.4)	-8	(4.5)
Italy	475	(2.0)	489	(1.8)	494	(1.9)	18	(3.4)	5	(3.0)
Croatia	493	(2.4)	486	(2.8)	491	(3.1)	-2	(4.4)	5	(4.4)
Luxembourg	486	(1.1)	484	(1.2)	491	(1.3)	5	(2.5)	7	(2.3)
Portugal	474	(3.0)	493	(2.9)	489	(3.7)	15	(5.2)	-4	(4.9)
Russia	479	(3.7)	478	(3.3)	486	(2.9)	7	(5.0)	8	(4.6)
Sweden	503	(2.4)	495	(2.7)	485	(3.0)	-19	(4.3)	-10	(4.3)
Iceland	491	(1.6)	496	(1.4)	478	(2.1)	-13	(3.3)	-17	(2.9)
Dubai (UAE)	m		466	(1.2)	474	(1.4)	m		8	(2.3)
Slovakia	488	(2.6)	490	(3.0)	471	(3.6)	-17	(4.8)	-19	(4.9)
Israel	454	(3.7)	455	(3.1)	470	(5.0)	16	(6.5)	15	(6.0)
Greece	473	(3.2)	470	(4.0)	467	(3.1)	-7	(4.9)	-3	(5.3)
Turkey	424	(3.8)	454	(3.6)	463	(3.9)	40	(5.8)	10	(5.5)
Bulgaria	434	(6.1)	439	(5.9)	446	(4.8)	12	(8.0)	7	(7.7)
Chile	438	(4.3)	447	(2.9)	445	(2.9)	7	(5.5)	-3	(4.3)
Serbia	436	(3.0)	443	(2.4)	445	(3.4)	9	(4.9)	2	(4.4)
Thailand	421	(2.1)	425	(3.0)	444	(2.9)	23	(4.1)	19	(4.4)
UAE	m		429	(3.3)	439	(3.8)	m		10	(5.2)
Romania	418	(4.2)	428	(3.4)	439	(3.3)	20	(5.6)	11	(4.9)
Costa Rica	m		430	(2.8)	429	(2.9)	m		-1	(4.3)
Kazakhstan	m		400	(3.1)	425	(3.0)	m		24	(4.5)
Malaysia	m		422	(2.7)	420	(3.0)	m		-3	(4.3)
Uruguay	428	(2.7)	427	(2.6)	416	(2.8)	-12	(4.3)	-11	(4.0)
Mexico	410	(2.7)	416	(1.8)	415	(1.3)	5	(3.5)	-1	(2.6)
Montenegro	412	(1.1)	401	(2.0)	410	(1.1)	-2	(2.4)	9	(2.7)
Jordan	422	(2.8)	415	(3.5)	409	(3.1)	-13	(4.6)	-6	(4.9)
Argentina	391	(6.1)	401	(4.6)	406	(3.9)	14	(7.5)	5	(6.2)
Brazil	390	(2.8)	405	(2.4)	405	(2.1)	14	(4.0)	-1	(3.5)
Colombia	388	(3.4)	402	(3.6)	399	(3.1)	11	(4.9)	-3	(5.0)
Tunisia	386	(3.0)	401	(2.7)	398	(3.5)	13	(4.9)	-3	(4.6)
Albania	m		391	(3.9)	397	(2.4)	m		7	(4.8)
Qatar	349	(0.9)	379	(0.9)	384	(0.7)	34	(2.2)	4	(1.8)
Indonesia	393	(5.7)	383	(3.8)	382	(3.8)	-12	(7.1)	-1	(5.6)
Peru	m		369	(3.5)	373	(3.6)	m		4	(5.2)

Notes: m – country did not participate in the respective study cycle.

Figures 4.1. and 4.2. show the change in proportion of students at the lower science proficiency levels (level 1 and below) and the highest levels (level 5 and above) in 2012 compared to 2006. As in mathematics, in sciences also the proportion of students with very low performance has decreased in Latvia, while the proportion of students with very high achievements has remained the same.

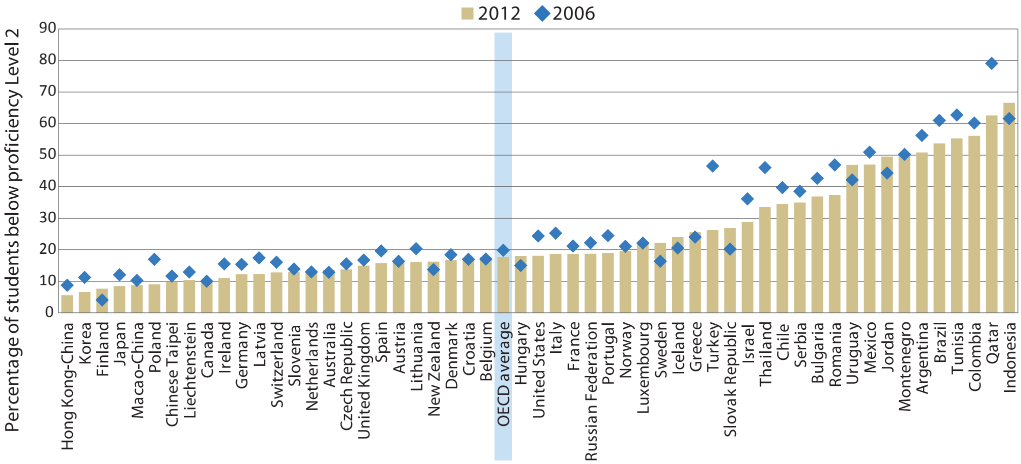


Figure 4.1 ***Percentage of low-performing students in science in 2006 and 2012 (OECD, 2014 d, p. 237)***

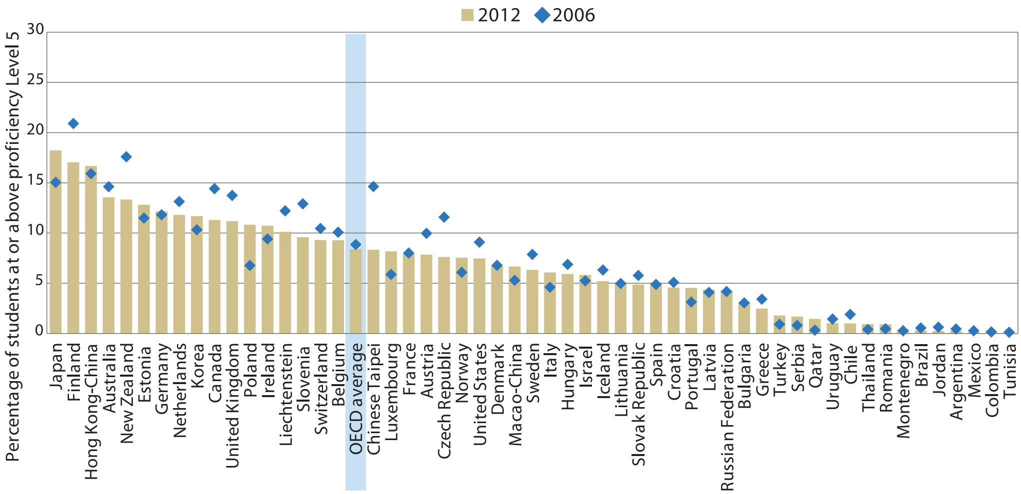


Figure 4.2 ***Percentage of top performers in science in 2006 and 2012 (OECD, 2014 d, p. 237)***

Table 4.7 shows the average performance of students from the 25 European Union countries in science literacy in the years 2006, 2009 and 2012. Invariably, the highest performance is demonstrated by the Finnish and Estonian students, the lowest – by the Greek, Bulgarian and Romanian students.

Table 4.7 Average performance of European Union students in science literacy, 2006, 2009 and 2012

Country	Average in 2006	Country	Average in 2009	Country	Average in 2012
Finland	563	Finland	554	Finland	545
Estonia	531	Estonia	528	Estonia	541
Netherlands	525	Netherlands	522	Poland	526
Slovenia	519	Germany	520	Germany	524
Germany	516	Great Britain	514	Netherlands	522
Great Britain	515	Slovenia	512	Ireland	522
Czech Republic	513	Poland	508	Great Britain	514
Austria	511	Ireland	508	Slovenia	514
Belgium	510	Belgium	507	Czech Republic	508
Ireland	508	Hungary	503	Austria	506
Hungary	504	Czech Republic	500	Belgium	505
Sweden	503	Denmark	499	Latvia	502
Poland	498	France	498	France	499
Denmark	496	Sweden	495	Denmark	498
France	495	Latvia	494	Lithuania	496
Latvia	490	Austria	494	Spain	496
Lithuania	488	Portugal	493	Hungary	494
Slovakia	488	Lithuania	491	Italy	494
Spain	488	Slovakia	490	Luxembourg	491
Luxembourg	486	Italy	489	Portugal	489
Italy	475	Spain	488	Sweden	485
Portugal	474	Luxembourg	484	Slovakia	471
Greece	473	Greece	470	Greece	467
Bulgaria	434	Bulgaria	439	Bulgaria	446
Romania	418	Romania	428	Romania	439
EU countries' average	497	EU countries' average	497	EU countries' average	500

Latvian student performance slowly but surely improves, in 2012 it already was a little (not statistically significantly) above the EU average performance. In ranking, Latvia has risen by three points, surpassing France, Denmark, Hungary and Sweden, but not Austria.

Summary

The study defines scientific literacy as an individual's scientific knowledge and use of that knowledge to identify questions, acquire new knowledge, to explain scientific phenomena and to draw evidence-based conclusions about science-related issues. Scientific literacy includes both knowledge of science and knowledge about science. Scientific literacy is expressed in score points or in six proficiency levels.

Science items are multifaceted; they cover a variety of life and scientific aspects. Five different areas of application are used therein (health, natural resources, environment, hazard, frontiers of science and technology) associated with the three main contexts – personal, social and global. The science content is divided into four areas: physical systems, living systems, earth and space systems, technology systems. To solve the science items, students must be able to identify scientific problems, to explain phenomena scientifically, as well as to perform scientific verification.

The average science performance shown by students in various countries ranges from 580 to 373 points. Shanghai (China) students' performance is statistically significantly higher than that of all other participating countries. With a relatively large difference in performance follows Hong Kong (China), Singapore, Japan. The highest performance among the European countries is shown by Finnish, Estonian and Polish students. Statistically significantly above the OECD average is the performance of the students of Liechtenstein, German, the Netherlands, Irelands, Switzerland, Slovenia, Great Britain, Czech Republic and Belgium. Latvia, along with Austria, France, Denmark and the United States forms the group of five countries where the average performance is no different from the OECD countries' average performance of students. Very low student performance in science is observed in Peru, Indonesia, Qatar, Tunisia and Albania. From the European countries, the lowest performance is that of the Albanian and Montenegrin students. Slightly better performance is shown by the students in Cyprus, Romania, Serbia and Bulgaria.

The average science proficiency of Latvian students does not statistically significantly differ from the OECD average performance, which is a very good achievement of our education system. However, the comparison of proficiency groups shows that Latvia has too few students whose proficiency corresponds to the highest level of performance, so, in this respect, our education system is in need of significant improvements.

The greatest increase in the science proficiency since 2006 has been observed in Turkey, Qatar, Romania and Thailand, however, these countries still have a long way to go to the medium and high performance. Among the countries with relatively high performance, a significant improvement has been observed in Poland, Italy, Korea, Japan and Latvia. Performance has declined in the European countries with a relatively high level of education – Finland, Hungary, Sweden, Slovakia, Iceland. In 2006, Latvian student performance in science was lower than the Swedish students' performance, in 2009 – the same, whereas in 2012 – statistically significantly higher.

Looking at the average performance in science literacy shown by 25 European Union countries' students in 2006, 2009 and 2012, it should be noted that invariably the highest performance is shown by the Finnish and Estonian pupils, the lowest – by the Greek, Bulgarian and Romanian students. Latvian student performance is improving, in 2012 it was already a little (not statistically significantly) above the EU average performance. In ranking, Latvia has risen by three places, surpassing France, Denmark, Hungary and Sweden, but not Austria.

5. READING LITERACY OF STUDENTS

5.1. Definition of reading literacy and its proficiency levels

What do fifteen year old students around the world know and are able to do as readers – are they able to find the written texts they require, to interpret and use information, to critically analyse it, based on their personal experience and understanding? Do they read different kinds of texts for different purposes and in different contexts or interests, or for any particular purpose? The goal of PISA reading competency assessment is to provide answers to these and other questions.

Regarding the multilateral aspects of life related to reading literacy, as well as the PISA goal – to assess how well the education system prepares young people for life, – a reading competency evaluation concept has been developed and improved in PISA. PISA reading literacy assessment is intended to explore, when people read written texts in different forms, their objectives when choosing the texts for reading – from functional and limited, like finding a certain piece of information, to more extensive – to read in order to learn and understand, or, in other words, to do, to think and to be.

Reading literacy covers a wide range of cognitive skills – from recognition of a written text, knowledge of words, grammar, language and text structure, to the knowledge of the world in its entirety. It also includes meta-cognitive skills – using a variety of appropriate strategies in the work with a text. PISA characterises reading literacy as an active, purposeful and functional use of reading in different situations and for different purposes.

In PISA 2009, reading literacy was defined as understanding, using, reflecting on and engaging with written texts, in order to achieve one's goals, to develop one's knowledge and potential, and to participate in society (OECD, 2010a). Reading literacy involves reading of various types of related text (for example, description, narration, interpretation, argumentation, instruction) and variously structured documents (such as forms, advertisements, tables, diagrams).

Table 5.1 Levels of proficiency in reading (OECD, 2010a)

Level (lower score limit)	What students can typically do
Level 6 (698 points)	Tasks at this level typically require the reader to make multiple inferences, comparisons and contrasts that are both detailed and precise. They require demonstration of a full and detailed understanding of one or more texts and may involve integrating information from more than one text. Tasks may require the reader to deal with unfamiliar ideas, in the presence of prominent competing information, and to generate abstract categories for interpretations. Reflect and evaluate tasks may require the reader to hypothesise about or critically evaluate a complex text on an unfamiliar topic, taking into account multiple criteria or perspectives, and applying sophisticated understandings from beyond the text. A salient condition for access and retrieve tasks at this level is precision of analysis and fine attention to detail that is inconspicuous in the texts.
Level 5 (626 points)	Tasks at this level that involve retrieving information require the reader to locate and organise several pieces of deeply embedded information, inferring which information in the text is relevant. Reflective tasks require critical evaluation or hypothesis, drawing on specialised knowledge. Both interpretative and reflective tasks require a full and detailed understanding of a text whose content or form is unfamiliar. For all aspects of reading, tasks at this level typically involve dealing with concepts that are contrary to expectations.
Level 4 (553 points)	Tasks at this level that involve retrieving information require the reader to locate and organise several pieces of embedded information. Some tasks at this level require interpreting the meaning of nuances of language in a section of text by taking into account the text as a whole. Other interpretative tasks require understanding and applying categories in an unfamiliar context. Reflective tasks at this level require readers to use formal or public knowledge to hypothesise about or critically evaluate a text. Readers must demonstrate an accurate understanding of long or complex texts whose content or form may be unfamiliar.
Level 3 (480 points)	Tasks at this level require the reader to locate, and in some cases recognise the relationship between, several pieces of information that must meet multiple conditions. Interpretative tasks at this level require the reader to integrate several parts of a text in order to identify a main idea, understand a relationship or construe the meaning of a word or phrase. They need to take into account many features in comparing, contrasting or categorising. Often the required information is not prominent or there is much competing information; or there are other obstacles in the text, such as ideas that are contrary to expectation or negatively worded. Reflective tasks at this level may require connections, comparisons, and explanations, or they may require the reader to evaluate a feature of the text. Some reflective tasks require readers to demonstrate a fine understanding of the text in relation to familiar, everyday knowledge. Other tasks do not require detailed text comprehension but require the reader to draw on less common knowledge.

Level (lower score limit)	What students can typically do
Level 2 (407 points)	Some tasks at this level require the reader to locate one or more pieces of information, which may need to be inferred and may need to meet several conditions. Others require recognising the main idea in a text, understanding relationships, or construing meaning within a limited part of the text when the information is not prominent and the reader must make low level inferences. Tasks at this level may involve comparisons or contrasts based on a single feature in the text. Typical reflective tasks at this level require readers to make a comparison or several connections between the text and outside knowledge, by drawing on personal experience and attitudes.
Level 1.a (335 points)	Tasks at this level require the reader to locate one or more independent pieces of explicitly stated information; to recognise the main theme or author's purpose in a text about a familiar topic; or to make a simple connection between information in the text and common, everyday knowledge. Typically, the required information in the text is prominent and there is little, if any, competing information. The reader is explicitly directed to consider relevant factors in the task and in the text.
Level 1.b (262 points)	Tasks at this level require the reader to locate a single piece of explicitly stated information in a prominent position in a short, syntactically simple text with a familiar context and text type, such as a narrative or a simple list. The text typically provides support to the reader, such as repetition of information, pictures or familiar symbols. There is minimal competing information. In tasks requiring interpretation the reader may need to make simple connections between adjacent pieces of information.

Reading literacy means not only the ability to grasp the superficial meaning of the text, but also the ability to understand and appreciate the author's skill, and the capacity to express one's views about the text. The reader must understand the text structure and genre and be able to

- to follow the author's judgments,
- to compare and contrast the information contained in the text,
- to draw conclusions,
- to analyse the evidence in the text according to one's personal opinion,
- to see and understand the irony, metaphors and humour,
- to discern linguistic nuances,
- to recognize the text construction forms that serve for persuading and influencing the readers,
- to associate the read material with one's experience and knowledge.

Student performance in reading literacy can be viewed in two ways – in points and in proficiency levels. In points, a scale is used, where the average reading performance of all OECD countries in the research conducted in 2000 equals 500 and the standard deviation 100. In the light of the cognitive content of individual items and literacy point scale, reading proficiency was grouped into seven levels – the highest – level 6, the lowest – level 1b.

The description of the reading competency levels on the single scale of reading is provided in Table 5.1.

5.2. Types of PISA 2012 reading literacy items

Elements of reading literacy assessment

The PISA reading literacy assessment is built on three major item characteristics: situation – the range of broad contexts or purposes for which reading takes place; text – the range of material that is read; and aspect – the cognitive approach that determines how readers engage with a text. Text authors have used all of these elements to draw up the reading literacy items. Some of these elements are used to form the basis of reading literacy assessment scale.

Characterisation of text

PISA tests are classified according to the medium in which they are prepared, the environment, which determines whether the reader can change the content of the particular text version's content (only electronic texts), by text format and type. Since the Latvian students performed only the printed (paper) tests, the scoring elements of electronic texts will not be discussed.

The results of PISA 2000 reading literacy assessment showed that there were countries with different average student performance depending on the text format – continuous or non-continuous, and the boys' and girls' average performance differed less in the subscale of non-continuous texts. These results and their impact on education policy determined the decision to include the text format subscale in PISA 2009.

A continuous text usually consists of sentences, which are arranged in paragraphs. They can form broader structures like a section, chapter or book. Continuous text examples are: a newspaper article, essay, story, report and letter. A non-continuous text differs from the continuous text both by its structure and according to the manner of reading. The smallest unit of the continuous text is a sentence, while the non-continuous text consists of several lists. Some of these can be simple, others can form combinations of simple lists. The examples of non-continuous texts are lists, tables, graphs, diagrams, instructions, catalogues, maps, etc.

Reading of both the continuous and non-continuous text requires knowledge of the respective text structure and functions, as well as a specific reading strategy. In everyday life, the reader often must use both knowledge and strategies to integrate the information included in the text of a different format. To test these reader's skills, the test also included mixed and multiple format texts.

The mixed text is defined as containing elements of both continuous and non-continuous formats. To form a good mixed text (for example, a prose text with a table or graph), the components should be mutually consistent and relevant at the local and global level. Mixed texts are found in reference books, magazine articles, reviews and reports, where the author has used a variety of data display types.

Multiple texts comprise several discrete parts that are juxtaposed for a particular occasion, according to content, they may be related or unrelated, they can complement each other, or, on the contrary, – contradict other passages. Individual passages can be in both continuous and non-continuous text format.

Text type

All texts in PISA are classified by text type according to the main rhetorical purpose of the text. This ensures that the assessment includes a range of texts representing different types of reading. It is not conceived of as a variable that influences the difficulty of an item. Text types included in the reading tests have been classified into six categories:

- Description – characterizes the features of the objects in the space and usually provides an answer to the question "who?" (e.g., description of a location in a journal of a trip, offer of goods in a catalogue, user's manual, etc.)
- Narration – characterizes objects' properties in time and generally provides an answer to the question "when" or "in what sequence?" (e.g., novel, short story, play, biography, report in a newspaper, etc.)
- Exposition – provides information on a variety of single or complex concepts or elements in which these concepts and their interaction can be analysed and usually provides an answer to the question "how?" (e.g., essays, summaries, graphs showing the development trend of a phenomenon, minutes of a meeting, entries of encyclopaedia, etc.)
- Argumentation – shows the mutual relations between different concepts or suggestions, usually provides an answer to the question "why?" (e.g., commentaries, scientific substantiations, letters, posters, advertisements, etc.)

- Instruction – provides guidance on what to do in order to successfully carry out a specific task (e.g., laws, rules, statutes, recipes, etc.)
- Transaction – exchange of information by interacting with a reader (e.g., letters, invitations, surveys, interviews, etc.).

Aspects of assessment

The aspect of the text is the second most important element in preparing PISA reading items. It helps assess the student's ability to use a variety of strategies and techniques, to set goals when working with a text. Reading items have been used in three aspects, which are also the basis of reading literacy evaluation subscales:

- access and retrieve information,
- integrate and interpret information,
- reflect upon and evaluate information.

Both printed and electronic texts of the items devoted to the information gathering aspect require the skills to find, select and store information. In daily life, the reader often needs specific information, such as to find a phone number, check the train or the bus departure time or establish a particular fact to prove or negate some assumption. Sometimes, if the required information is directly and clearly indicated in the text, it is relatively easy to find. However, the information gathering aspect items are not always easy, one sometimes has to find more than one piece of information or some knowledge of text structure and functions may be needed. When reading printed texts, the reader, in order to find the part of the text that contains the information he is seeking, may be required to use navigation tools, such as titles, captions to images, or tables.

The items devoted to the integrating and interpreting aspect are related to expanding the original text comprehension. In order to integrate a text, the reader must understand the interrelationships between the different parts of the text. These relationships may include problem-solving, causes and effects, equivalence or opposites. To perform this task, the reader must determine, what kind of relationship this is. It can be easily seen if, for example, it is stated that "Y is caused by X", or if the reader must draw his own conclusions. Parts of the text, which are mutually connected, can be located next to each other, in different chapters of the text or even in different texts. Interpretation is related to understanding of something that has not been defined before. It can also be associated with recognising a more complex relationship or the need to draw conclusions about the associations perceived in a phrase or a sentence.

Items of reflecting and evaluation are related to knowledge, ideas and values outside the text. In assessing the text and reflecting on it, the reader forms a judgment about the text and associates the read material with his previous experience or knowledge of the outside world. Reflecting upon and evaluating the content of the text, the reader should also use the knowledge gained from other sources, develop an understanding of what is said directly and indirectly in the text, and, additionally, using the knowledge about the structure of the text, a variety of text types and styles, provide an objective evaluation of its quality and suitability.

The previously defined three aspects are quite extensive, and they should be seen as interrelated and interdependent rather than as completely separate and independent of each other. From a cognitive point of view, they can be seen as partly hierarchical: it is impossible to integrate or interpret the information, if it has not been previously obtained, and it is impossible to reflect on the information and evaluate it, if you cannot access and interpret it in various ways. Each PISA item, however, is intended to emphasize one or the other aspect, and the classification of appropriate aspect of every reading item is determined by its goal.

Reading situations

Four reading situations are distinguished in PISA framework:

- personal,
- public,
- occupational,
- educational.

The situations are used to select texts and reading item relation to the context and the text author's intended purpose. Choosing the texts for different reading situations, a most varied content is achieved in reading items of the test. The reading situations can be perceived as a general categorization of texts based on their imaginary usage. PISA reading situation definitions are not based simply on the location where reading takes place. For example, textbooks (educational reading) are read both at school and at home, and the reading process and the goal differ very little in these two environments, while the literary texts, which are also read at school, are usually read for personal purposes.

Reading for personal purposes is related to the choice of texts satisfying the individual's personal, practical and intellectual interests, as well as maintaining or developing personal connections with other people, such as personal letters. Reading for personal purposes is also associated with fiction, biography and informative articles to satisfy one's curiosity and provide relaxation.

Reading for public purposes is focussed on participation in the wider community's activities. It also includes reading of official documents and informative reports (about current affairs). These texts are often associated with more or less anonymous contacts.

Reading for educational purposes or reading in order to learn something is closely linked with texts aimed at teaching. Textbooks are a typical example of such texts. Reading for education is usually associated with the acquisition of information as a part of a larger task. In this situation, the reading material is determined by the teacher rather than chosen by students themselves.

Reading for occupational purposes or reading for work, to accomplish something professionally, is focussed on the texts associated with a job or an immediate task. Such texts can help the reader in search of employment, e.g., reading advertisements in newspapers.

Response formats of reading literacy items

PISA 2009 tests include reading literacy items, which have been developed, taking into account all the elements described above: text, aspect and situation. Each test item is unique in terms of its content, the required skills and sphere of knowledge. The item content is disclosed in stimulating material, which is usually a fragment of a text. The text can also include tables, diagrams, photographs, schemes. Each item of this kind has several questions (131 reading literacy items in total), and to respond to these questions the students must use the respective knowledge and skills.

Similarly to the previous PISA cycles, PISA 2009 also employed different response formats of reading literacy items:

- open constructed-response items – a student must write an answer and indicate or explain the procedure of solution or substantiation of the item;
- short response items – a student must write an answer (usually a figure or a word) without an explanation;
- multiple-choice items – a student must select the correct answer from the list of options;
- complex multiple-choice items – a student must choose the correct answer from the list of optional answers offered for several questions of the item.

The uniform design of the tests (the test booklets in the previous PISA cycles were made according to the same principles) helps establish a single reading literacy scale, where each item is linked to a point on the scale, indicating the item difficulty level in points, and a point assigned on this scale is also consistent with each student's performance that characterizes the assessment of student's reading proficiency.

The relative degree of test item difficulty is calculated in accordance with the proportion of test participants, who have completed these items correctly. The student's individual proficiency level in a separate test is calculated by taking into account the proportion of correctly solved items. A single continuous scale shows the correlations between the difficulty of the item and the student's performance in points. By creating a scale that represents the degree of each item's difficulty, a corresponding proficiency level for each item can be specified. In turn, indicating each student's performance on the same scale, it is possible to describe the level of reading literacy achieved by the student.

5.3. Example of PISA 2012 reading literacy item

TELECOMMUTING

THE WAY OF THE FUTURE

Just imagine how wonderful it would be to "telecommute"[1] to work on the electronic highway, with all your work done on a computer or by phone! No longer would you have to jam your body into crowded buses or trains or waste hours and hours travelling to and from work. You could work wherever you want to – just think of all the job opportunities this would open up!

Molly

DISASTER IN THE MAKING

Cutting down on commuting hours and reducing the energy consumption involved is obviously a good idea. But such a goal should be accomplished by improving public transportation or by ensuring that workplaces are located near where people live. The ambitious idea that telecommuting should be part of everyone's way of life will only lead people to become more and more self-absorbed. Do we really want our sense of being part of a community to deteriorate even further?

Richard

Use "Telecommuting" above to answer the questions that follow.

1 "Telecommuting" is a term coined by Jack Nilles in the early 1970s to describe a situation in which workers work on a computer away from a central office (for example, at home) and transmit data and documents to the central office via telephone lines.

What is one kind of work for which it would be difficult to telecommute? Give a reason for your answer.

....

....

Telecommuting scoring

Question intent:

Reflect and evaluate: Reflect on and evaluate the content of a text. Use prior knowledge to generate an example that fits a category described in a text

Correct answer: Identifies a kind of work and gives a plausible explanation as to why a person who does that kind of work could not telecommute. Responses MUST indicate (explicitly or implicitly) that it is necessary to be physically present for the specific work.

- Building. It's hard to work with the wood and bricks from just anywhere.
- Sportsperson. You need to really be there to play the sport.
- Plumber. You can't fix someone else's sink from your home!
- Digging ditches because you need to be there.
- Nursing – it's hard to check if patients are ok over the Internet.

5.4. Performance of Latvian students in reading literacy: international comparison

Table 5.2 shows the average performance of the participating countries' students in points and the comparison of these figures. The highest performance is achieved by East Asian students from Shanghai (China), Hong Kong (China), Singapore, Japan, Korea and Taiwan (China). Among the European countries, the highest performance is shown by the students from Finland, Ireland, Poland and Estonia. The Latvian students' performance in reading – 489 points – is slightly below the OECD average (496 points). However, this difference is statistically significant. Our students' performance is statistically significantly different from the performance of the Czech, Italian, Austrian, Hungarian, Spanish, Luxembourg, Portuguese, Israeli, Croatian and Swedish students. Our students do better than our neighbours – the Lithuanian and Russian students. The lowest performance in Europe is shown by the students from Bulgaria, Romania and Montenegro.

Table 5.2 Comparison of student performance in reading literacy in various countries (OECD, 2014d, p. 177)

Mean score	Comparison country/ economy	Countries/economies whose mean score is NOT statistically significantly different from that comparison country's/economy's score
570	Shanghai (China)	
545	Hong Kong (China)	Singapore, Japan, Korea
542	Singapore	Hong Kong (China), Japan, Korea
538	Japan	Hong Kong (China), Singapore, Korea
536	Korea	Hong Kong (China), Singapore, Japan
524	Finland	Ireland, Taiwan (China), Canada, Poland, Liechtenstein
523	Ireland	Finland, Taiwan (China), Canada, Poland, Liechtenstein
523	Taiwan (China)	Finland, Ireland, Canada, Poland, Estonia, Liechtenstein
523	Canada	Finland, Ireland, Taiwan (China), Poland, Liechtenstein
518	Poland	Finland, Ireland, Taiwan (China), Canada, Estonia, Liechtenstein, New Zealand, Australia, the Netherlands, Viet Nam
516	Estonia	Taiwan (China), Poland, Liechtenstein, New Zealand, Australia, the Netherlands, Viet Nam
516	Liechtenstein	Finland, Ireland, Taiwan (China), Canada, Poland, Estonia, New Zealand, Australia, the Netherlands, Belgium, Switzerland, Macao (China), Viet Nam, Germany
512	New Zealand	Poland, Estonia, Liechtenstein, Australia, the Netherlands, Belgium, Switzerland, Macao (China), Viet Nam, Germany, France
512	Australia	Poland, Estonia, Liechtenstein, New Zealand, the Netherlands, Belgium, Switzerland, Macao (China), Viet Nam, Germany, France
511	The Netherlands	Poland, Estonia, Liechtenstein, New Zealand, Australia, Belgium, Switzerland, Macao (China), Viet Nam, Germany, France, Norway
509	Belgium	Liechtenstein, New Zealand, Australia, the Netherlands, Switzerland, Macao (China), Viet Nam, Germany, France, Norway
509	Switzerland	Liechtenstein, New Zealand, Australia, the Netherlands, Belgium, Macao (China), Viet Nam, Germany, France, Norway
509	Macao (China)	Liechtenstein, New Zealand, Australia, the Netherlands, Belgium, Switzerland, Viet Nam, Germany, France, Norway
508	Viet Nam	Poland, Estonia, Liechtenstein, New Zealand, Australia, the Netherlands, Belgium, Switzerland, Macao (China), Germany, France, Norway, United Kingdom, USA
508	Germany	Liechtenstein, New Zealand, Australia, the Netherlands, Belgium, Switzerland, Macao (China), Viet Nam, France, Norway, United Kingdom
505	France	New Zealand, Australia, the Netherlands, Belgium, Switzerland, Macao (China), Viet Nam, Germany, Norway, United Kingdom, USA

Mean score	Comparison country/ economy	Countries/economies whose mean score is NOT statistically significantly different from that comparison country's/economy's score
504	Norway	Netherlands, Belgium, Switzerland, Macao (China), Viet Nam, Germany, France, UK, USA, Denmark
499	Great Britain	Viet Nam, Germany, France, Norway, USA, Denmark, Czech Republic
498	USA	Viet Nam, France, Norway, United Kingdom, Denmark, Czech Republic, Italy, Austria, Hungary, Portugal, Israel
496	Denmark	Norway, United Kingdom, United States, Czech Republic, Italy, Austria, Hungary, Portugal, Israel
493	Czech Republic	United Kingdom, USA, Denmark, Italy, Austria, Latvia, Hungary, Spain, Luxembourg, Portugal, Israel, Croatia
490	Italy	USA, Denmark, Czech Republic, Austria, Latvia, Hungary, Spain, Luxembourg, Portugal, Israel, Croatia, Sweden
490	Austria	USA, Denmark, Czech Republic, Italy, Latvia, Hungary, Spain, Luxembourg, Portugal, Israel, Croatia, Sweden
489	Latvia	Czech Republic, Italy, Austria, Hungary, Spain, Luxembourg, Portugal, Israel, Croatia, Sweden
488	Hungary	USA, Denmark, Czech Republic, Italy, Austria, Latvia, Spain, Luxembourg, Portugal, Israel, Croatia, Sweden, Iceland
488	Spain	Czech Republic, Italy, Austria, Latvia, Hungary, Luxembourg, Portugal, Israel, Croatia, Sweden
488	Luxembourg	Czech Republic, Italy, Austria, Latvia, Hungary, Spain, Portugal, Israel, Croatia, Sweden
488	Portugal	USA, Denmark, Czech Republic, Italy, Austria, Latvia, Hungary, Spain, Luxembourg, Israel, Croatia, Sweden, Iceland, Slovenia
486	Israel	USA, Denmark, Czech Republic, Italy, Austria, Latvia, Hungary, Spain, Luxembourg, Portugal, Croatia, Sweden, Iceland, Slovenia, Lithuania, Greece, Turkey, Russia
485	Croatia	Czech Republic, Italy, Austria, Latvia, Hungary, Spain, Luxembourg, Portugal, Israel, Sweden, Iceland, Slovenia, Lithuania, Greece, Turkey
483	Sweden	Italy, Austria, Latvia, Hungary, Spain, Luxembourg, Portugal, Israel, Croatia, Iceland, Slovenia, Lithuania, Greece, Turkey, Russia
483	Iceland	Hungary, Portugal, Israel, Croatia, Sweden, Slovenia, Lithuania, Greece, Turkey
481	Slovenia	Portugal, Israel, Croatia, Sweden, Iceland, Lithuania, Greece, Turkey, Russia
477	Lithuania	Israel, Croatia, Sweden, Iceland, Slovenia, Greece, Turkey, Russia
477	Greece	Israel, Croatia, Sweden, Iceland, Slovenia, Lithuania, Turkey, Russia
475	Turkey	Israel, Croatia, Sweden, Iceland, Slovenia, Lithuania, Greece, Russia
475	Russia	Israel, Sweden, Slovenia, Lithuania, Greece, Turkey
463	Slovakia	
449	Cyprus	Serbia

Mean score	Comparison country/ economy	Countries/economies whose mean score is NOT statistically significantly different from that comparison country's/economy's score
446	Serbia	Cyprus, United Arab Emirates, Chile, Thailand, Costa Rica, Romania, Bulgaria
442	UAE	Serbia, Chile, Thailand, Costa Rica, Romania, Bulgaria
441	Chile	Serbia, United Arab Emirates, Thailand, Costa Rica, Romania, Bulgaria
441	Thailand	Serbia, United Arab Emirates, Chile, Costa Rica, Romania, Bulgaria
441	Costa Rica	Serbia, United Arab Emirates, Chile, Thailand, Romania, Bulgaria
438	Romania	Serbia, United Arab Emirates, Chile, Thailand, Costa Rica, Bulgaria
436	Bulgaria	Serbia, United Arab Emirates, Chile, Thailand, Costa Rica, Romania
424	Mexico	Montenegro
422	Montenegro	Mexico
411	Uruguay	Brazil, Tunisia, Colombia
410	Brazil	Uruguay, Tunisia, Colombia
404	Tunisia	Uruguay, Brazil, Colombia, Jordan, Malaysia, Indonesia, Argentina, Albania
403	Columbia	Uruguay, Brazil, Tunisia, Jordan, Malaysia, Indonesia, Argentina
399	Jordan	Tunisia, Colombia, Malaysia, Indonesia, Argentina, Albania, Kazakhstan
398	Malaysia	Tunisia, Colombia, Jordan, Indonesia, Argentina, Albania, Kazakhstan
396	Indonesia	Tunisia, Colombia, Jordan, Malaysia, Argentina, Albania, Kazakhstan
396	Argentina	Tunisia, Colombia, Jordan, Malaysia, Indonesia, Albania, Kazakhstan
394	Albania	Tunisia, Jordan, Malaysia, Indonesia, Argentina, Kazakhstan, Qatar, Peru
393	Kazakhstan	Jordan, Malaysia, Indonesia, Argentina, Albania, Qatar, Peru
388	Qatar	Albania, Kazakhstan, Peru
384	Peru	Albania, Kazakhstan, Qatar
	Average performance of students is statistically significantly above the OECD average.	
	Average performance of students is not statistically significantly different from the OECD average – 496 points.	
	Average performance of students is statistically significantly below the OECD average.	

Table 5.3 shows the distribution of reading proficiency levels in all participating countries of the study. The information in the table is arranged according to the number of students at the highest – level 6. Similarly to mathematics and science, the proportion of Latvian students at the highest level is very small – 0.3%.

The following example can serve for comparison – if there is a large school with 1000 students, only three of them will reach the highest level of performance. If in Latvia in one class group, for example, in all the 9th grades, there are about 20 000 students in total, only 60 of them will achieve the highest level of performance. It is far from enough to provide the country with highly professional doctors, scientists, politicians and businessmen.

Table 5.3 Percentage of students at each level of reading proficiency (OECD, 2014d, p. 375)

	Below level 1b	Level 1b	Level 1a	Level 2	Level 3	Level 4	Level 5	Level 6
Singapore	0.5	1.9	7.5	16.7	25.4	26.8	16.2	5.0
Japan	0.6	2.4	6.7	16.6	26.7	28.4	14.6	3.9
Shanghai (China)	0.1	0.3	2.5	11.0	25.3	35.7	21.3	3.8
New Zealand	1.3	4.0	11.0	20.8	26.3	22.7	10.9	3.0
France	2.1	4.9	11.9	18.9	26.3	23.0	10.6	2.3
Finland	0.7	2.4	8.2	19.1	29.3	26.8	11.3	2.2
Canada	0.5	2.4	8.0	19.4	31.0	25.8	10.8	2.1
Australia	0.9	3.1	10.2	21.6	29.1	23.3	9.8	1.9
Hong King (China)	0.2	1.3	5.3	14.3	29.2	32.9	14.9	1.9
Norway	1.7	3.7	10.8	21.9	29.4	22.3	8.5	1.7
Belgium	1.6	4.1	10.5	20.2	27.3	24.0	10.7	1.6
Korea	0.4	1.7	5.5	16.4	30.8	31.0	12.6	1.6
Israel	3.8	6.9	12.9	20.8	25.3	20.6	8.1	1.5
Taiwan (China)	0.6	2.5	8.4	18.1	29.9	28.7	10.4	1.4
Luxembourg	2.0	6.3	13.8	23.4	25.8	19.7	7.5	1.4
Poland	0.3	2.1	8.1	21.4	32.0	26.0	8.6	1.4
Ireland	0.3	1.9	7.5	19.6	33.4	26.0	10.1	1.3
Great Britain	1.5	4.0	11.2	23.5	29.9	21.3	7.5	1.3
Sweden	2.9	6.0	13.9	23.5	27.3	18.6	6.7	1.2
OECD average	1.3	4.4	12.3	23.5	29.1	21.0	7.3	1.1
USA	0.8	3.6	12.3	24.9	30.5	20.1	6.9	1.0
Switzerland	0.5	2.9	10.3	21.9	31.5	23.8	8.2	1.0
Estonia	0.2	1.3	7.7	22.7	35.0	24.9	7.5	0.9

	Below level 1b	Level 1b	Level 1a	Level 2	Level 3	Level 4	Level 5	Level 6
Czech Republic	0.6	3.5	12.7	26.4	31.3	19.4	5.3	0.8
The Netherlands	0.9	2.8	10.3	21.0	29.2	26.1	9.0	0.8
Germany	0.5	3.3	10.7	22.1	29.9	24.6	8.3	0.7
Italy	1.6	5.2	12.7	23.7	29.7	20.5	6.1	0.6
Liechtenstein	0.0	1.9	10.5	22.4	28.6	25.7	10.4	0.6
Macao (China)	0.3	2.1	9.0	23.3	34.3	24.0	6.4	0.6
Iceland	2.3	5.4	13.3	24.7	29.9	18.6	5.2	0.6
Bulgaria	8.0	12.8	18.6	22.2	21.4	12.7	3.8	0.5
Cyprus	6.1	9.7	17.0	25.1	24.9	13.2	3.5	0.5
Spain	1.3	4.4	12.6	25.8	31.2	19.2	5.0	0.5
Greece	2.6	5.9	14.2	25.1	30.0	17.2	4.6	0.5
Portugal	1.3	5.1	12.3	25.5	30.2	19.7	5.3	0.5
Russia	1.1	5.2	16.0	29.5	28.3	15.3	4.2	0.5
Hungary	0.7	5.2	13.8	24.3	29.9	20.4	5.3	0.4
Viet Nam	0.1	1.5	7.8	23.7	39.0	23.4	4.2	0.4
Denmark	0.8	3.1	10.7	25.8	33.6	20.5	5.1	0.4
Slovenia	1.2	4.9	15.0	27.2	28.4	18.2	4.7	0.3
Austria	0.8	4.8	13.8	24.2	29.6	21.2	5.2	0.3
Slovakia	4.1	7.9	16.2	25.0	26.8	15.7	4.1	0.3
Latvia	0.7	3.7	12.6	26.7	33.1	19.1	3.9	0.3
Turkey	0.6	4.5	16.6	30.8	28.7	14.5	4.1	0.3
Croatia	0.7	4.0	13.9	27.8	31.2	17.8	4.2	0.2
Qatar	13.6	18.9	24.6	21.9	13.5	5.8	1.4	0.2
Serbia	2.6	9.3	21.3	30.8	23.3	10.5	2.0	0.2
UAE	3.3	10.4	21.8	28.6	24.0	9.7	2.1	0.2
Lithuania	1.0	4.6	15.6	28.1	31.1	16.3	3.1	0.2
Romania	2.5	10.3	24.4	30.6	21.8	8.7	1.5	0.1
Albania	12.0	15.9	24.4	24.7	15.9	5.9	1.1	0.1
Argentina	8.1	17.7	27.7	27.3	14.6	4.0	0.5	0.1
Thailand	1.2	7.7	24.1	36.0	23.5	6.7	0.8	0.1
Montenegro	4.4	13.2	25.7	29.2	19.9	6.6	0.9	0.0
Uruguay	6.4	14.7	25.9	28.9	17.4	5.7	0.9	0.0
Mexico	2.6	11.0	27.5	34.5	19.6	4.5	0.4	0.0

	Below level 1b	Level 1b	Level 1a	Level 2	Level 3	Level 4	Level 5	Level 6
Chile	1.0	8.1	23.9	35.1	24.3	6.9	0.6	0.0
Brazil	4.0	14.8	30.4	30.1	15.8	4.4	0.5	0.0
Peru	9.8	20.6	29.5	24.9	11.4	3.3	0.5	0.0
Costa Rica	0.8	7.3	24.3	38.1	22.9	6.0	0.6	0.0
Jordan	7.5	14.9	28.3	30.8	15.5	2.9	0.1	0.0
Tunisia	6.2	15.5	27.6	31.4	15.6	3.5	0.2	0.0
Colombia	5.0	15.4	31.0	30.5	14.5	3.2	0.3	0.0
Indonesia	4.1	16.3	34.8	31.6	11.5	1.5	0.1	0.0
Kazakhstan	4.2	17.3	35.6	31.3	10.4	1.2	0.0	0.0
Malaysia	5.8	16.4	30.5	31.0	13.6	2.5	0.1	0.0

Table 5.4 shows the PISA participating countries' student performance in reading literacy since 2000, as well as the changes registered over the period from 2000 to 2012 (i.e., since the beginning of the study), and between 2009 and 2012 (i.e., within the last cycle). Leaving aside the countries with very low performance, it is evident that the greatest performance increase since 2000 has taken place in Poland, Israel, Liechtenstein and Latvia. In case of Israel and Latvia, the relatively low performance in 2000 must be noted. The greatest decrease is experienced by the Northern European countries – Sweden, Iceland and the European leader in education – Finland. Looking at the changes since 2009, it is evident that the largest increase in performance has been achieved by Taiwan (China), Ireland, Macao (China), Thailand, Japan and Poland. The greatest decrease in performance – in Iceland, Slovakia, Sweden and Finland. The international community already relatively long ago noticed the decrease of Swedish students' average performance in international comparative studies (not only PISA), while Finland's drop in performance has not yet been devoted proper attention.

Table 5.4 Average performance in reading and its changes (countries arranged according to performance in 2012), (OECD, 2014d, p. 383, 384)

	Average in 2000		Average in 2003		Average in 2006		Average in 2009		Average in 2012		Changes between 2000 and 2012		Changes between 2009 and 2012	
Shanghai (China)	m		m		m		556	(2.4)	570	(2.9)	m		14	(4.1)

	Average in 2000		Average in 2003		Average in 2006		Average in 2009		Average in 2012		Changes between 2000 and 2012		Changes between 2009 and 2012	
Hong Kong (China)	525	(2.9)	510	(3.7)	536	(2.4)	533	(2.1)	545	(2.8)	19	(4.7)	11	(3.9)
Singapore	m		m		m		526	(1.1)	542	(1.4)	m		16	(2.4)
Japan	522	(5.2)	498	(3.9)	498	(3.6)	520	(3.5)	538	(3.7)	16	(6.8)	18	(5.3)
Korea	525	(2.4)	534	(3.1)	556	(3.8)	539	(3.5)	536	(3.9)	11	(5.2)	-3	(5.5)
Finland	546	(2.6)	543	(1.6)	547	(2.1)	536	(2.3)	524	(2.4)	-22	(4.3)	-12	(3.7)
Ireland	527	(3.2)	515	(2.6)	517	(3.5)	496	(3.0)	523	(2.6)	-3	(4.8)	28	(4.2)
Taiwan (China)	m		m		496	(3.4)	495	(2.6)	523	(3.0)	m		28	(4.3)
Canada	534	(1.6)	528	(1.7)	527	(2.4)	524	(1.5)	523	(1.9)	-11	(3.5)	-1	(2.9)
Poland	479	(4.5)	497	(2.9)	508	(2.8)	500	(2.6)	518	(3.1)	39	(6.0)	18	(4.4)
Estonia	m		m		501	(2.9)	501	(2.6)	516	(2.0)	m		15	(3.7)
Liechtenstein	483	(4.1)	525	(3.6)	510	(3.9)	499	(2.8)	516	(4.1)	33	(6.3)	16	(5.2)
New Zealand	529	(2.8)	522	(2.5)	521	(3.0)	521	(2.4)	512	(2.4)	-17	(4.4)	-9	(3.7)
Australia	528	(3.5)	525	(2.1)	513	(2.1)	515	(2.3)	512	(1.6)	-16	(4.6)	-3	(3.2)
The Netherlands	m		513	(2.9)	507	(2.9)	508	(5.1)	511	(3.5)	m		3	(6.4)
Belgium	507	(3.6)	507	(2.6)	501	(3.0)	506	(2.3)	509	(2.2)	2	(4.8)	3	(3.6)
Switzerland	494	(4.2)	499	(3.3)	499	(3.1)	501	(2.4)	509	(2.6)	15	(5.5)	9	(3.9)
Macao (China)	m		498	(2.2)	492	(1.1)	487	(0.9)	509	(0.9)	m		22	(2.1)
Germany	484	(2.5)	491	(3.4)	495	(4.4)	497	(2.7)	508	(2.8)	24	(4.5)	10	(4.2)
France	505	(2.7)	496	(2.7)	488	(4.1)	496	(3.4)	505	(2.8)	1	(4.6)	10	(4.7)
Norway	505	(2.8)	500	(2.8)	484	(3.2)	503	(2.6)	504	(3.2)	-1	(4.9)	1	(4.4)
Great Britain	m		m		495	(2.3)	494	(2.3)	499	(3.5)	m		5	(4.5)
OECD average	496	(0.7)	497	(0.6)	490	(0.7)	496	(0.5)	498	(0.6)	2	(1.0)	2	(0.9)

	Average in 2000		Average in 2003		Average in 2006		Average in 2009		Average in 2012		Changes between 2000 and 2012		Changes between 2009 and 2012	
USA	504	(7.0)	495	(3.2)	c		500	(3.7)	498	(3.7)	-7	(8.3)	-2	(5.5)
Denmark	497	(2.4)	492	(2.8)	494	(3.2)	495	(2.1)	496	(2.6)	-1	(4.3)	1	(3.7)
Czech Republic	492	(2.4)	489	(3.5)	483	(4.2)	478	(2.9)	493	(2.9)	1	(4.4)	15	(4.4)
Italy	487	(2.9)	476	(3.0)	469	(2.4)	486	(1.6)	490	(2.0)	2	(4.3)	4	(3.0)
Austria	507	(2.4)	491	(3.8)	490	(4.1)	m		490	(2.8)	-18	(4.4)	m	m
Latvia	458	(5.3)	491	(3.7)	479	(3.7)	484	(3.0)	489	(2.4)	31	(6.3)	5	(4.1)
Hungary	480	(4.0)	482	(2.5)	482	(3.3)	494	(3.2)	488	(3.2)	8	(5.6)	-6	(4.8)
Spain	493	(2.7)	481	(2.6)	461	(2.2)	481	(2.0)	488	(1.9)	-5	(4.1)	7	(3.2)
Luxembourg	m		479	(1.5)	479	(1.3)	472	(1.3)	488	(1.5)	m		16	(2.6)
Portugal	470	(4.5)	478	(3.7)	472	(3.6)	489	(3.1)	488	(3.8)	18	(6.4)	-2	(5.1)
Israel	452	(8.5)	m		439	(4.6)	474	(3.6)	486	(5.0)	34	(10.1)	12	(6.4)
Horvātija	m		m		477	(2.8)	476	(2.9)	485	(3.3)	m		9	(4.7)
Sweden	516	(2.2)	514	(2.4)	507	(3.4)	497	(2.9)	483	(3.0)	-33	(4.4)	-14	(4.5)
Iceland	507	(1.5)	492	(1.6)	484	(1.9)	500	(1.4)	483	(1.8)	-24	(3.4)	-18	(2.8)
Slovenia	m		m		494	(1.0)	483	(1.0)	481	(1.2)	m		-2	(2.3)
Lithuania	m		m		470	(3.0)	468	(2.4)	477	(2.5)	m		9	(3.8)
Greece	474	(5.0)	472	(4.1)	460	(4.0)	483	(4.3)	477	(3.3)	3	(6.4)	-6	(5.7)
Turkey	m		441	(5.8)	447	(4.2)	464	(3.5)	475	(4.2)	m		11	(5.7)
Russia	462	(4.2)	442	(3.9)	440	(4.3)	459	(3.3)	475	(3.0)	13	(5.7)	16	(4.8)
UAE	m		m		m		459	(1.1)	468	(1.3)	m		9	(2.4)
Slovakia	m		469	(3.1)	466	(3.1)	477	(2.5)	463	(4.2)	m		-15	(5.1)
Serbia	m		m		401	(3.5)	442	(2.4)	446	(3.4)	m		4	(4.5)

	Average in 2000		Average in 2003		Average in 2006		Average in 2009		Average in 2012		Changes between 2000 and 2012		Changes between 2009 and 2012	
Chile	410	(3.6)	m		442	(5.0)	449	(3.1)	441	(2.9)	32	(5.2)	-8	(4.6)
Taiwan	431	(3.2)	420	(2.8)	417	(2.6)	421	(2.6)	441	(3.1)	11	(5.1)	20	(4.4)
Costa Rica	m		m		m		443	(3.2)	441	(3.5)	m		-2	(5.0)
Romania	428	(3.5)	m		396	(4.7)	424	(4.1)	438	(4.0)	10	(5.8)	13	(5.9)
Bulgaria	430	(4.9)	m		402	(6.9)	429	(6.7)	436	(6.0)	6	(8.1)	7	(9.1)
UAE	m		m		m		423	(3.7)	432	(3.3)	m		9	(5.2)
Mexico	422	(3.3)	400	(4.1)	410	(3.1)	425	(2.0)	424	(1.5)	2	(4.4)	-2	(3.0)
Montenegro	m		m		392	(1.2)	408	(1.7)	422	(1.2)	m		15	(2.6)
Uruguay	m		434	(3.4)	413	(3.4)	426	(2.6)	411	(3.2)	m		-14	(4.4)
Brazil	396	(3.1)	403	(4.6)	393	(3.7)	412	(2.7)	410	(2.1)	14	(4.5)	-2	(3.8)
Tunisia	m		375	(2.8)	380	(4.0)	404	(2.9)	404	(4.5)	m		0	(5.6)
Colombia	m		m		385	(5.1)	413	(3.7)	403	(3.4)	m		-10	(5.3)
Jordan	m		m		401	(3.3)	405	(3.3)	399	(3.6)	m		-6	(5.1)
Malaysia	m		m		m		414	(2.9)	398	(3.3)	m		-16	(4.7)
Indonesia	371	(4.0)	382	(3.4)	393	(5.9)	402	(3.7)	396	(4.2)	26	(6.3)	-6	(5.9)
Argentina	418	(9.9)	m		374	(7.2)	398	(4.6)	396	(3.7)	-22	(10.8)	-2	(6.1)
Albania	349	(3.3)	m		m		385	(4.0)	394	(3.2)	45	(5.2)	9	(5.4)
Kazakhstan	m		m		m		390	(3.1)	393	(2.7)	m		2	(4.4)
Qatar	m		m		312	(1.2)	372	(0.8)	388	(0.8)	m		16	(2.0)
Peru	327	(4.4)	m		m		370	(4.0)	384	(4.3)	57	(6.7)	14	(6.1)

m – the country has not participated in PISA in these years.
c – no credible data were obtained.

Table 5.5 shows the percentage of students at the highest and lowest levels of reading proficiency since 2000, as well as the changes since the previous cycle in 2009. In Latvia, 4.2% of students have achieved level 5 or 6. Although since 2009 Latvia in this position has seen an increase of 1.2%, the Latvian students' results must be assessed as low from this point of view. The biggest increase in performance at levels 5 and 6 is shown by the East Asian countries (Taiwan (China), Shanghai (China), Singapore, Japan, Hong Kong (China), Macao (China), as well as by Liechtenstein, Ireland and France.

Table 5.5 Percentage of students below level 2 and at level 5 or above in reading PISA 2000 through 2012 (OECD, 2014d, p. 376, 377)

	Proficiency levels in 2000		Proficiency levels in 2003		Proficiency levels in 2006		Proficiency levels in 2009		Proficiency levels in 2012		Changes between 2009 and 2012	
	Below level 2	Level 5 or 6	Below level 2	Level 5 or 6	Below level 2	Level 5 or 6	Below level 2	Level 5 or 6	Below level 2	Level 5 or 6	Below level 2	Level 5 or 6
Taiwan (China)	m	m	m	m	15.3	4.7	15.6	5.2	11.5	11.8	-4.1	6.6
Liechtenstein	22.1	5.1	10.4	13.0	14.3	9.8	15.7	4.6	12.4	10.9	-3.3	6.3
Shanghai (China)	m	m	m	m	m	m	4.1	19.5	2.9	25.1	-1.1	5.6
Singapore	m	m	m	m	m	m	12.5	15.7	9.9	21.2	-2.6	5.5
Japan	10.1	9.9	19.0	9.7	18.4	9.4	13.6	13.4	9.8	18.5	-3.8	5.1
Hong Kong (China)	9.1	9.5	12.0	5.7	7.1	12.8	8.3	12.4	6.8	16.8	-1.5	4.4
Ireland	11.0	14.2	11.0	9.3	12.1	11.7	17.2	7.0	9.6	11.4	-7.7	4.4
Macao (China)	m	m	9.7	1.7	13.0	3.0	14.9	2.9	11.5	7.0	-3.4	4.1
France	15.2	8.5	17.5	7.4	21.7	7.3	19.8	9.6	18.9	12.9	-0.8	3.3
Luxembourg	m	m	22.7	5.2	22.9	5.6	26.0	5.7	22.2	8.9	-3.9	3.2
Poland	23.2	5.9	16.8	8.0	16.2	11.6	15.0	7.2	10.6	10.0	-4.5	2.8
Turkey	m	m	36.8	3.8	32.2	2.1	24.5	1.9	21.6	4.3	-2.9	2.5
Estonia	m	m	m	m	13.6	6.0	13.3	6.1	9.1	8.3	-4.2	2.3

	Proficiency levels in 2000		Proficiency levels in 2003		Proficiency levels in 2006		Proficiency levels in 2009		Proficiency levels in 2012		Changes between 2009 and 2012	
	Below level 2	Level 5 or 6	Below level 2	Level 5 or 6	Below level 2	Level 5 or 6	Below level 2	Level 5 or 6	Below level 2	Level 5 or 6	Below level 2	Level 5 or 6
Israel	33.2	4.2	m	m	38.9	5.0	26.5	7.4	23.6	9.6	-3.0	2.2
Spain	16.3	4.2	21.1	5.0	25.7	1.8	19.6	3.3	18.3	5.5	-1.2	2.2
Norway	17.5	11.2	18.1	10.0	22.4	7.7	15.0	8.4	16.2	10.2	1.2	1.8
Bulgaria	40.3	2.2	m	m	51.1	2.1	41.0	2.8	39.4	4.3	-1.6	1.5
Russia	27.4	3.2	34.0	1.7	35.3	1.7	27.4	3.2	22.3	4.6	-5.1	1.5
Serbia	m	m	m	m	51.7	0.3	32.8	0.8	33.1	2.2	0.3	1.4
Germany	22.6	8.8	22.3	9.6	20.0	9.9	18.5	7.6	14.5	8.9	-4.0	1.3
Croatia	m	m	m	m	21.5	3.7	22.4	3.2	18.7	4.4	-3.7	1.2
Latvia	30.1	4.2	18.0	6.0	21.2	4.5	17.6	2.9	17.0	4.2	-0.6	1.2
Korea	5.8	5.7	6.8	12.2	5.8	21.7	5.8	12.9	7.6	14.1	1.9	1.2
Belgium	19.0	12.0	17.9	12.5	19.4	11.3	17.7	11.2	16.2	12.3	-1.6	1.1
Albania	70.4	0.1	m	m	m	m	56.7	0.2	52.3	1.2	-4.3	1.0
Switzerland	20.4	9.2	16.7	7.9	16.4	7.7	16.8	8.1	13.7	9.1	-3.1	1.0
Portugal	26.3	4.2	21.9	3.8	24.9	4.6	17.6	4.8	18.8	5.8	1.2	1.0
Czech Republic	17.5	7.0	19.3	6.4	24.8	9.2	23.1	5.1	16.9	6.1	-6.2	0.9
Romania	41.3	2.2	m	m	53.5	0.3	40.4	0.7	37.3	1.6	-3.1	0.9
Italy	18.9	5.3	23.9	5.2	26.4	5.2	21.0	5.8	19.5	6.7	-1.5	0.9
OECD average	19.1	9.0	18.4	8.7	20.8	8.7	18.1	8.2	17.7	8.8	-0.5	0.7
Great Britain	m	m	m	m	19.0	9.0	18.4	8.0	16.6	8.8	-1.8	0.7
Denmark	17.9	8.1	16.5	5.2	16.0	5.9	15.2	4.7	14.6	5.4	-0.6	0.7

	Proficiency levels in 2000		Proficiency levels in 2003		Proficiency levels in 2006		Proficiency levels in 2009		Proficiency levels in 2012		Changes between 2009 and 2012	
	Below level 2	Level 5 or 6	Below level 2	Level 5 or 6	Below level 2	Level 5 or 6	Below level 2	Level 5 or 6	Below level 2	Level 5 or 6	Below level 2	Level 5 or 6
Thailand	37.1	0.5	44.0	0.5	44.6	0.3	42.9	0.3	33.0	0.8	-9.9	0.5
Lithuania	m	m	m	m	25.7	4.4	24.4	2.9	21.2	3.3	-3.2	0.4
Montenegro	m	m	m	m	56.3	0.4	49.5	0.6	43.3	1.0	-6.3	0.4
Slovenia	m	m	m	m	16.5	5.3	21.2	4.6	21.1	5.0	-0.1	0.4
Canada	9.6	16.8	9.5	12.6	11.0	14.5	10.3	12.8	10.9	12.9	0.6	0.1
Indonesia	68.7	c	63.3	0.1	58.3	0.1	53.4	c	55.2	0.1	1.8	0.0
Peru	79.5	0.1	m	m	m	m	64.8	0.5	59.9	0.5	-4.9	0.0
Tunisia	m	m	62.7	0.3	59.0	0.2	50.2	0.2	49.3	0.2	-0.9	0.0
Malaysia	m	m	m	m	m	m	44.0	0.1	52.7	0.1	8.8	0.0
Mexico	44.1	0.9	52.0	0.5	47.0	0.6	40.1	0.4	41.1	0.4	1.0	0.0
Slovakia	m	m	24.9	3.5	27.8	5.4	22.2	4.5	28.2	4.4	6.0	-0.1
Jordan	m	m	m	m	49.6	0.2	48.0	0.2	50.7	0.1	2.7	-0.1
The Netherlands	m	m	11.5	8.8	15.1	9.1	14.3	9.8	14.0	9.8	-0.3	-0.1
Qatar	m	m	m	m	81.6	0.6	63.5	1.7	57.1	1.6	-6.3	-0.1
Costa Rica	m	m	m	m	m	m	32.6	0.8	32.4	0.6	-0.2	-0.2
Colombia	m	m	m	m	55.7	0.6	47.1	0.6	51.4	0.3	4.3	-0.2
Kazakhstan	m	m	m	m	m	m	58.7	0.4	57.1	0.0	-1.6	-0.3
Hungary	22.7	5.1	20.5	4.9	20.6	4.7	17.6	6.1	19.7	5.6	2.2	-0.4
Argentina	43.9	1.7	m	m	57.9	0.9	51.6	1.0	53.6	0.5	2.0	-0.4
Greece	24.4	5.0	25.3	5.7	27.7	3.5	21.3	5.6	22.6	5.1	1.3	-0.5

	Proficiency levels in 2000		Proficiency levels in 2003		Proficiency levels in 2006		Proficiency levels in 2009		Proficiency levels in 2012		Changes between 2009 and 2012	
	Below level 2	Level 5 or 6	Below level 2	Level 5 or 6	Below level 2	Level 5 or 6	Below level 2	Level 5 or 6	Below level 2	Level 5 or 6	Below level 2	Level 5 or 6
Dubai (UAE)	m	m	m	m	m	m	31.0	5.3	26.8	4.8	-4.3	-0.5
Chile	48.2	0.5	m	m	36.3	3.5	30.6	1.3	33.0	0.6	2.5	-0.7
Brazil	55.8	0.6	50.0	1.9	55.5	1.1	49.6	1.3	49.2	0.5	-0.4	-0.8
Uruguay	m	m	39.8	5.3	46.6	3.1	41.9	1.8	47.0	0.9	5.1	-0.8
Finland	7.0	18.5	5.7	14.7	4.8	16.7	8.1	14.5	11.3	13.5	3.2	-1.0
Australia	12.5	17.6	11.8	14.6	13.4	10.6	14.2	12.8	14.2	11.7	-0.1	-1.0
Sweden	12.6	11.2	13.3	11.4	15.3	10.6	17.4	9.0	22.7	7.9	5.3	-1.1
New Zealand	13.7	18.7	14.5	16.3	14.5	15.9	14.3	15.7	16.3	14.0	1.9	-1.8
USA	17.9	12.2	19.4	9.3	c	c	17.6	9.9	16.6	7.9	-1.0	-1.9
Iceland	14.5	9.1	18.5	7.1	20.5	6.0	16.8	8.5	21.0	5.8	4.2	-2.7
Austria	14.6	8.8	20.7	8.3	21.5	9.0	m	m	19.5	5.5	m	m

m – the country has not participated in PISA in these years.
c – no credible data were obtained.

Table 5.6 shows the average student performance in the EU countries between 2006 and 2012. Overall, the national average performance of European students is improving – from 483 to 491 points. The Latvian student performance also increases, yet it is still below the average level of the EU students. Over the past three years, Latvia has moved up in ranking by one place, overtaking Hungary, Portugal and Sweden, where the students' performance has dropped. The Czech and Austrian students' performance in 2009 was lower than that of the Latvian students, whereas in 2012 it was higher.

Table 5.6 Average performance in reading literacy by students of EU countries in 2006, 2009 and 2012

Country	Average in 2006	Country	Average in 2009	Country	Average in 2012
Finland	547	Finland	536	Finland	524
Ireland	517	The Netherlands	508	Ireland	523
Poland	508	Belgium	506	Poland	518
The Netherlands	507	Estonia	501	Estonia	516
Sweden	507	Poland	500	The Netherlands	511
Belgium	501	Sweden	497	Belgium	509
Estonia	501	Germany	497	Germany	508
Germany	495	Ireland	496	France	505
Great Britain	495	France	496	Great Britain	499
Denmark	494	Denmark	495	Denmark	496
Slovenia	494	Great Britain	494	Czech Republic	493
Austria	490	Hungary	494	Austria	490
France	488	Portugal	489	Italy	490
Czech Republic	483	Italy	486	Latvia	489
Hungary	482	Latvia	484	Hungary	488
Latvia	479	Slovenia	483	Luxembourg	488
Luxembourga	479	Greece	483	Portugal	488
Portugal	472	Spain	481	Spain	488
Lithuania	470	Czech Republic	478	Sweden	483
Italy	469	Slovakia	477	Slovenia	481
Slovakia	466	Luxembourg	472	Lithuania	477
Spain	461	Austria	470	Greece	477
Greece	460	Lithuania	468	Slovakia	463
Bulgaria	402	Bulgaria	429	Romania	438
Romania	396	Romania	424	Bulgaria	436
EU countries' average	483	EU countries' average	486	EU countries' average	491

Summary

PISA reading literacy is defined as understanding, using, reflecting on and engaging with written texts, in order to achieve one's goals, to develop one's knowledge and potential, and to participate in the life of the society (OECD, 2010a). Reading literacy involves reading of various types of text bodies (for example, description, narration, interpretation, argumentation, instruction) and variously structured documents (such as forms, advertisements, tables, diagrams).

PISA reading items are constructed, taking into account three main elements: the text (format, type, medium, environment), aspect (access and retrieve; integrate and interpret; reflect and evaluate) and the situation (personal, public, occupational, educational). Tests contain several different types of reading items – open constructed-response items, short response items, multiple-choice items; complex multiple-choice items;

The student performance in reading literacy can be assessed in two ways – in points and proficiency levels. In 2012, the highest performance was shown by East Asian countries, the students from Shanghai (China), Hong Kong (China), Singapore, Japan, Korea and Taiwan (China). Among European countries, the highest performance was achieved by the students of Finland, Ireland, Poland and Estonia. The Latvian students' average performance in reading is slightly below the OECD average, however, this difference is statistically significant. Our students' performance is not statistically significantly different from the performance of the students from the Czech Republic, Italy, Austria, Hungary, Spain, Luxembourg, Portugal, Israel, Croatia and Sweden. Our students' performance is higher than that of our neighbours – the Lithuanian and Russian students. The lowest performance in Europe was shown by the Bulgarian, Romanian and Montenegrin students.

Similarly to mathematics and science, in 2012 the number of Latvian students at the highest proficiency level was very low – 0.3%. The following example can serve for comparison – if there is a large school with 1000 students, only three of them will reach the highest level of performance. If in Latvia in one class group, for example, all the 9th grades, there are about 20 000 students in total, only 60 of them will have the highest level of performance. It is not enough to provide a country with highly professional doctors, scientists, politicians and businessmen.

The greatest growth of performance since 2000, disregarding the countries with very low performance, is shown by Poland, Israel, Liechtenstein and Latvia. However, in case of Israel and Latvia, the relatively low performance in 2000 must be noted. The greatest decrease is experienced by the Northern European countries – Sweden, Iceland and the European leader in education – Finland. Since 2009, the largest increase in performance has been shown by Taiwan (China), Ireland, Macao (China), Thailand, Japan and Poland. The greatest decrease in performance –

by Iceland, Slovakia, Sweden and Finland. The international community already relatively long ago noticed the decrease in the Swedish students' average performance in international comparative studies (not only PISA), whereas the decline in Finland's performance has not yet been given proper attention.

Overall, the average performance of European Union countries' students over the period from 2006 to 2012 increased. The Latvian students' average performance also rose, yet it was still below the European Union's average level. Over the past three years, Latvia has moved up in ranking by one place, surpassing Hungary, Portugal and Sweden, where the students' performance has dropped. By contrast, the Czech and Austrian students' performance in 2009 was lower than in that of Latvian students, but in 2012 – already higher.

6. THE RELATION OF LATVIAN STUDENT PERFORMANCE TO VARIOUS CONTEXTUAL FACTORS

6.1. The changes of student performance over time

OECD PISA was designed as a cyclic long-term study, and one of its most important tasks is to study the trends in student performance in relation to various social and economic factors affecting the learning process and achievements. Any trend research framework is characterized by the cyclical nature of the study, similar principles of participant sampling as well as by the opportunity to associate and compare the achievements of different study cycles.

The data in OECD PISA study are collected every three years. Each time, the sampling follows the same principles – this allows to compare the results obtained at different times and to identify trends in performance. As we know, all of the OECD PISA cycles have involved 15-year-old students. The most serious weakness of the trend studies is that during the preparation of the study one cannot foresee all the possible trends (changes) that appear during the study and that should be explained by biological, environmental or intervention factors. Therefore, school and student survey questions in each subsequent cycle of the study are partially modified or supplemented. Test items also vary from cycle to cycle, yet to be able to link the students' performance in different study cycles, which is required for the detection of trends, the so-called link items were included in all of the OECD PISA cycles – the set of tasks, whose content, presentation, questions to be answered, remain unchanged. Consequently, the set of the study variables consists of the linking items and the standard part of the surveys, as well as each study cycle-specific test items and survey questions.

The first full-scale OECD PISA study in reading took place in 2000 (reading was the main content area), in mathematics – in 2003, and in natural sciences – in 2006 (see Figure 6.1). In OECD PISA 2009 cycle, reading again was the main content

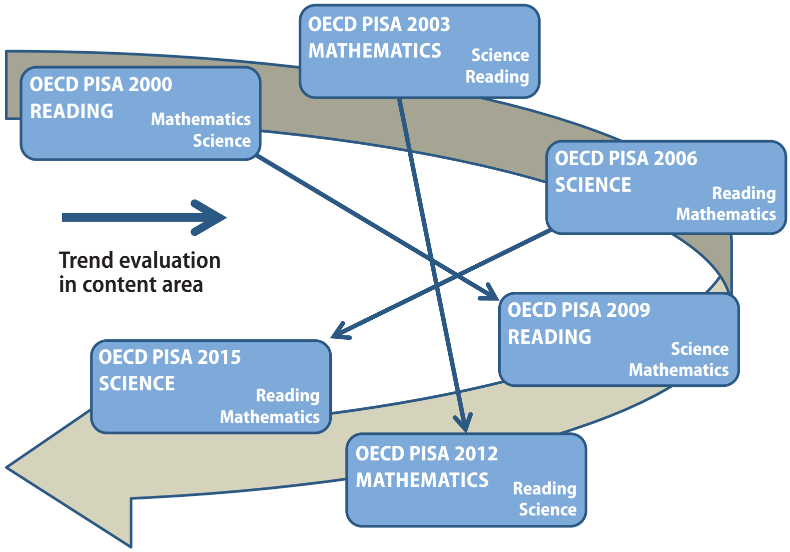


Figure 6.1 OECD PISA 2000–2015 – trend research process

area, and for the first time it was possible to carry out a full-scale evaluation of trends compared to 2000. The main content area of OECD PISA 2012 cycle again was mathematics, allowing to assess student achievement trends in mathematics compared to 2003. In OECD PISA 2015 survey the main content area was science, permitting to complete the first full-scale evaluation of student performance trends in all content areas of research since the start of the research program in 2000.

Each participating country has an interest both to ascertain their student performance trends in the OECD PISA reading, mathematics and science content areas and to obtain the public education system assessment in an international context.

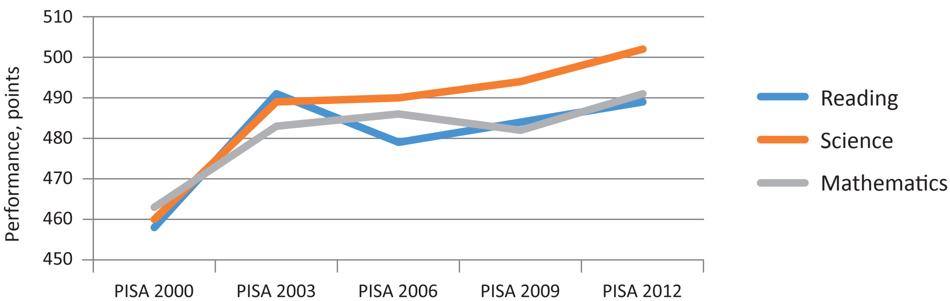


Figure 6.2 The average results of Latvian students in OECD PISA mathematics, science and reading content areas

Latvian student performance in the OECD PISA test within the period from 2000 to 2012 is shown in Figure 6.2. Summing up the results of the five research cycles, there emerges a positive overall trend – the performance of 15-year-old students of Latvia in the OECD PISA is clearly getting better – the comparison of the average results of 2000 and 2012 demonstrates that the students in all content areas have improved their results by 30 points.

The growth of Latvian student performance was not uniform, as the most significant performance peak in the test results was observed in the first two cycles of OECD PISA in 2000 and 2003. This is partly explained by the fact that additional difficulties for Latvian students in the first study cycle were caused by the unconventional test format. Subsequently, a steady positive tendency in the growth of the results was seen only in the science content area. On the other hand, not only growth, but also decline was observed in mathematics and reading within some of the study cycles, such as reading in 2006 and mathematics in 2009. Thus, the Latvian student performance in the OECD PISA over 12 years can be characterised as slightly improving, yet the positive trend leaves something to be desired.

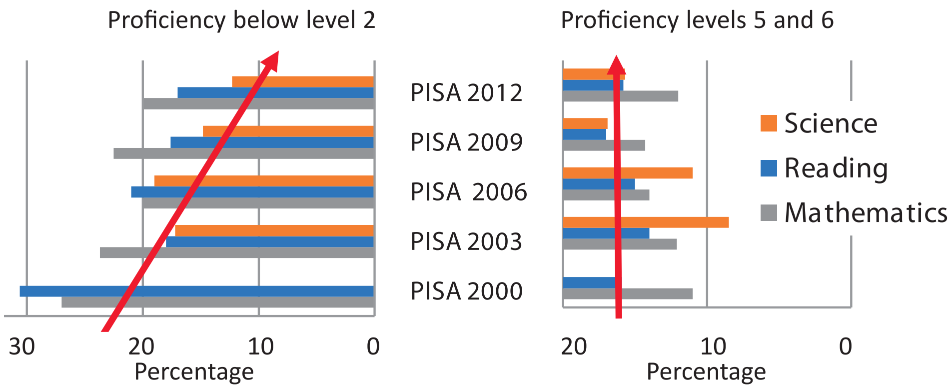


Figure 6.3 Percentage of students from Latvia within lowest (below level 2) and highest (5–6) proficiency levels of OECD PISA

In the framework of OECD PISA study, particular attention was devoted to the low and high performance change trends in all three content areas. During the period from 2000 to 2012 in Latvia (see Figure 6.3) there was a significant decrease in the number of students with low performance (proficiency below level 2).

At the same time, it should be recognized that in the period from 2000 to 2012 the number of students in Latvia with high performance in OECD PISA content areas has practically remained unchanged. In comparison with the OECD average results, there are approximately two times less students in Latvia, whose performance in OECD PISA under corresponds to proficiency levels 5 and 6.

Although currently OECD PISA can be considered the major international comparative education study, in the period from 1995 to 2009 Latvia also participated in several other international studies, such as IEA TIMSS and IEA PIRLS. Latvia showed the highest score in performance change – about 4.5% of the standard deviation (see Figure 6.4). At the same time, countries like France, Ireland, Norway, the Czech Republic, Slovakia and Sweden showed a negative performance change indicator. This result illustrates that Latvian student performance in international studies over a longer term has a growth trend positively characterizing the national general education system and its development.

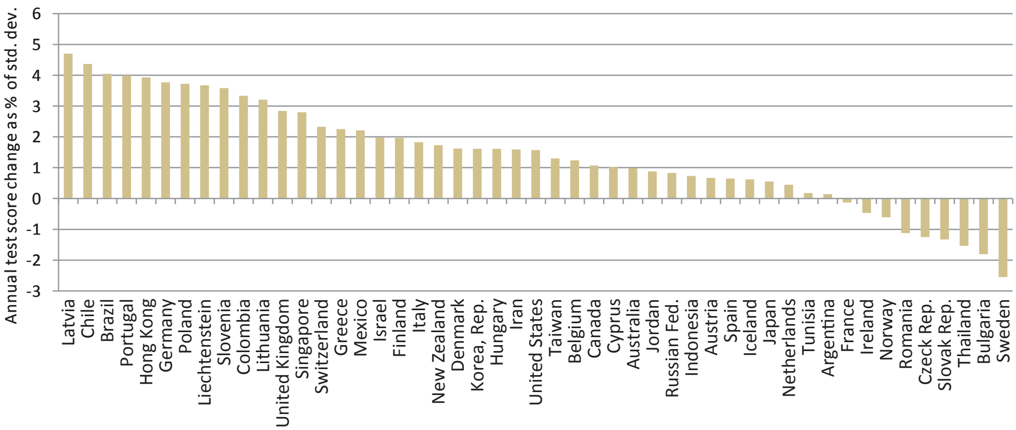


Figure 6.4 Annual average performance growth of OECD PISA participating countries' students in all content areas 1995–2009 (% of standard deviation)

Figure 6.5 shows the average performance of students by country, combining the results of two studies (OECD PISA and IEA TIMSS). Latvia in this chart occupies the 24th place among 76 countries.

Once more, the positive performance growth tendency was shown by Latvian students in IEA TIMSS results for the period from 1995 to 2007 (after 2007, Latvia ceased to participate in this study). Tables 6.1 and 6.2 provide a summary of data on the changes in performance shown by IEA TIMSS participating countries' students of 4th to 8th grades in mathematics and science. In both cases, Latvian student performance growth was remarkable indeed: the average performance of the 4th grade students in science rose by 56 points, and in mathematics – by 38 points (respectively, the second and the fourth fastest growth rate). Notably, the positive trend of performance growth in science was observed in eight countries, while in mathematics – in 12 countries out of about 20 countries participating in both studies.

Note: Latvia occupies the 24[th] place among 76 countries.

Figure 6.5 The average performance of students in OECD PISA 2012 and IEA TIMSS 2011 in the countries of the world (Hanushek, Woessmann, 2015, p. 37)

The average performance in science and mathematics shown by IEA TIMSS participating countries' students of the 8[th] grade in TIMSS 2003 and the changes in performance since 1995 are displayed in Table 6.2. The average performance growth of Latvian 8[th] graders both in science and mathematics was the third highest among the countries participating in the study (respectively, 37 and 17 point increase).

Table 6.1 The average performance of 4th grade students in TIMSS, science, from 1995 to 2007 (IEA TIMSS databases)

Country	Average performance in 2007	Difference between 1995 and 2007 average performance	Country	Average performance in 2007	Difference between 1995 and 2007 average performance
	Science			Mathematics	
Singapore	587	63	England	541	57
Latvia	542	56	Hong Kong	607	50
Iran	436	55	Slovenia	502	40
Slovenia	518	54	Latvia	537	38
Hong Kong	554	46	New Zealand	492	23
Hungary	536	28	Australia	516	22
England	542	14	Iran	402	15
Australia	527	6	USA	529	11
New Zealand	504	-1	Singapore	599	9
USA	539	-3	Taiwan	576	1
Japan	548	-5	Japan	568	1
Netherlands	523	-7	Scotland	494	1
Austria	526	-12	Norway	473	-3
Scotland	500	-14	Hungary	510	-12
Czech Republic	515	-17	Netherlands	535	-14
Armenia	484	-27	Austria	505	-25
Norway	477	-27	Czech Republic	486	-54
Russia	546	m	Armenia	500	m
Italy	535	m	Russia	544	m
Taiwan	557	m	Italy	507	m
Tunisia	317	m	Lithuania	530	m
Lithuania	514	m	Morocco	341	m
Morocco	297	m	Tunisia	326	m

Note: m – country did not participate in the 1995 study.

Table 6.2 The average performance of 8th grade students in TIMSS, science, from 1995 to 2003 (IEA TIMSS databases)

Country	Science: Average performance in 2003	Science: Difference between 2003 and 1995 average performance	Country	Mathematics: Average performance in 2003	Mathematics: Difference between 2003 and 1995 average performance
Lithuania	519	56	Lithuania	502	30
China, Hong Kong	556	46	China, Hong Kong	586	17
Latvia	512	37	Latvia	508	17
USA	527	15	USA	504	12
Australia	527	13	Korea	589	8
Korea	558	13	Netherlands	536	7
Scotland	512	10	Scotland	498	4
New Zealand	520	9	Hungary	529	3
Slovenia	520	7	Romania	475	1
Hungary	543	6	Slovenia	493	-2
Romania	470	-1	Singapore	605	-3
Japan	552	-2	Australia	505	-4
Singapore	578	-3	Iran	411	-7
Netherlands	536	-6	New Zealand	494	-7
Iran	453	-9	Cyprus	459	-8
Russia	514	-9	Japan	570	-11
Cyprus	441	-11	Belgium (Flemish)	537	-13
Slovakia	517	-15	Russia	508	-16
Belgium (Flemish)	516	-17	Slovakia	508	-26
Norway	494	-21	Norway	461	-37
Sweden	524	-28	Sweden	499	-41
Bulgaria	479	-66	Bulgaria	476	-51

Although the authors of OECD PISA study have emphasized on several occasions that the study should not be regarded as a competition with the most important goal to win a place in the ranking table, in each cycle of the study this result draws quite a lot of attention. Latvian students in the period from 2000 to 2012 in all content areas achieved results which enabled them to take the 21st to 36th position in the overall list of the countries participating in the study within various study cycles. It must be admitted that over the 12 years a significant growth has hardly been observed. The place achieved in mathematics could be considered a relative exception, when after the negative scores over the period from 2000 to 2009, in the 2012 survey cycle the students obtained a considerably higher result. Science and reading content areas also showed similar, yet less pronounced dynamics of the scores gained until 2009, and a better result in 2012.

OECD PISA study is steadily expanding, more and more countries or educational systems take part in it:

- In 2000 – 45 countries;
- In 2003 – 41 countries;
- In 2006 – 57 countries;
- In 2009 – 75 countries;
- In 2012 – 65 countries.

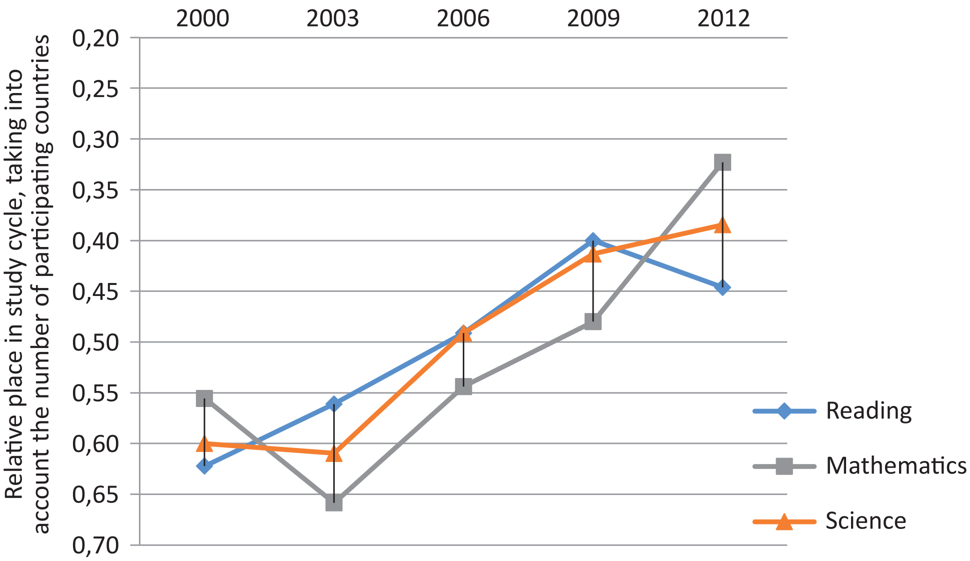


Figure 6.6 ***The place of Latvia in the OECD PISA ranking table, taking into account the total number of countries participating in the study cycle***

Thus, the place obtained by each participating country or education system should be adjusted according to the total number of participants. For example, the fifth place in the competition of ten countries is certainly not the same as the fifth place among 30 countries. The relative place of Latvia in the countries' ranking table in each study cycle, taking into account the total number of participating countries, is shown in Figure 6.6. The relative place of Latvia in the ranking table was calculated by dividing the obtained place with the total number of participants of the respective study cycle. For instance, Latvian students in mathematics content area in 2000 ranked 25th among 45 participating countries, in 2003, with 41 countries participating, they obtained the 27th place, in 2006, among 57 countries – the 31st place, in 2009, among 75 countries – the 36th place, and in 2012, among 65 countries, their highest – 21st place. The relative place in ranking table is determined by dividing the place obtained by Latvia with the total number of countries participating in the relevant cycle of the study. In this case, we clearly see a positive trend – Latvia's result in the ranking table, taking into account the total number of countries participating in the study, improves from cycle to cycle. It could be taken somewhat for granted, assuming that the education systems of the new countries acceding to the study were "weaker" in comparison with Latvia. However, there is no unequivocal evidence to support this statement.

Summary

Summarizing the above-discussed achievements of Latvian students in the OECD PISA study over 12 years, a number of important results should be specified:

- five study cycles show a positive overall trend – the performance of Latvian fifteen-year-old students in the OECD PISA test is improving, an increase by approximately 30 points in all test content areas in the period from 2000 to 2012 was observed; likewise, Latvia ranked first in the growth of performance from 1995 to 2009, taking into account the performance growth dynamics in several international educational studies (PISA, TIMSS, PIRLS);
- the growth of Latvian student performance has not been equable, – only the science content area showed a stable positive growth of results, whereas in the content areas of mathematics and reading within particular cycles of the study not only the growth of results, but also the decline was observed;
- the overall positive growth tendency of student performance is an affirmation of the successful work and development of Latvian general education system;
- while generally the performance growth trends among the Latvian fifteen-year-old students has been positive, it should be still faster, given that during

the entire OECD PISA study Latvia did not achieve a higher place than the 21st in the ranking table encompassing all the participating countries – it confirms the need to accelerate the growth in the future study cycles;

- the comparative analysis of the results obtained in various cycles of IEA TIMSS educational study suggests that the period from 1995 to 2007 was marked by pronounced average performance growth among the Latvian students of the 4–8th grade both in mathematics and science;
- the 24th place taken by Latvia among 76 countries in the joint OECD PISA and IEA TIMSS average result chart proves that the general basic education provided in Latvia is competitive. Given that there are 196 independent countries in the world and that all the developed countries already participate in the OECD PISA study, Latvia is among the 15–25% of the countries enjoying the best education systems worldwide.

6.2. Socio-economic status of students and schools, and its relation to achievement

One of the most important goals of any education system is to provide all students with equal public education opportunities. In all OECD PISA cycles as of the year 2000, students' performance in mathematics, science and reading were also evaluated in the context of a indices characterizing the SES of a family and a school. The term "socio-economic status" is quite an extensive set of parameters characterizing a student, a school or an education system. OECD PISA evaluates students' SES according to the social, cultural and economic status index consisting of such parameters as the education of the student's parents and their employment status, as well as the resources allocated for education and household needs in the family's possession.

The relationship between student performance and their SES is schematically shown in Figure 6.7. Each point represents one student and his or her performance (on the vertical axis) and the family's SES (on the horizontal axis). Important aspects are both the slope of the regression line, which is characterized by the extent of change in performance, if the SES index changes by one unit, and the extent of point concentration around regression line, which is characterized by the correlation coefficient value. The greater slope of the line and the lower variation level of the points around it – points are closer to line (i.e., the higher the value of the correlation coefficient), the relatively stronger is the impact of the SES on performance.

This approach allows us to display the research results and to measure the SES impact to performance of a particular country, group of countries, for example, the OECD countries, or a sufficiently large group of students inside the country.

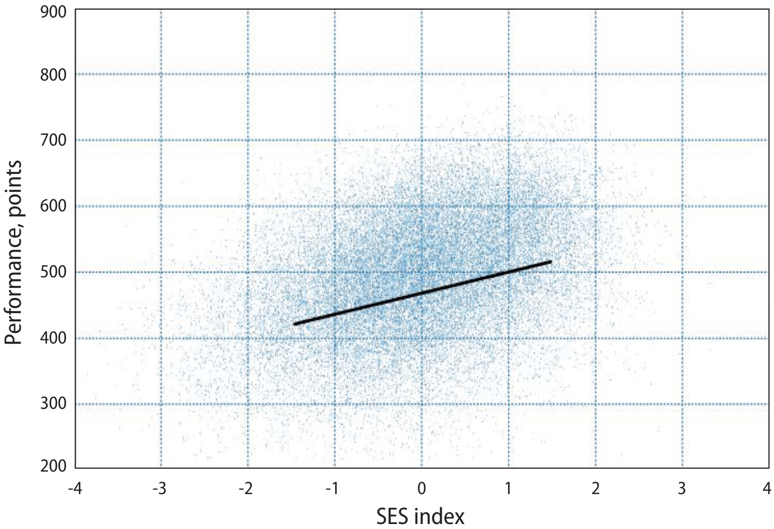


Figure 6.7 The relationship between students' SES and performance

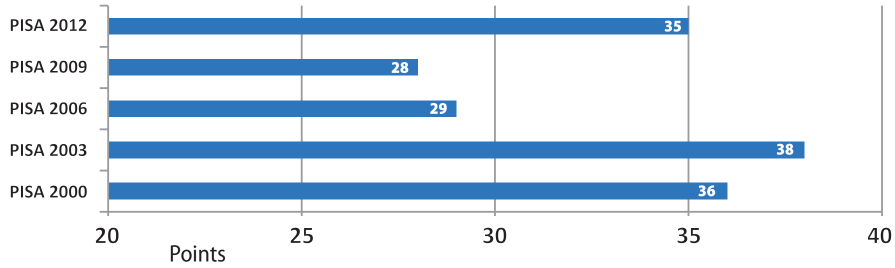
OECD PISA 2012 enables comparing each participating country's average performance in mathematics and the impact of the SES upon it. On the average in the OECD countries, 14% of the performance variance can be explained by the impact of the SES. In Figure 6.8, each country corresponds to a point whose coordinates consist of two figures - the average score in mathematics received by the students of the respective country, and the percentage of variance in mathematics performance explained by the SES index. The chart is divided into four quadrants:

- the average student performance in mathematics is above the OECD countries' average, and the equity of education is above the overall OECD countries' result;
- the average student performance in mathematics is above the OECD countries' average, but the equity of education is below the overall OECD countries' result;
- the average student performance in mathematics is below the OECD countries' average, and the equity of education is below the overall OECD countries' result;
- the average student performance in mathematics is below the OECD countries' average, and the equity of education is above the overall OECD countries' result.

Figure 6.8 The average mathematics performance in PISA 2012 and impact of SES (OECD, 2013c, p. 27)

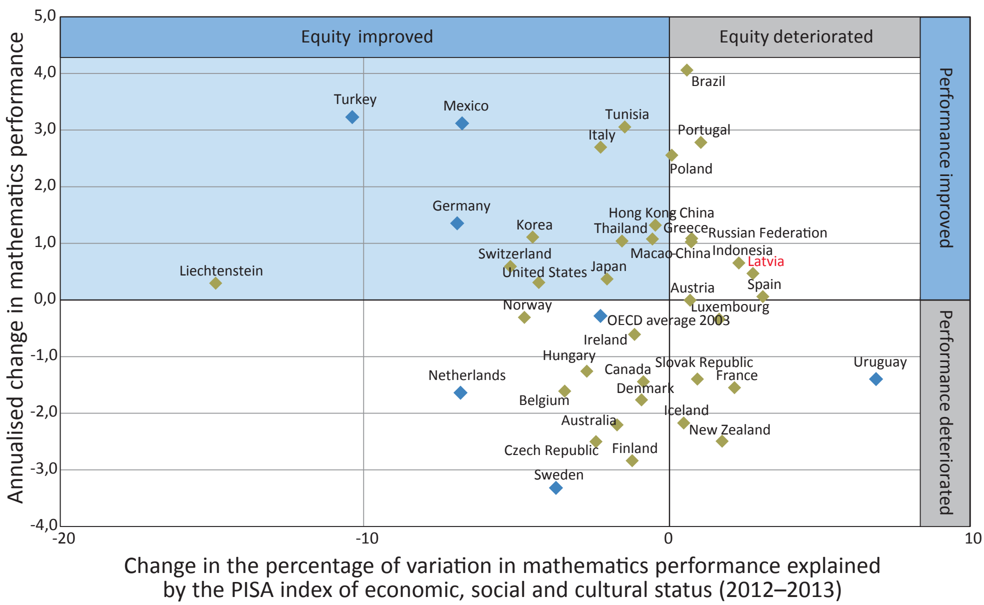
As shown in Figure 6.8, Latvia is positioned near the relative origin of the coordinates. The Latvian students' average performance is only slightly lower (difference is not statistically significant) than the OECD average, but the performance variance, which can be explained by the SES index, is close to the OECD average. Hence we may conclude that the equity of education in Latvia is the same as the average in the OECD countries. Similar analyses in the previous PISA cycles showed that the equity of education in Latvia was somewhat higher than the average of the OECD countries.

The increase of the student's SES impact on his or her performance is also manifested by the change in the average performance of students, as the SES index changes by one unit, because, in comparison with 2009, it has increased (see Figure 6.9).



6.9. attēls *The changes in average performance of Latvian students, as SES index changes by one unit*

The changes in the Latvian students' performance in mathematics over the period from 2003 to 2012 within OECD cycles showed a slight increase in performance (see Figure 6.10), although the dependence of performance in mathematics on the SES also slightly rose during that period – it is considered an undesirable trend indicating that the performance of various educational institutions has become less equal.



Note: Changes in both equity and performance between 2003 and 2012 that are statistically significant are indicated in a darker tone

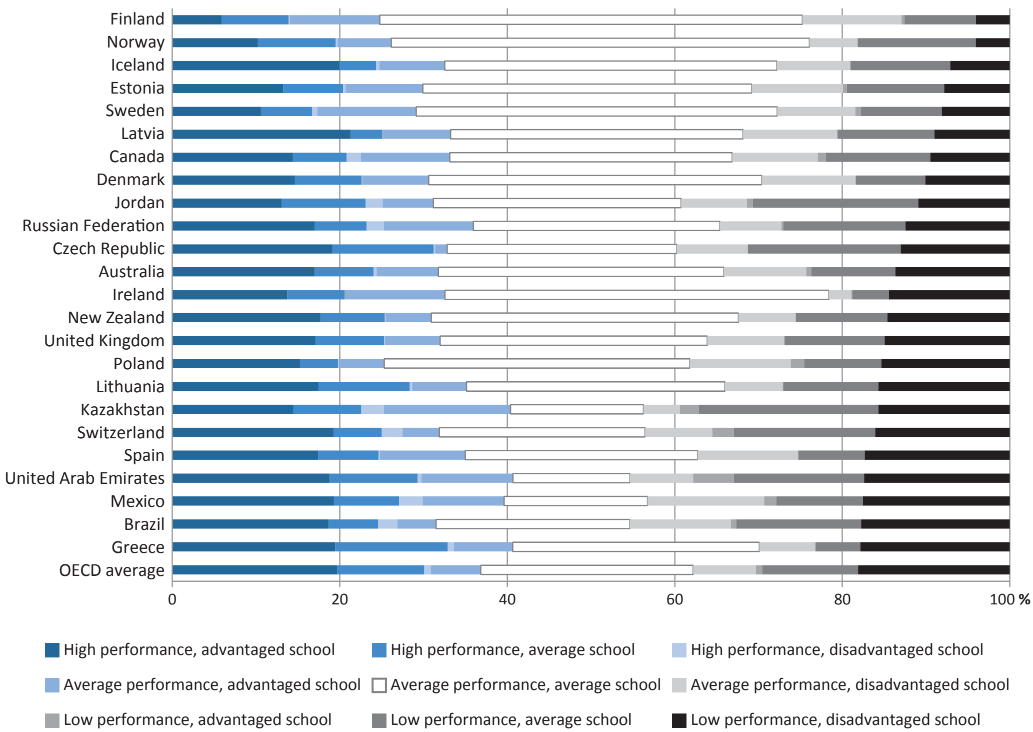
Figure 6.10 *Change between 2003 and 2012 in the percentage of variation in mathematics performance explained by SES and annualised mathematics performance (OECD, 2013c, p. 57)*

For more detailed understanding and analysis of the situation, the SES index of a specific school (or a group of schools) is defined by dividing the sum of all the student's SES in that school by the number of students. Thus, the school's SES is an average value characterizing the corpus of students in that particular school in relation to their families' SES. By applying the two-level (SES of school and students) regression analysis (OECD, 2013c, p. 200), the obtained result shows that the school's SES differences are responsible for 62.2% of the PISA 2012 mathematics performance variation among the Latvian schools, while only 5.5 % of the performance variation is determined by the students' SES. Both results shown by Latvia practically coincide with the corresponding OECD average, 62.8% and 5.3% respectively. It means that the school's average SES greatly determines the difference in the school's performance in comparison with other schools with their specific SES.

Consequently, the school's SES is a particularly important factor in the analysis of performance differences among schools, therefore, the schools are primarily divided into groups according to their SES, which can be done in different ways. One of the methods (OECD, 2013c, p. 49) is to divide the schools into three groups: schools with an average SES – if the difference between school's SES and student's average SES in the respective country is not statistically significant, schools with a high SES – if the school's SES is statistically significantly above the average students' SES in the country, and schools with a low SES – if the school's SES is below the average SES in the country. If the school is represented in the study only by a few 15-year-old students, then that school most often falls into the middle group. According to this division, the average SES of each of these three school groups in Latvia is: -0.95 – for the schools with a low SES, -0.32 – for the schools with an average SES, 0.32 – for the schools with a high SES. The respective average values of OECD countries are: -0.56, -0.02, 0.60. And, of course, the average performance of students in these school groups differs in all countries – it is lower in the group with the lowest SES, and best in the group with the highest SES. The mathematics performance of Latvia in PISA 2012 resulted in the average of 452 points in the schools with a low SES, 480 points in schools with an average SES, and 534 points in schools with a high SES. These groups of schools in Latvia with low, medium and high SES have the following respective proportion of students: 20.2%, 50.3% and 29.5%. About half of Latvia's rural schools belong to the group with a low SES, and virtually no rural schools have a high SES.

According to earlier observations, the SES, however, is not the only factor that is related to the student performance. PISA results show that there are also groups of schools with a low SES performing at a medium level. To conduct a comprehensive analysis of this aspect, it is necessary to divide the schools into groups, not only by their average SES, but also by their average performance in a given measurement, such as PISA 2012 mathematics test. The groups of schools with high, medium and low test performance are constituted similarly to the groups of schools with differing SES. The group of schools with average performance include the schools where the average performance of students in the test is not statistically significantly different from the average national performance indicator (for example, in PISA 2012 mathematics test that indicator for Latvia was 491 points), the schools with low performance, in this sense, are the ones whose average performance is statistically significantly lower than the average in the country, and the schools with high performance are those whose average performance is statistically significantly higher than the national average. In Latvia, 20.5% of the students attend the group of schools with low performance, 54.7% of the students study at schools with average performance, whereas 24.9% of the students – at the schools with high performance. It is essential to distinguish between the schools defined above as having low, medium and high overall performance of the school, and the performance of students in the test, according to one or another level of proficiency, such as students with low achievements – the first level of proficiency and lower, students with high achievements – the fifth level of proficiency and higher.

Figure 6.11 shows the percentage of students in each country attending schools having a particular combination of a specific SES group and a group of performance. Of course, the division exactly in these nine groups is relative, it must be taken into account that every school has its own specific SES and performance level, the distribution of these parameters is continual, and part of the schools are very close to the boundaries of this notional division (corresponds to them). However, this enables drawing some general conclusions. Figure 6.11 shows that different countries have diverse situations, because the division of schools according to their SES is determined by the influence of various circumstances, and the education system in every country is capable to offset the impact of low school SES at a differing degree. In the OECD countries, on average, 18% of students study in schools with both low SES and performance, while 20% attend schools with high SES and high performance. The smallest number of students attending schools with low SES and performance is in Finland (only 4% of students). Finland is followed by such countries as Norway (4.1%), Iceland (7.1%), Estonia (7.8%), Sweden (8.1%), Latvia (9.0%), Canada (9.5 %) and Denmark (10.1%). Consequently, in the international context, comparatively few students in Latvia attend schools with a low SES and a low performance in mathematics test of PISA 2012, while 11.2% of students attend schools with a low SES, whose performance corresponds to the average level. However, it is those 9% of students (school percentage is higher than that of the students, because this group also contains the relatively small schools) that create considerable problems for us, because the education system is not able to fully compensate for the low school SES, this being a regional development issue (see also Chapter 6.5). Figure 6.11 also demonstrates that 11.5% of the students in Latvia attend schools with low performance and average-level SES. An increase in the level of performance achieved by these students could certainly be addressed by upgrading the education system. By all means, Latvia also has many schools with high performance – 21.3% of Latvian students have a high level of performance, learning in schools with a high SES level. They are joined by yet another 3.8% of the students who attend schools with high performance, but an average level of SES.



Note: Countries are ranked in ascending order according to the proportion of students in low-performing schools that are also with low school SES.

Figure 6.11 ***Distribution of students across school performance and socio-economic profile (OECD, 2013c, p. 52). The figure does not include all PISA 2012 participating countries, the list is closed below the OECD average indicator line***

Chapters 6.4 and 6.5 confirm the fact that the performance analysis, depending on the location of the school (Riga, urban, rural area) and type of school (gymnasiums, secondary schools, primary schools) to a great extent must take into account the SES index.

Summary

The correlation between the student performance and the SES exists in all countries – the students from families with a lower SES on the average show a lower performance in the OECD PISA test and all the other comparative studies across all content areas and all age groups, yet the strength of this correlation varies in different countries.

The analysis of PISA 2012 results shows that the extent to which the test results achieved by fifteen-year-old Latvian students depend on their family's material status, availability of educational and cultural resources at home, parental education and occupation (i.e., student SES), is broadly consistent with the average of the OECD countries. However, in the recent years this dependency has become a little more pronounced in Latvia, because our country has descended from the previous, higher position within the international comparison to an average level of OECD countries with respect to equity of education. Although, according to international comparison, this relationship is still relatively moderate in Latvia, a slight deterioration in overall situation has been observed lately. It prompts us to assess the situation and look for the ways to help students from families with lower SES, and especially schools having relatively large number of these students, to raise their educational performance.

The average SES level of a school has a significant impact on its students' performance – it can be observed when comparing various schools in Latvia and the average results in the OECD countries. The family's SES does not have as great an influence on the same school students' performance differences, but the overall school performance level is determined by the SES level of that school.

The more detailed analysis of the schools' SES and average school performance shows that 21.3% of Latvia's students attend schools with a high overall level of performance and a high SES level. These are joined by a further 3.8% of the students who attend schools with a high performance, but an average level of the SES, while 9% of Latvia's students study at schools with a low school SES and a low performance level.

Raising the students' performance level at these schools is certainly not just a matter of the education system, but, above all, a regional development issue, if the school is located in an area, where the families' SES are generally low, and perhaps in part it is also a matter of student enrolment in these schools. 11.5% of students attend schools with a low performance level, yet a medium SES level, and in this group of schools the facilitating of the quality of the educational work should be a decisive factor in improving its results.

The international comparison with regard to performance of schools and their SES is favourable to Latvia – in the OECD countries, on the average, 18% of students

attend schools with a low SES and low performance, and 20% attend schools with a high SES and high performance. The relative proportions of these students in Latvia are, respectively, 9.0% and 21.3%. Consequently, according to the international comparison, in Latvia the number of students who attend schools with a low performance and a low SES, is relatively small. The smallest number of students attending schools with low SES and low performance is seen in Finland – only 4%. Finland is followed by Norway (4.1%), Iceland (7.1%), Estonia (7.8%), Sweden (8.1%), Latvia (9.0%), Canada (9.5 %) and Denmark (10.1%).

6.3. Students with a high socio-economic status and their performance

On the average, students' achievements are related to the socio-economic status of their families – the students with a high SES show higher performance, while the students with a lower SES – lower performance (OECD, 2013). Looking at the SES as a single, separate factor, it has the greatest impact on student performance (OECD, 2004). Quite a lot of research work has been dedicated to the factors influencing the performance of students with a low SES, particularly emphasizing the socially elastic students (resilient) group (in the educational context, the term "socially elastic, flexible students" denotes those with a low SES and high performance). The research dedicated to these topics in Latvia was carried out by Ieva Kārkliņa (Kārkliņa, 2012; Kārkliņa, 2013a; Kārkliņa, 2013b). The factors that affect the progress of students with a high SES have been examined less – the analysis of these factors is the goal of the current chapter.

Different indicators can be chosen to characterize the students' SES, for example, parents' education, parents' occupation, the number of books at home, etc. It has been found that some of the SES indicators are positively correlated with student performance – e.g., the number of books at home, musical instruments at home, the student's own desk for studies, but some have a negative influence – e.g., a personal TV or DVD player, also a mobile phone (Twist, Schagen, Hodgson, 2007). Some authors, for example, Martin Carnoy with colleagues (Carnoy, Khavenson, Ivanova, Rothstein, 2013), use only the number of books at home for the purpose of classifying social groups. This indicator is obtained as the manifesting variable without complex calculations, and is similarly measured in virtually all studies. The OECD PISA chief characteristic indicator of the SES is the socio-economic and cultural status index ESCS, which includes parental education, parental occupation, the number of books at home, and the presence or absence of a variety of things in the family's possession (OECD, 2013). This index will be used for the students' SES characterization in this chapter.

Table 6.3 The average performance of Baltic Sea countries' students in mathematics, science and reading

Country	Average performance in mathematics	Average performance in science	Average performance in reading
Estonia	521	541	516
Finland	519	545	524
Poland	518	526	518
Germany	514	524	508
Denmark	500	498	496
Latvia	491	502	489
Russia	482	486	475
Lithuania	479	496	477
Sweden	478	485	483

Note: The table is arranged according to performance in mathematics.

International comparative education research is a unique opportunity to make a comparison between a number of countries, it gives a better chance to discover regularities. On the other hand – as more than 60 very different countries participated in PISA, it is not productive to compare one country (Latvia) with all the participating countries. This chapter will review the Baltic Sea countries. The choice was determined by the fact that all the Baltic Sea countries are geographically close, and this, in turn, determines intensive cultural exchanges both in a peaceful (voluntary) environment and as a result of various wars (forced processes). The selected countries and their students' average performance in PISA 2012 is shown in Table 6.3. The difference between the country with the highest performance in mathematics (Estonia), and the country where it is the lowest (Sweden) is 43 points, therefore it can be concluded that the difference in performance of the Baltic Sea countries' students is not very large. The mathematics performance of the students from Estonia, Finland, Poland, Germany and Denmark is statistically significantly higher than the OECD average. Latvian students' performance does not differ from the average, whereas the Russian, Lithuanian and Swedish students' performance is lower than the OECD average. Latvian students' average performance in mathematics is statistically significantly lower than that of Estonia, Finland, Poland, Germany and Denmark, yet statistically significantly higher than the Russian, Lithuanian and Swedish student achievements. Looking at the changes since 2003, we can see that the performance of students in the Baltic Sea countries tend to converge. The average national student performance in reading from 2003 to 2012 is shown in Figure 6.12.

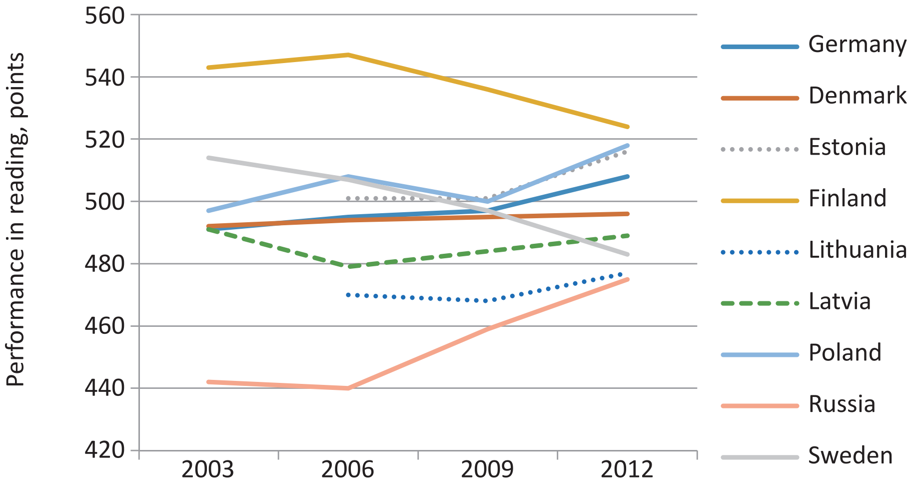


Figure 6.12 The average performance of Baltic Sea countries' students in reading from 2003 to 2012

Method of data analysis

Each country's students were divided into 10 approximately equal groups according to the PISA index of economic, social and cultural status (ESCS). The division was made separately in each country, irrespective of the differences in the national ESCS average values. The first group consisted of about 10% of the students with the lowest SES in the country, while the tenth group contained the students with the highest SES. The average ESCS of each country and each group is shown in Table 6.4. The highest average ESCS values are shown by the Scandinavian countries (Denmark, Finland and Sweden) and Germany, the medium – by Estonia, Russia and Lithuania, while Poland and Latvia have the lowest values. Notably, the index values remain unchanged linearly by the SES groups. The greatest difference in index values between the adjacent groups is observed between the first and the second, as well as the ninth and the tenth group. Both are "open groups", i.e., the first is not limited from the bottom, but the tenth – from the top. The first group consists of the students with extremely low ESCS values, which significantly lowers the average value of the group, but the tenth is formed by the students with extremely high ESCS values increasing the group's average value. The great difference between the first and the second group indicates that the first group has very low average index values. It is expected that the performance of the first SES group's students will be significantly lower than those of the second group. The average index values of Latvian students in almost every SES group are the second lowest – in the first and the second group they are only slightly higher than those of Lithuania, in the fourth to the seventh group slightly higher than those of Poland, and in the ninth and the tenth group – higher than those of Russia. The average ESCS values in the higher SES groups of the analysed countries differed even 1.5 times (Denmark and Germany with higher average values, Russia and Latvia – with lower ones).

The average performance shown by each of these groups is reflected in Figure 6.13, but the average performance in reading – in Figure 6.14. As expected from the comparatively very low values of ESCS in the first SES group, the performance of students in this SES group is significantly lower than that of the second group's students. In all countries except Estonia, Finland and Poland, we have seen a remarkable decline in performance of the student group with the lowest SES.

Table 6.4 Average ESCS values in Baltic Sea countries and SES groups of these countries

	SES group 1	SES group 2	SES group 3	SES group 4	SES group 5	SES group 6	SES group 7	SES group 8	SES group 9	SES group 10	Average
Denmark	-1.3	-0.7	-0.4	-0.1	0.2	0.5	0.8	1.0	1.3	1.7	0.43
Finland	-1.1	-0.6	-0.2	0.1	0.3	0.6	0.8	1.0	1.2	1.5	0.36
Sweden	-1.2	-0.6	-0.3	0.0	0.2	0.5	0.7	0.9	1.1	1.5	0.28
Germany	-1.4	-0.8	-0.5	-0.2	0.0	0.3	0.6	0.9	1.3	1.7	0.19
Estonia	-1.2	-0.8	-0.5	-0.2	0.0	0.3	0.6	0.8	1.1	1.4	0.11
Russia	-1.4	-0.9	-0.6	-0.4	-0.2	0.1	0.3	0.5	0.7	1.1	-0.11
Lithuania	-1.7	-1.2	-0.9	-0.6	-0.3	0.1	0.4	0.7	0.9	1.3	-0.13
Poland	-1.5	-1.1	-0.9	-0.7	-0.5	-0.2	0.1	0.6	1.0	1.4	-0.21
Latvia	-1.6	-1.2	-0.9	-0.6	-0.3	0.0	0.3	0.5	0.8	1.2	-0.26

Note: The table is arranged according to the countries' socio-economic and cultural status index average value.

Figures 6.13 and 6.14 reflect that in all the reviewed countries student achievement is related to their SES – on the average, the students with a higher SES show higher performance. The difference between the achievements of the students with a high and a low SES within one country is higher than the difference between the average performance between countries. In the countries with high average performance, Estonia, Finland and Poland, there is a relatively lower dependence of student performance on their SES – the curves' gradients are lower. This is achieved by increasing the low-income students' performance. It should be noted that the Swedish and Danish student performance is relatively closely related to their SES: this contradicts our perception of the Scandinavian countries' successful policy of student equality.

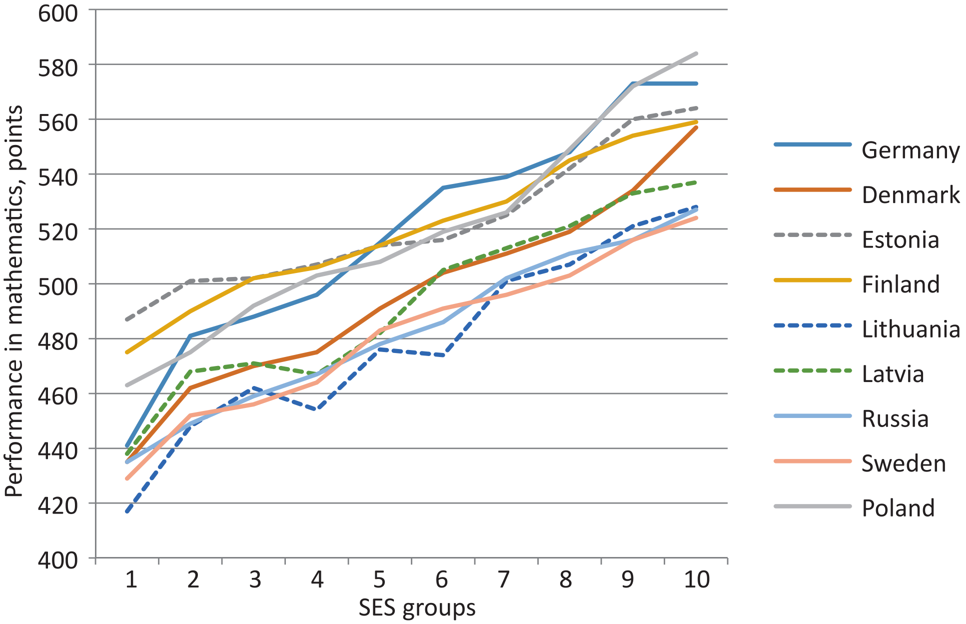


Figure 6.13 Performance of Baltic Sea countries' students in mathematics, in particular SES groups

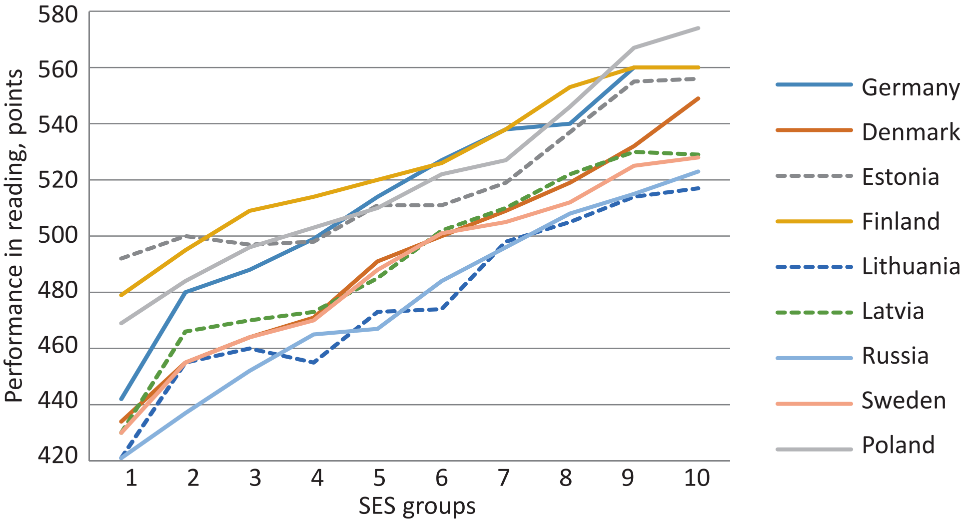


Figure 6.14 Performance of Baltic Sea countries' students in reading, in particular SES groups

Performance distribution according to the SES tends to persist over a long period of time. Figure 6.15 shows Latvian student performance in certain SES groups according to study cycles from the year 2003 onwards. It reveals that particularly low average performance is shown by the group of students with the lowest SES (this was most pronounced in the studies of 2006 and 2012, but somewhat less conspicuous in the studies of 2003 and 2009). Student performance in the second to the fifth group is relatively similar, with minor differences. Student performance in the sixth to the ninth group is markedly growing. The tenth group of students did not show a higher average performance than the ninth group of students only in the 2012 cycle. The decline in performance or failure to increase is also characteristic of other countries, – Finland, Germany, Estonia.

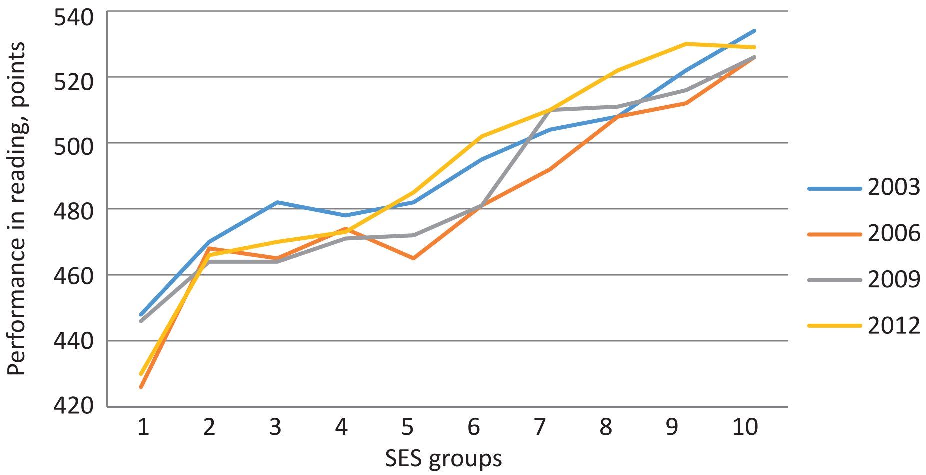


Figure 6.15 Performance of Latvian students in reading according to SES groups in four PISA cycles

Hereafter, the chapter will provide a review of the students from the highest socio-economic status group. The interrelations between the SES of this group of Latvian students and their performance are shown in Figure 6.16. First of all, it should be emphasized that the SES differences in this group are great, as there is no previous group limiting it from above. Most students' performance is higher than 491 points, which is the average of all Latvian students, many students' performance exceeds 544 points (in accordance with the fifth level of competence in mathematics). Of course, there are also students whose performance is below 420 points (the threshold of the second level of competence). In this group of students, the achievements do not correlate with the SES. A similar relationship is present also in reading (see Figure 6.16).

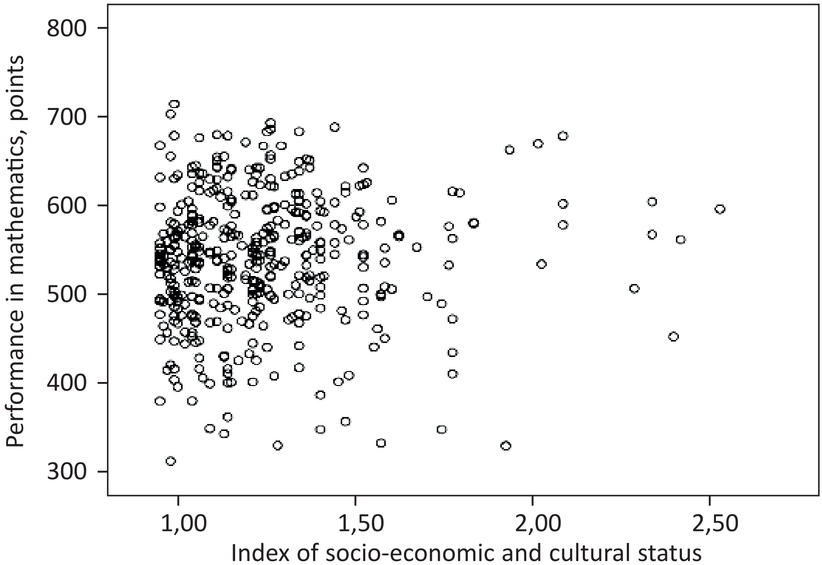


Figure 6.16 Graph of interrelations between student SES and performance in mathematics

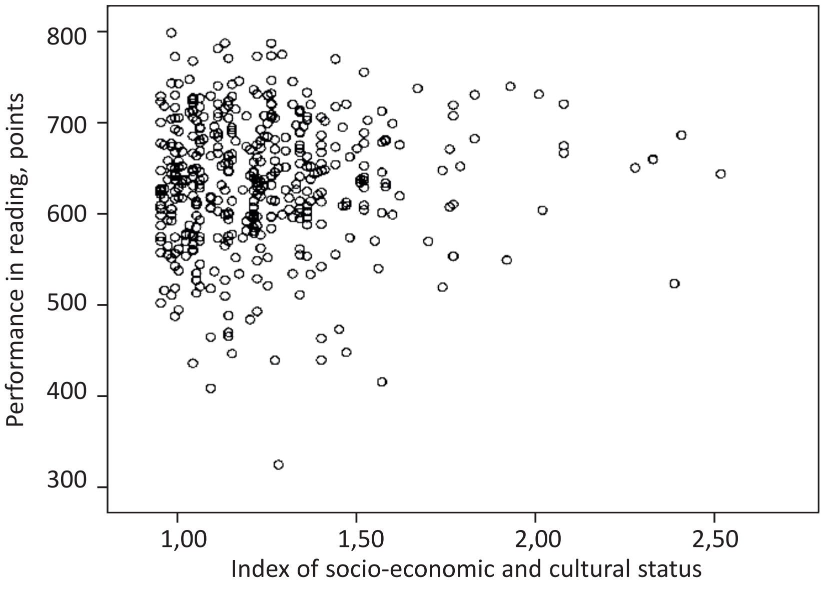


Figure 6.17 Graph of interrelations between student SES and performance in reading

Students with a high SES do not study only in Riga or the city schools, they also study in small towns and rural areas. Altogether, 211 Latvian schools participated in PISA 2012, and the students belonging to the tenth SES group studied in 116 schools, which is 55% of all schools. 34 schools (29%) had one student with a high SES, 21 schools (18%) – two students, and 91 schools (78%) had five or less students with a high SES. It should be emphasized that the relative number of schools, which are attended by the wealthier students, characterizes the equality or inequality of the schools in the country. Consequently, it can be seen that a relatively large cluster of schools (45%) has formed in Latvia, where there are no students from families with a high socio-economic and cultural capital. If the individual schools have a lot of students with a low SES, it is a threat of low performance (Johansson, Preuschoff, 2008). Scandinavian countries, Poland, and also Estonia are more socially cohesive (see Table 6.5).

Table 6.5 The number of schools in PISA 2012 in Baltic sea countries and the number of schools with students of the 10th SES group

Country	Number of schools in PISA 2012	Number of schools with students of Group 10	Percentage of schools with students of Group 10
Denmark	341	256	75
Estonia	206	143	69
Finland	311	257	83
Germany	230	148	64
Latvia	211	116	55
Lithuania	216	131	61
Poland	184	140	76
Russia	227	136	60
Sweden	209	160	77

Contemplating the difference between the performance of the highest SES group and the average performance, it can be observed that this difference has a tendency to decline (see Figure 6.18). It is particularly pronounced in Germany, where the difference from 89 points has dropped to 53 points. Also, the relatively large difference in Poland has decreased significantly.

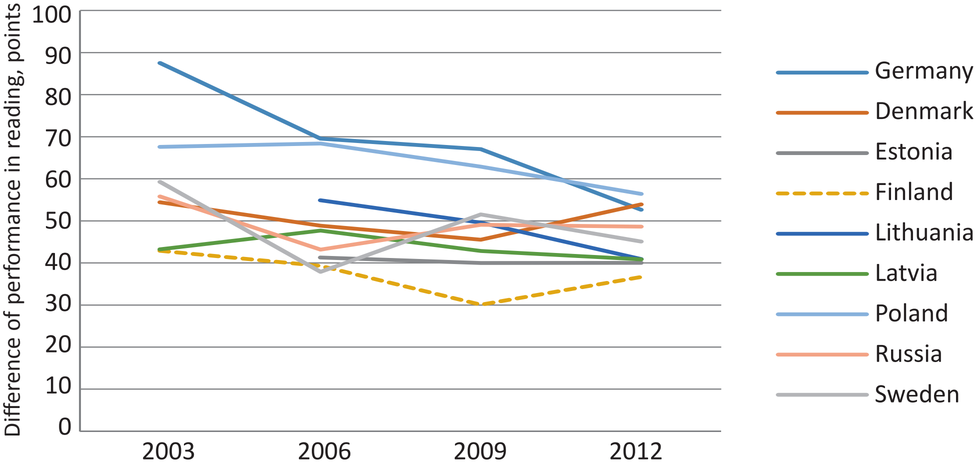


Figure 6.18 ***Difference between the performance of the highest SES group and the average performance in reading, Baltic Sea countries, from 2003 to 2012***

Results of data analysis

Student performance is influenced by many factors. At the national level, one of the factors is the national wealth – richer countries with a higher *per capita* GDP show a higher student performance. For example, looking at OECD countries' performance in mathematics, in PISA 2003 the corresponding regression coefficient of determination was 0.28, which indicates a strong performance and GDP connection (OECD, 2004). At the national level, one must take into account the location of the school – city, town, rural areas. In Latvia, a significantly higher performance is observed among the students of Riga and larger cities, lower results are shown by the students of rural schools (Geske, Grīnfelds, Kangro, Kiseļova, 2013).

An important factor in achieving high performance is the discipline – both school attendance and behaviour during the lessons. The survey of students in the framework of the study included three questions regarding truancy – late arrival at school, skipping one or more school days, or skipping a lesson within a school day. Looking at the group with a high SES, the relationship between late arrival at school and performance, as well as skipping an entire day and performance was observed. Tables 6.6 and 6.7 show the absences of the students in the highest SES group. Admittedly, Latvian students in this comparison show the lowest discipline – only 44% of the students have not arrived late at school, and only 79% have not skipped an entire school day. Just as bad is the discipline of Russia's students. The German students represent a stark contrast – 95% have not skipped a single day without justification.

Table 6.6 Answers to the question "How many times did you arrive late at school in the last two full weeks of school?"given by students with a high SES

Country	Never (%)	Once or twice (%)	Three or four times (%)	Five times or more often (%)
Denmark	58	28	9	5
Estonia	58	30	8	4
Finland	52	33	10	5
Germany	77	18	3	2
Latvia	44	35	13	8
Lithuania	56	31	8	5
Poland	57	28	8	6
Russia	52	31	8	8
Sweden	45	34	13	8

Table 6.7 Answers to the question "How many times did you skip a whole school day in the last two full weeks of school?" given by students with a high SES

Country	Never (%)	Once or twice (%)	Three or four times (%)	Five times or more often (%)
Denmark	89	9	1	1
Estonia	85	12	2	1
Finland	89	9	1	1
Germany	95	4	1	0
Latvia	79	17	2	2
Lithuania	81	16	2	1
Poland	84	13	1	1
Russia	79	16	3	3
Sweden	93	6	1	1

Of course, the unjustified absences of students are related to low performance. This is shown in Tables 6.8 and 6.9, and Figure 6.18. These tables show the standardized regression coefficients of one-parameter regression equations. In the regression, the dependent variable is the students' performance in mathematics, the independent variable – students' responses in the Likert Scale to the questions addressing late arrival to school and skipping school days. The negative coefficients point to the decrease in performance in relation to increased truancy. The observation that late arrival for school in Latvia is not connected with performance can be explained by the fact that also the students with high performance tend to arrive late at school in

Latvia. A similar conclusion could be true regarding the German students, however, the German students seldom are late. In Poland this relationship also is not statistically significant. A relatively strong relationship between missing the beginning of lessons and performance in mathematics is observed in Russia, Sweden, Estonia and Finland. The connection of performance with skipped days is not statistically significant in Germany, Poland and Sweden. However, as we see in Figure 6.18, the truants show lower performance.

Table 6.8 Relation of student performance with arriving late for school within the last two weeks. The one-parameter regression model

Country	Standardized regression coefficient	Standard error of coefficient
Denmark	-0.10*	0.04
Estonia	-0.17**	0.06
Finland	-0.18**	0.04
Germany	-0.01	0.06
Latvia	-0.05	0.07
Lithuania	-0.14**	0.05
Poland	-0.10	0.06
Russia	-0.20**	0.06
Sweden	-0.22**	0.06

* Coefficient statistically significant with 95% confidence.
** Coefficient statistically significant with 99% confidence.

Table 6.9 Relation of student performance with skipping one or more school days within the last two weeks. The one-parameter regression model

Country	Standardized regression coefficient	Standard error of coefficient
Denmark	-0.14**	0.04
Estonia	-0.14**	0.05
Finland	-0.16**	0.04
Germany	-0.07	0.10
Latvia	-0.18**	0.06
Lithuania	-0.18*	0.07
Poland	-0.09	0.05
Russia	-0.22**	0.05
Sweden	-0.04	0.04

* Coefficient statistically significant with 95% confidence.
** Coefficient statistically significant with 99% confidence.

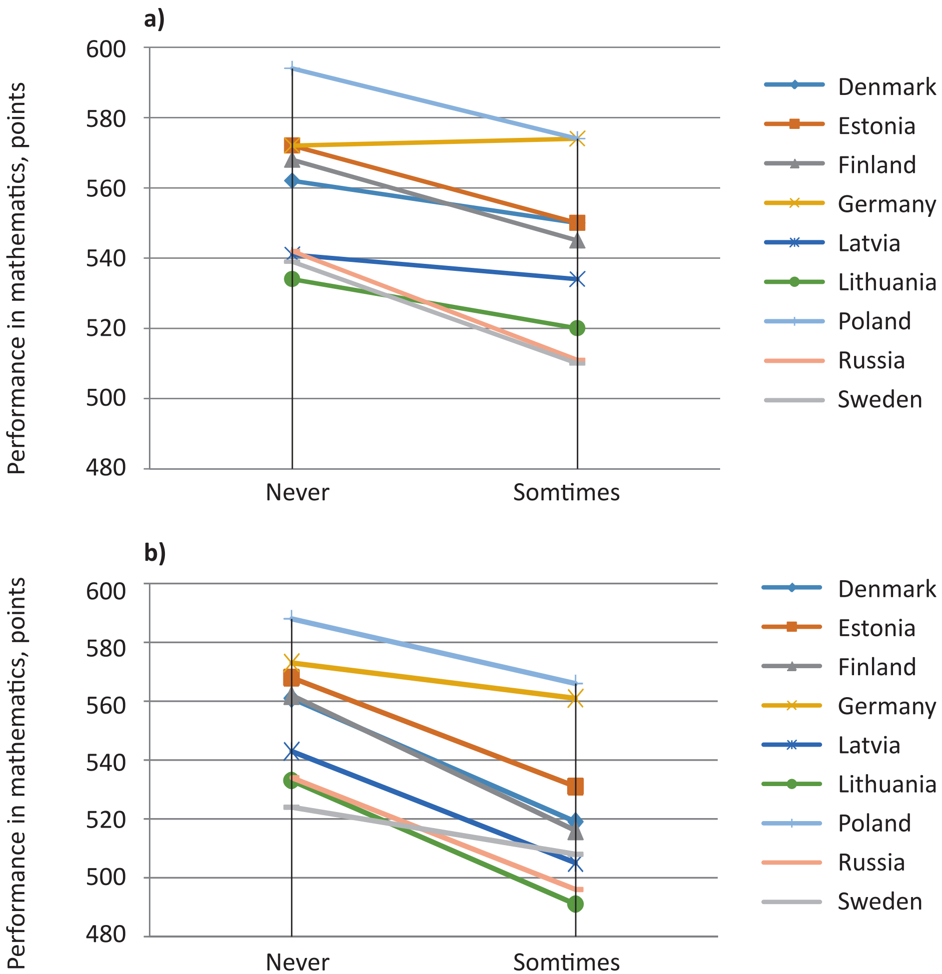


Figure 6.19 The relation of student performance in mathematics with missing the beginning of lessons (a) and skipping an entire day (b)

The disciplinary climate at school is characterized by an index designed on the basis of the students' answers to the question "How often do these things happen in your mathematics lessons? a) Students don't listen to what the teacher says. b) There is noise and disorder. c) The teacher has to wait a long time for the students to quiet down. d) Students cannot work well. e) Students don't start working for a long time after the lesson begins." The average values of the index for students with a high SES in the Baltic Sea countries are shown in Table 6.10. This index, like other PISA indices, are regulated on an average value of 0 and a standard deviation of 1. A higher index value indicates a higher discipline in the classroom. The following table shows the standardized regression coefficients of the equation, where the dependent variable is the students' performance, and the independent value is the disciplinary climate. For comparison – the lowest disciplinary climate values are shown by the Finnish and Swedish students, but the highest ones – by Lithuanian and Russian students. Positive relation of discipline to performance exists in all the Baltic Sea countries, only in Finland and Sweden this relationship is not statistically significant.

Table 6.10 Relation of student performance with disciplinary climate index. The one-parameter regression model

Country	Average value of disciplinary climate index	Standardized regression coefficient	Standard error of coefficient
Denmark	0.09	0.10*	0.05
Estonia	0.20	0.18	0.11
Finland	-0.29	0.09	0.06
Germany	0.06	0.19**	0.06
Latvia	0.10	0.13*	0.06
Lithuania	0.43	0.15*	0.06
Poland	0.11	0.25**	0.07
Russia	0.36	0.24**	0.06
Sweden	-0.13	0.14*	0.07

* Coefficient statistically significant with 95% confidence.
** Coefficient statistically significant with 99% confidence.

Table 6.11 Relation of student performance with teacher support index. The one-parameter regression model

Country	The average value of teacher support index	Standardized regression coefficient	Standard error of coefficient
Denmark	0.28	0.17**	0.05
Estonia	-0.13	0.18*	0.09
Finland	0.21	0.08	0.06
Germany	-0.39	0.13	0.07
Latvia	-0.02	0.18*	0.08
Lithuania	0.04	0.08	0.07
Poland	-0.35	0.20**	0.05
Russia	0.27	0.05	0.06
Sweden	0.39	0.15*	0.06

* Coefficient statistically significant with 95% confidence.
** Coefficient statistically significant with 99% confidence.

The teachers' support in learning mathematics and, of course, also other subjects, is of a paramount importance. Teachers' support is characterized by teacher support index. The lowest teacher support index is observed in Germany and Poland, the highest – in Sweden, Russia and Denmark. Looking at the relation of high-SES students' index to performance, it is obvious (see Table 6.11) that the relationship is determined – the students with higher performance feel a greater teacher support. This effect is well depicted in the graphs showing the relation of student performance and student answers regarding teachers' help and support during mathematics lessons. The group of questions addressed the situations during the lessons of mathematics. Figure 6.20 shows the connection between performance and assertion "The teacher shows an interest in every student's learning". The students with high performance are more inclined to think that the teachers are interested in their students' achievements. Figure 6.21 shows the relation between performance and assertion "The teacher gives extra help when the students need it". Here again the students with higher performance indicate a greater teacher's assistance. Those with higher performance also assert that "The teacher helps the students with their learning" (see Figure 6.22). On the average, higher performance is characteristic of the students, who say that often "The teacher continues teaching until the students understand" (see Figure 6.23). However, the Lithuanian students are an exception here. The teacher should also give the students an opportunity to express opinions, which is also related to higher performance (see Figure 6.24).

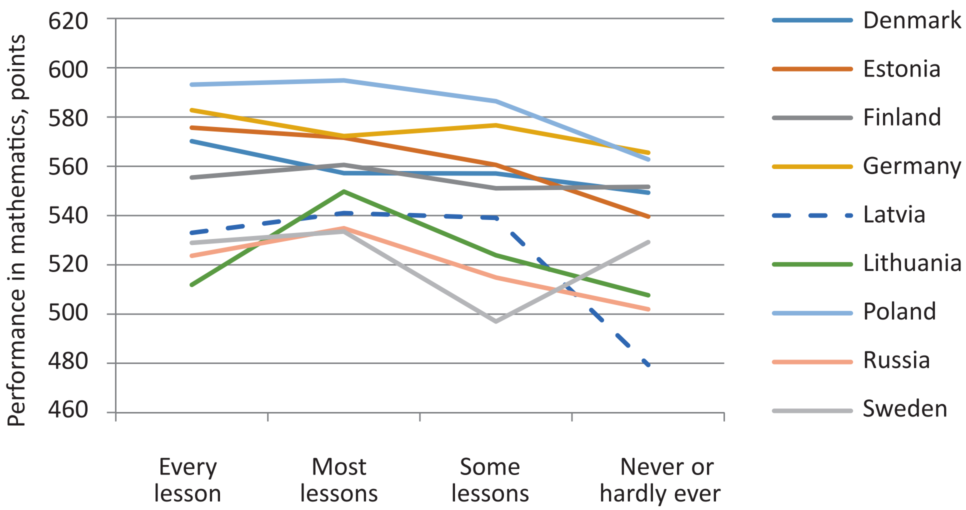


Figure 6.20 The relation of high-SES student performance with the assertion "The teacher shows an interest in every student's learning"

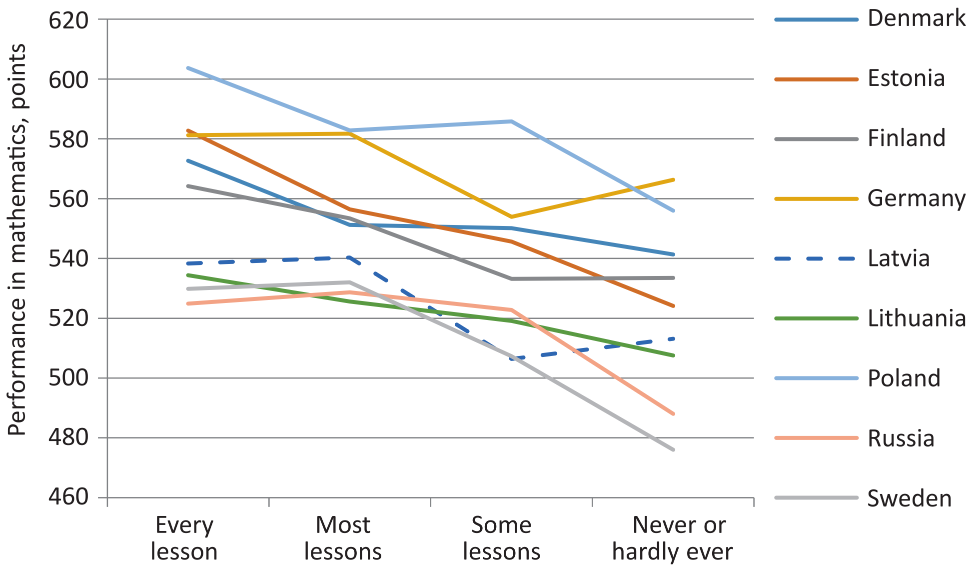


Figure 6.21 ***The relation of high-SES student performance with the assertion "The teacher gives extra help when students need it"***

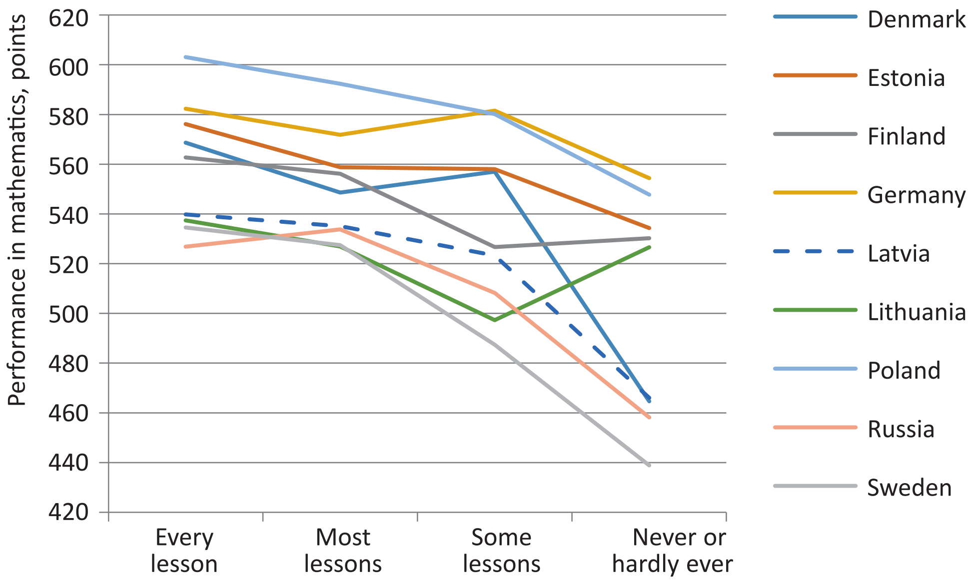


Figure 6.22 ***The relation of high-SES student performance with the assertion "The teacher helps students with their learning"***

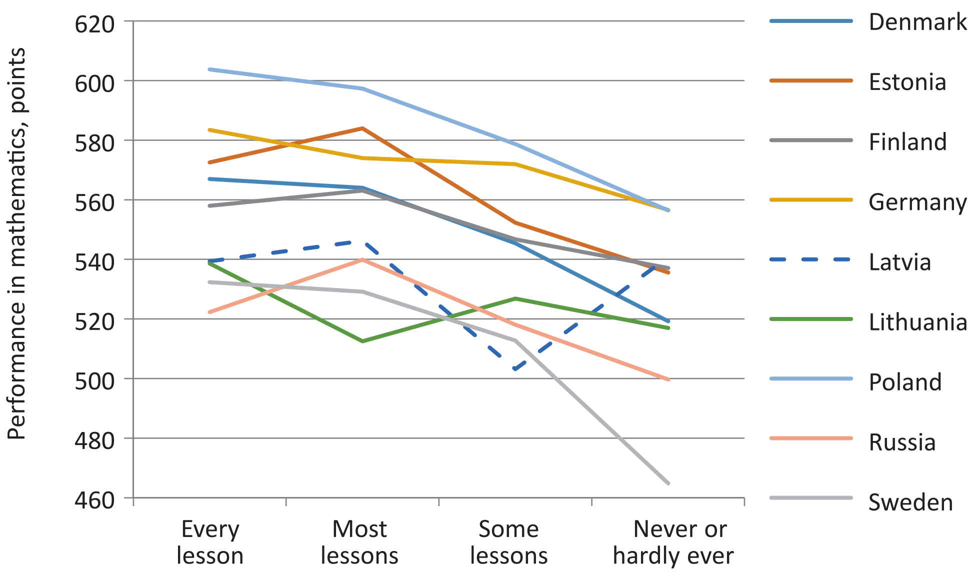


Figure 6.23 ***The relation of high-SES student performance with the assertion "The teacher continues teaching until the students understand"***

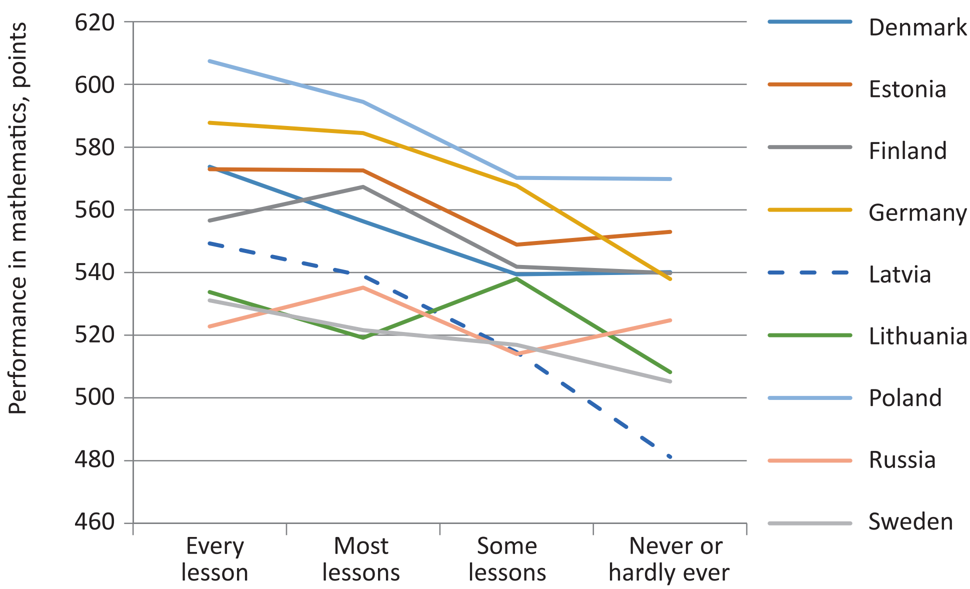


Figure 6.24 ***The relation of high-SES student performance with the assertion "The teacher gives students an opportunity to express opinions"***

Table 6.12 Time devoted by high-SES students to homework

Country	Hours on average	Division of students according to time devoted to homework (%)			
		0–4 hours	5–9 hours	10–14 hours	15 hours or more
Denmark	4.9	55	36	7	2
Estonia	7.4	35	37	18	11
Finland	3.1	80	18	2	0
Germany	5.0	57	29	10	3
Latvia	7.0	35	36	20	10
Lithuania	7.6	33	33	23	11
Poland	7.2	42	31	15	12
Russia	10.9	18	29	27	26
Sweden	4.5	64	25	8	3

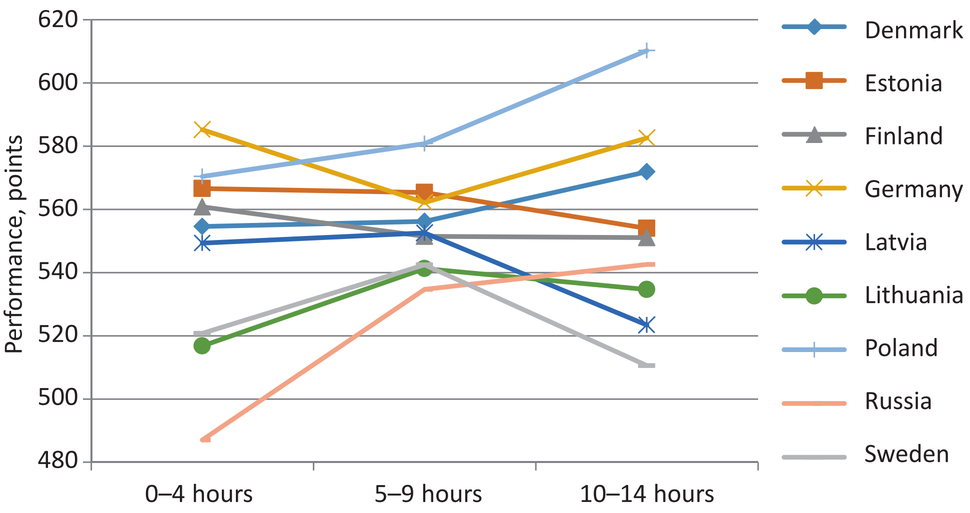


Figure 6.25 The relation of high-SES student performance with the time devoted to homework

Traditionally, lessons at school are planned with a view that homework will also be done. This is particularly characteristic of the post-Soviet countries. Among the Baltic Sea countries, the greatest amount of time to homework is devoted by Russia's students with a high SES (on average almost 11 hours, or about two hours every day). Estonian, Latvian, Lithuanian and Polish students devote an average of 7 to 7.6 hours per week to homework. The least time to housework is devoted by Finnish students – an average of only three hours a week (see Table 6.12). Here we actually see two different approaches to studies. The high performance group includes Poland, Estonia (a lot of homework), Germany (medium amount of homework), Finland (little homework). The lowest performance is shown by the Russian students who relatively have the biggest amount of homework.

Figure 6.25 shows the relationship between performance and the time spent at homework. The increase in performance level with increasing duration of homework is observed in Poland, Denmark and Russia. In Latvia and Estonia, where students spend long hours doing homework, they have even slightly lower results. This can be explained by the less talented students' desire to obtain good grades or inefficient homework assigned by the teacher, requiring a large input of time.

And, of course, an important factor in performance is the students' motivation. We shall review three indexes related to students' attitudes towards mathematics: Anxiety about mathematics, Interest in mathematics and External motivation for learning mathematics.

The index "Interest in mathematics" is formed on the basis of student opinion regarding these assertions: "I enjoy reading about mathematics", "I look forward to my mathematics lessons", "I do mathematics because I enjoy it", "I am interested in the things I learn in mathematics".

The index "External motivation for learning mathematics" is formed on the basis of the students' opinions regarding these assertions: "Making an effort in mathematics is worth it because it will help me in the work that I want to do later on", "Learning mathematics is worthwhile for me because it will improve my career prospects", "Mathematics is an important subject for me because I need it for what I want to study later on", "I will learn many things in mathematics that will help me get a job".

The index "Anxiety about mathematics" is formed on the basis of the students' opinions regarding these assertions: "I often worry that it will be difficult for me in mathematics classes", "I get very tense when I have to do mathematics homework", "I get very nervous doing mathematics problems", "I feel helpless when doing a mathematics problem", "I worry that I will get poor grades in mathematics."

Table 6.13 The relation of student performance with index of students' external motivation for studying mathematics. The one-parameter regression model

Country	Average value of index "External motivation for studying mathematics"	Standardized regression coefficient	Standard error of coefficient
Denmark	0.56	0.14**	0.05
Estonia	0.19	0.19*	0.08
Finland	0.32	0.30**	0.05
Germany	-0.04	0.15*	0.06
Latvia	0.22	0.10	0.06
Lithuania	0.41	0.15*	0.06
Poland	0.14	0.28**	0.06
Russia	-0.06	0.18*	0.07
Sweden	0.50	0.24**	0.08

* Coefficient statistically significant with 95% confidence.
** Coefficient statistically significant with 99% confidence.

The external motivation for learning, in this case, is related to the students' perception of their future careers, and not with any immediate rewards for the accomplished work. It is a long-term motivation that in many 15-year-olds can be very weak – they do not yet seriously plan their lives. A teacher with interesting lessons will not promote it, either. It is therefore natural that the external motivation does not have a very strong impact on student performance, yet it has a positive effect on performance in all the Baltic Sea countries, the effect is statistically significant (except Latvia) (see Table 6.13). The highest influence of the external motivation is observed in Finland and Poland. Of the countries under consideration, the highest External motivation index values are achieved by Danish, Swedish and Lithuanian students, the lowest – by German and Russian students.

Table 6.14 shows the extent to which the performance is affected by the interest in mathematics (Internal motivation). Standardized regression coefficients are significantly higher than in the case of the external motivation, all of them, except the one for Lithuania, are statistically significant. On average, the greatest interest in mathematics has been expressed by the Danish, Swedish and Russian students, the least – by the Polish, German and Latvian students.

Student performance has a very strong correlation with the anxiety about mathematics (see Table 6.15). In other words – the students with lower performance are afraid to do mathematics problems, doubt their abilities, feel helpless in solving mathematical problems. This could be due to the previous negative experiences.

If the teacher ensured that the students solve the tasks assigned to them, these fears would not arise. Students need both psychological support and assistance in solving specific tasks.

Table 6.14 The relation of student performance with index of students' internal motivation for studying mathematics. The one-parameter regression model

Country	Average value of index "Internal motivation for studying mathematics"	Standardized regression coefficient	Standard error of coefficient
Denmark	0.62	0.33**	0.05
Estonia	0.13	0.30**	0.09
Finland	0.06	0.31**	0.05
Germany	0.03	0.33**	0.06
Latvia	0.04	0.26**	0.06
Lithuania	0.27	0.13	0.07
Poland	-0.04	0.30**	0.06
Russia	0.34	0.26**	0.05
Sweden	0.41	0.36**	0.06

* Coefficient statistically significant with 95% confidence.
** Coefficient statistically significant with 99% confidence.

Table 6.15 The relation of student performance with the index of students' anxiety about mathematics. The one-parameter regression model

Country	Average value of index "Anxiety about mathematics"	Standardized regression coefficient	Standard error of coefficient
Denmark	-0.80	-0.49**	0.04
Estonia	-0.36	-0.39**	0.07
Finland	-0.41	-0.47**	0.04
Germany	-0.48	-0.43**	0.05
Latvia	-0.17	-0.38**	0.08
Lithuania	-0.24	-0.44**	0.05
Poland	-0.09	-0.51**	0.05
Russia	-0.09	-0.45**	0.05
Sweden	-0.69	-0.44**	0.05

** Coefficient statistically significant with 99% confidence.

Summary

The analysis focussed on discovering the factors that influence the performance of students with a high SES. For data analysis, the Baltic Sea countries were chosen, all of which participated in the PISA study and are geographically close – this, in turn, determined the mutual influence and intense cultural exchanges both in peaceful times and as a result of warfare at different times throughout history. The socio-economic and cultural status index extensively used in PISA – ESCS – was chosen for SES measurement. The high SES group in each country was defined as 10% student group with the highest indicator values of the socio-economic and cultural status.

The average mathematics performance of the students with a high SES is higher than the average performance shown by the students from other SES groups in all countries except Germany. In Latvia, the students of the group with a high SES study in 116 schools from 211 schools participating in the study. In other words, students with a high SES study only in 55% of all schools –compared with other countries, it points to the socially heterogeneous school system in Latvia, that poses the threat of segregation.

Looking at the factors that influence the performance of students with a high SES, student discipline is of a particular importance (truancy, behaviour during lessons) and motivation, the teacher's assistance in learning and psychological support. Although it is sometimes argued that the students with a high SES can afford to take time off and still show high performance ("they are smart and learn at home"), it cannot be proved. On the contrary – both late arrival at school and skipping whole days of school leave a negative impact on student performance in all the reviewed countries. It should be noted that Latvian student discipline with regard to school attendance is particularly low. The discipline of students during the lessons is also essential.

The performance has a greater relation to the internal motivation of the 15-year-olds (interest in mathematics), but it is less related to the external motivation (relationship of mathematics to further training and employment). This is easily explained by the assumption that students have not yet defined their goals in life, which leads to lack of long-term motivation. Students live in the present and do not plan their future. Such a lack of goals can lead to infantilism in adulthood. Performance in mathematics has a strong negative correlation with anxiety about mathematics, i.e., fear to solve mathematics problems. Students need help both in the form of psychological support and explanation of mathematics themes.

The highly performing students more often point out that the teacher shows an interest in every student's progress; that additional assistance is provided, if required; that the teacher keeps explaining the subject matter until the students have

understood it. Contrary to the popular opinion that teachers tend to help students with low performance more, the students with high performance indicate this assistance more frequently.

The study once more confirmed the cornerstones of a good education – requirement of high student discipline, strong teacher support in mastering the subjects, and that all the stakeholders – parents, teachers, intellectuals, the media – should persevere in raising the students' motivation to learn.

6.4. Performance distribution of Latvian students in international comparison and its dependence on urbanization, type of school, education program implemented by school and student's gender

The comparison of students' performance distribution in Latvia with the OECD average and the relative number of students with low and high performance

Latvian students' performance distribution in mathematics is close to normal (see chart in Figure 6.26), and it can be asserted that the test objectives and items were appropriate for the students of Latvia. Similarly to reading and science, also in mathematics there are students with very poor literacy (in level 1 or below – less than 358 points), and students with very high achievement (in level 6 – more than 669 points).

The average proficiency of Latvian students in mathematics according to PISA 2012 complied with the OECD average. However, the average level of achievement in the country and the average level within one or another group of countries (OECD, EU, etc.) is only one basic indicator, which by itself is insufficient for making comprehensive conclusions and recommendations. A lot more detailed information is provided by Latvian performance distribution analysis (Figure 6.26) and comparison with the various OECD country average performance distribution parameters, as it is conventionally done in the OECD PISA cycles.

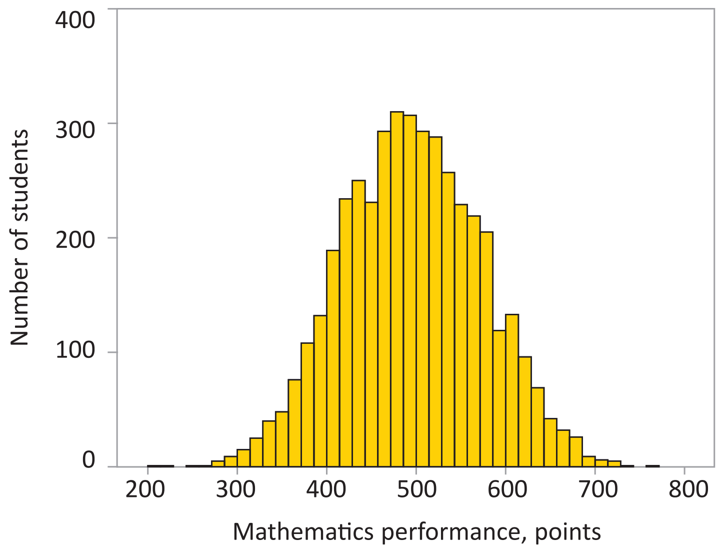


Figure 6.26 Latvian student performance distribution in mathematics

One of the most important distribution indicators is variation of performance – the difference between the students with the highest and the lowest performance. A smaller variation shows that the education system provides a comparatively greater equity regarding the education quality throughout the country, and, consequently, students have a greater opportunity to obtain education of equal quality. Of course, the average value of student performance distribution is also of a great importance. The OECD average distribution and the distribution in Latvia often nearly matches the so-called normal distribution. The variation parameters of distribution can be measured in different ways, for example, as distribution variance (if the average OECD distribution variance is taken as 100%, the variance in Latvia constitutes only 78%), as standard deviation, or as the score-point difference between the top 10% and bottom 10% of students, and similar methods. Figure 6.27 shows that on the average in OECD countries in the mathematics PISA 2012, the score-point difference between the 90th and 10th percentiles was 238 points, in Latvia this difference constituted 210 points. Only two other OECD countries had a similarly low variation – Estonia (209 points), and Mexico – (190 points) (OECD, 2013a, p. 305). It should be noted that in case of countries with a significantly lower average value of performance (as in Mexico and many non-OECD countries) the small variance is explained by the fact that the distribution encompasses very few students with a high and average performance compared to the OECD average.

Consequently, PISA 2012 mathematics performance variation in case of Latvia was one of the smallest in comparison with other OECD countries. Performance

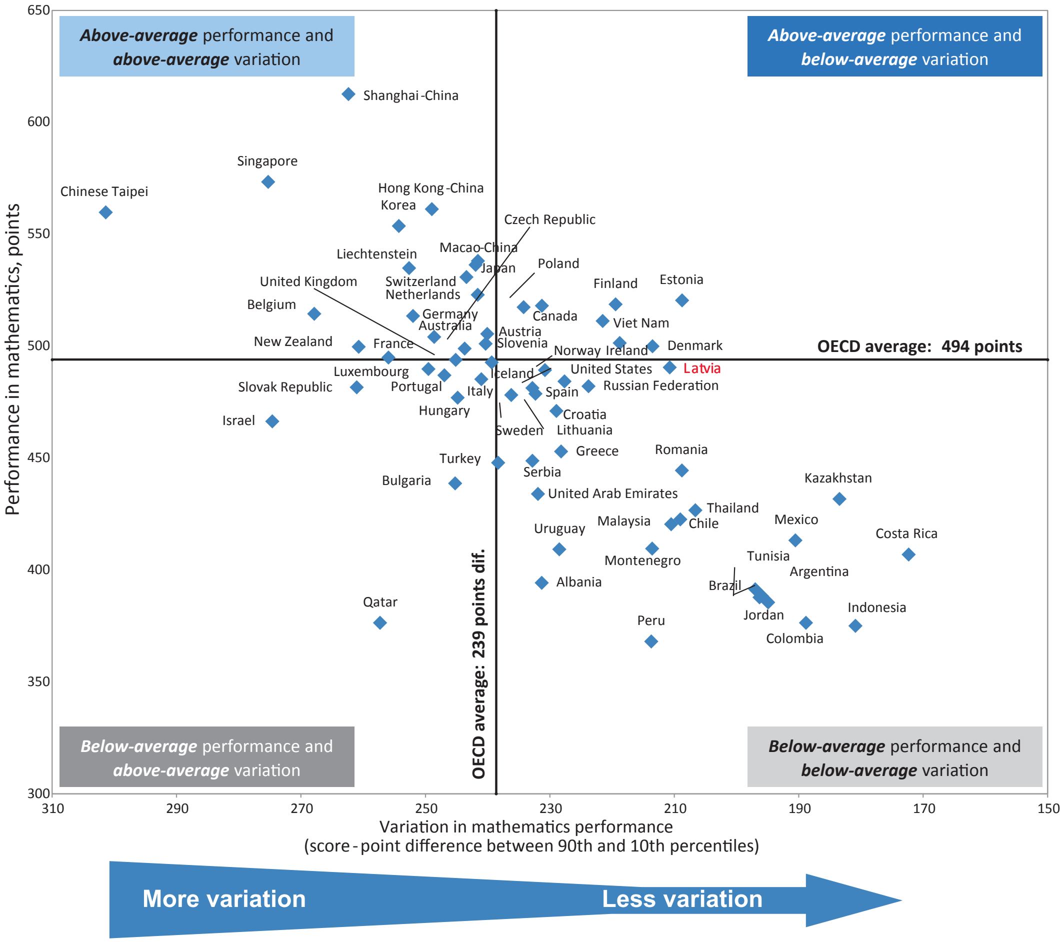
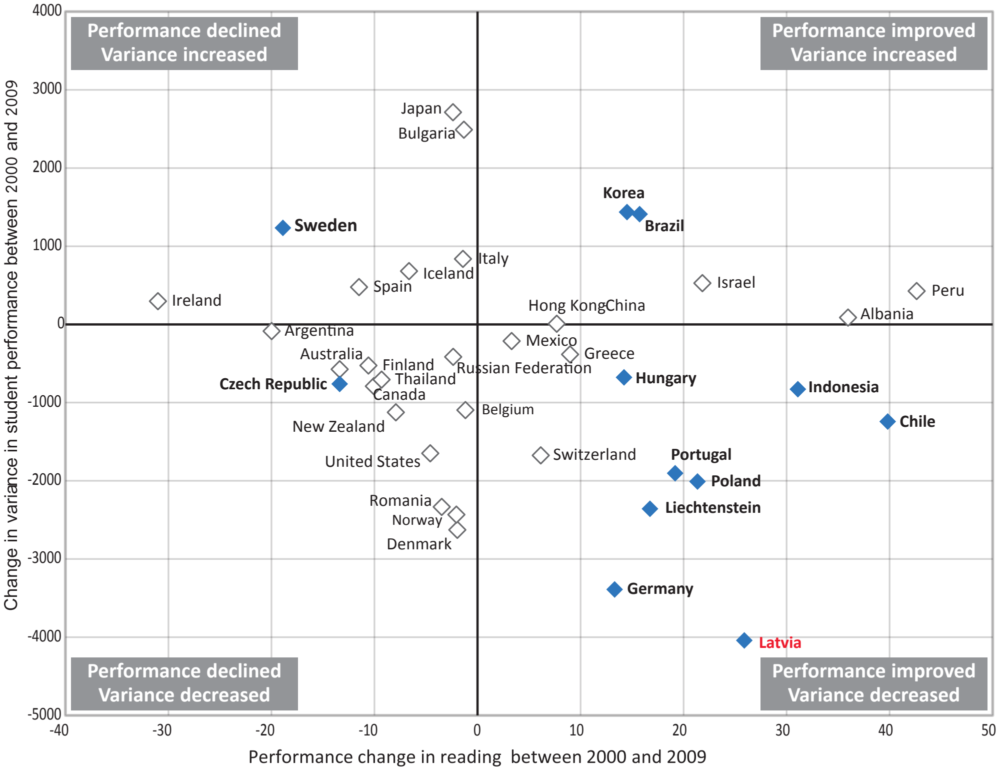


Figure 6.27 Relationship between performance in mathematics and variation in performance, PISA 2012, (OECD, 2014d, p. 72)

variation of Latvian students has been lower than the OECD average also in other PISA cycles and in all content areas, it has also decreased with a simultaneous increase in performance (Figure 6.28).

Figure 6.28 depicts the situation regarding reading literacy. It certainly characterises Latvian education system positively, because it means that the proficiency of diverse students (showing high, low and average performance) in various schools is less disparate than on the average in OECD countries – therefore, the education system ensures a comparatively greater equity in the quality of education in comparison to the OECD average.



Note: Countries in which both the change in variance and score point change in reading are statistically significant are marked in a darker tone.

Figure 6.28 Change in variance and change in reading performance between 2000 and 2009 (OECD 2010d, p. 76)

The facts described above – the average results in Latvia and OECD are practically the same, distribution in both cases is close to normal, while the indicators of Latvian student distribution variation are considerably lower – seem to automatically indicate that there should be relatively fewer students with a low performance and, unfortunately, fewer students with a high performance in Latvia than the average in OECD countries, because the low and high performance boundaries are determined according to the average OECD countries' distribution, which has a significantly greater variance.

This is generally confirmed by the results obtained in the research cycles. We are satisfied, of course, that Latvia has relatively fewer students with lower performance than the average in OECD countries, but the concern is caused by the fact that there are few students with a high performance in comparison with the OECD average within the given cycle of research and the content area, considering that those brightest students will have a major role in the country's future.

The situation is schematically represented in Figure 6.29, where the blue curve shows the OECD student performance distribution, and the continuous orange curve marks the Latvian students' performance distribution. OECD and the Latvian students' average performance is the same, as shown by the identical position of the maximum values of the curves with respect to the horizontal axis. The curves have different heights in order for the area below to be the same, it does not denote higher performance of Latvian students. The vertical line marks the limits of students with low and high performance in the OECD countries' performance distribution. It is evident that in proportion to the total number of students (i.e., the area under the respective distribution curve part) there are less students with low and also high performance in Latvia than in the OECD. However, the increase of Latvian student performance (i.e., the shift of the distribution designated with the orange curve in the direction of the high performance shown by the dashed curve) would increase the relative number of students with a high performance, and reduce the relative number of students with a low performance.

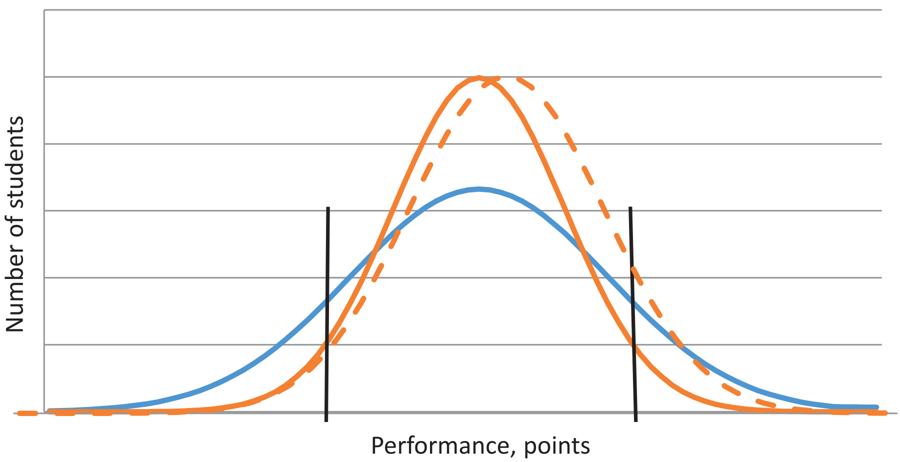


Figure 6.29 ***Schematic student performance distribution in Latvia and OECD countries***

The analysis given previously shows that in Latvia it is essentially necessary to raise the quality of education (students' literacy in mathematics, science and reading) as a whole, thereby increasing both average achievement and the relative number of students with a high performance, and decreasing the number of students with a low performance. That is the result to be achieved according to the strategic development documents of Latvia, for example, "The National Development Plan of Latvia for 2014–2020," sets forth the aim to "reduce the proportion of children and young people with low basic competencies, while increasing the number of students who demonstrate the highest level of competencies". The document defines the following performance indicators related to achievement of this goal: the relative number of students in the OECD PISA highest (levels 5 and 6) and lowest (level 1 and below) literacy levels in reading in 2020. Admittedly, the benchmarks to be reached in Latvia by 2020 are quite ambitious – 9% with regard to the highest performance and 13% to the lowest, especially concerning the highest performance, given that the corresponding measured values in PISA 2012 were 4.2% and 17%. European Union Strategy for 2020 (European Education and Training 2020 Strategy) proposes to reduce the number of students with low performance in mathematics, science and reading to 15% by 2020. The above documents are also used in planning the courses of action in "Education Development Guidelines 2014–2020."

It is important to be aware of the approximate number of students encompassed by the above-mentioned relative indicators, for example, 4% correspond to approximately 750 students with a high performance in reading, 9% –to as many as 1700 students, if the number of students has not changed (according to the OECD PISA data, 18.8 thousand students aged 15 studied in the schools of Latvia in 2012). Therefore, this is not a discussion about, say, a few dozen winners of international competitions, although, of course, the teachers' efforts in training many students for Latvian and international school subject Olympiads greatly contribute to raising the performance.

Certainly, respecting each student's everyday accomplishments and the level achieved so far is an important mission of the teacher's work, and the educators know that teaching good and excellent students is different from teaching weaker students, who study in the same class and attend the same lessons. It has always been a great challenge for teachers, demanding great professionalism. Therefore, the current secondary analysis of the PISA data is dedicated to finding the factors contributing to higher student performance (see Chapter 9). Another aspect important for improvements in the quality of work encompasses other issues related to educational work organization and policy – how and why the quality levels significantly differ in different schools, and whether any reforms are needed (see further), etc.

Performance distribution variation within schools and between schools

To continue the analysis of Latvian student mathematics performance variation in the international context, it is important to clarify, what part of the variation is determined by the differences between the student performance within a school and the part that is influenced by the difference between the schools.

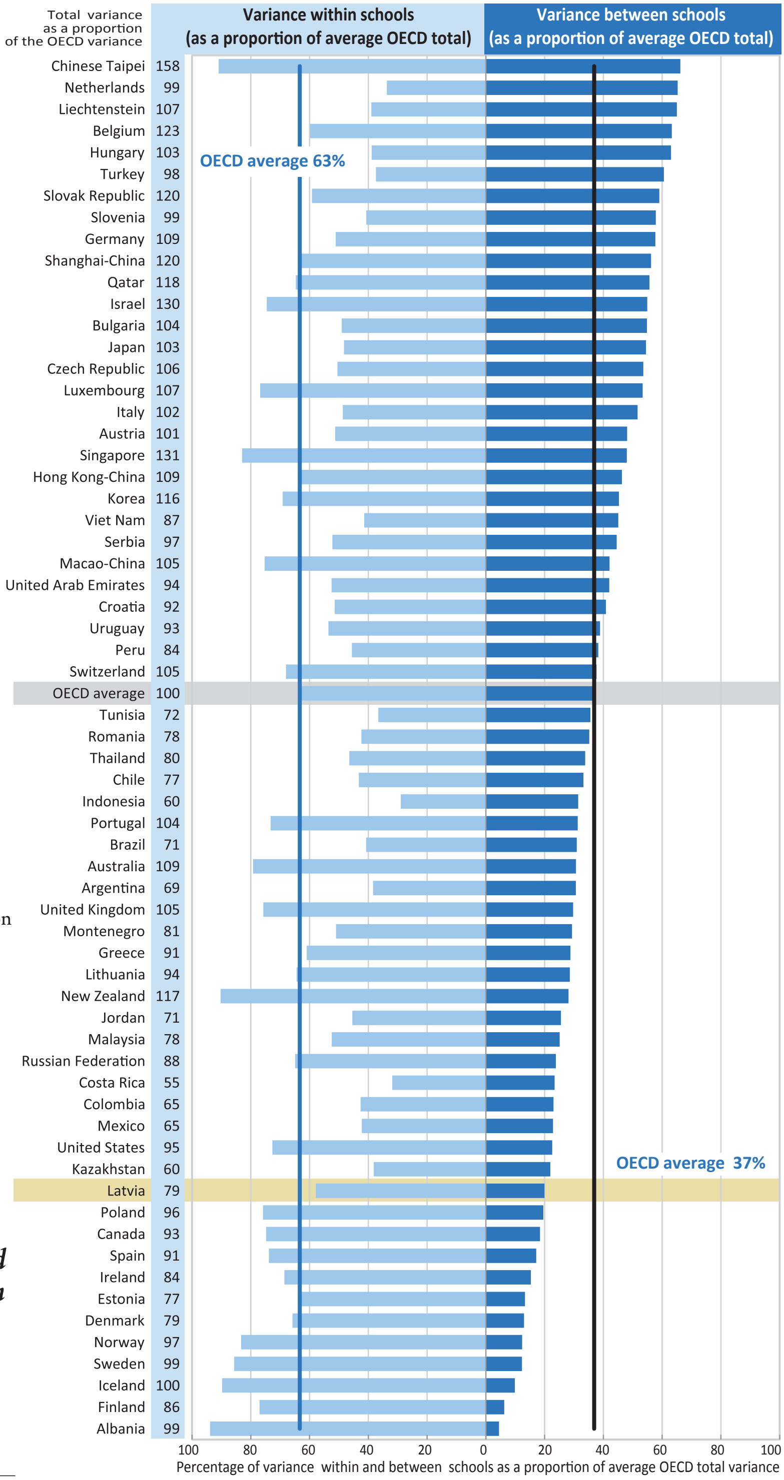
Figure 6.30 shows the extent to which the fifteen-year old students' performance in mathematics has been dispersed at the student and school level in each country participating in the study. The red-coloured columns represent the difference between the results achieved by students in different schools (between-school variance), while the gray columns show the performance variation part, that is attributable to that segment of differences in the results, which is due to the differences in the school. The vertical lines mark the average value of OECD countries' students' performance variance related to the differences between schools (37%) or within the same school (63%).

In comparison with the OECD PISA 2006 and 2009 cycles, Latvian students' performance variation on the between-school and within-school level has changed slightly, maintaining a constant tendency – the variance is lower than the average of OECD countries (see Table 6.16). This is particularly true of the between-school variance, which in Latvia is about two times lower than the average for OECD countries.

Table 6.16 The change between school and within school variance in Latvia, PISA 2006–2009–2012

OECD PISA cycle	Variance between schools (%)		Variance within schools (%)	
	Latvia	OECD average	Latvia	OECD average
2006	15	33	65	68
2009	16	42	60	65
2012	20	37	58	63

Figure 6.30. and Table 6.16 show the differences in performance between the schools in Latvia, which generally are much smaller than the average in OECD countries, and which largely are determined by SES differences, see Chapter 6.2). Consequently, to look for possible causes and solutions for decreasing the performance disparities between schools, the school groups with different SES should be distinguished and analyzed in greater detail. In this respect, the biggest difference can be observed between rural and urban schools.



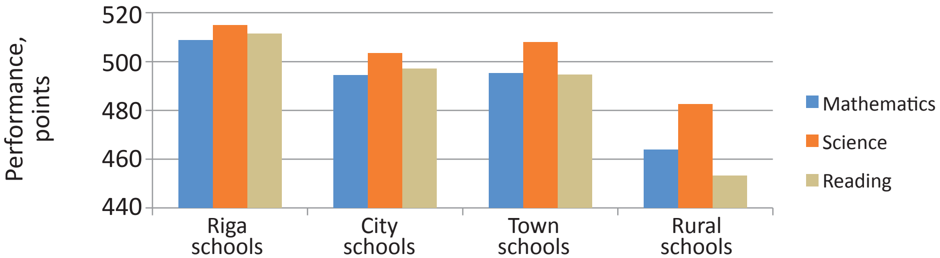
Countries and economies are ranked in descending order of the between-school variance as a proportion of the total variance in performance across OECD countries.

Figure 6.30 Total variance in mathematics performance and variance between and within schools, OECD PISA 2012 (OECD, 2013c, p. 47)

The relation of students' average performance to the location and type of school

The comparison of students' performance (in mathematics, science and reading) by urbanization or the location of the school is shown in Figure 6.31. Similar to the results of previous PISA cycles (see Figure 6.32), in PISA 2012 the best results again were demonstrated by the students of Riga schools, and the weakest – by the students of rural schools. Similarly, the average performance of Latvian students in Riga, urban and, particularly, rural schools was higher in science in comparison with the results achieved in other content areas.

As of 2003, student performance in mathematics depending on the location of the school has not considerably changed. The performance of students from Riga schools has slightly increased, while others have virtually remained on the level of 2003 (see Figure 6.32).



Note: Riga – capital city of Latvia, cities – Daugavpils, Jēkabpils, Jelgava, Jūrmala, Liepāja, Rēzekne, Rīga, Valmiera and Ventspils

Figure 6.31 The average mathematics, science and reading performance distribution of Latvian students according to school location, PISA 2012

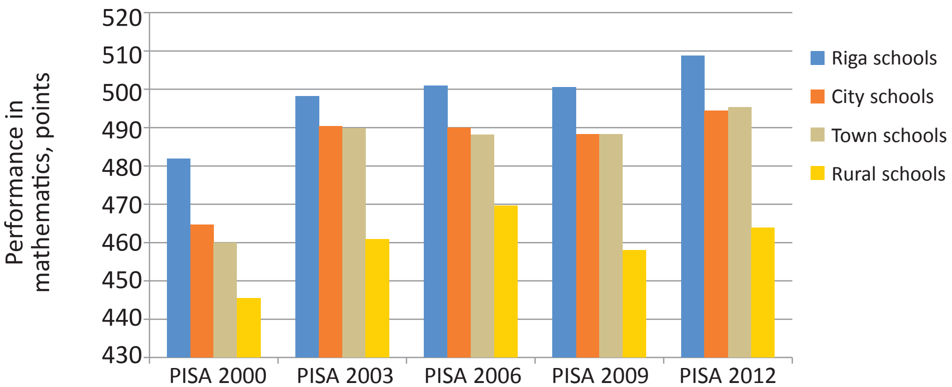


Figure 6.32 The average mathematics performance distribution of Latvian students according to school location PISA 2000–2003–2006–2009–2012

Latvian student performance distribution according to the school location and type of school (see Figure 6.32) is similar, because half of primary school students attend rural schools, yet their share is small in Riga and the largest cities (see Table 6.17). On the other hand, about one fifth of the secondary school students learn in rural areas and there are no gymnasiums.

Table 6.17 The distribution of students participating in PISA 2012 according to the type of school, language of studies, and school location

	Riga schools (%)	City schools (%)	Town schools (%)	Rural schools (%)
Type of school				
Gymnasiums	31	33	36	0
Secondary schools	37	21	20	22
Basic schools	12	8	29	51
Language of studies				
Latvian	19	16	27	38
Russian	64	22	4	10
Schools with two types of programs (Latvian and Russian)	1	25	15	59

Figure 6.33 shows the average performance distribution of Latvian students in PISA 2012 in all PISA content areas, depending on the type of school. In order to compare the performance of basic school (grades 1–9) students to the secondary school (grades 7–12 or 1–12) and gymnasium student performance (grades 7–12), the results of the tenth and higher grade fifteen-year olds are not included in the comparison (in PISA 2012, 3% of all participants belong to that category). Schematic diagram of Education System of Latvia is available, for example, European Commission/EACEA/Eurydice, 2015. The Structure of the European Education Systems 2015/16: Shematic Diagrams. Eurydice Facts and Figures. Consequently, the average performance in mathematics, reading and science shown by Latvian basic school students is lower than the performance of the secondary school and gymnasium students. An analogous correlation can be observed within the previous PISA cycles and in other international studies.

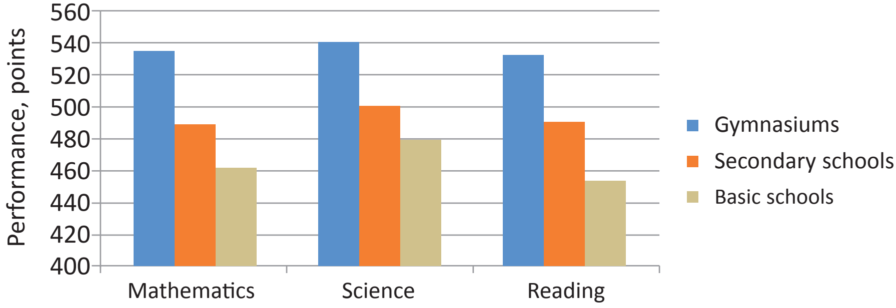


Figure 6.33 The average performance distribution of Latvian students according to the type of school

In order to make a more accurate conclusion about the higher performance in secondary schools in comparison with basic schools, one should take into account the previous analysis regarding the relative numbers of students in different types of schools, depending on their location (Table 6.16). It is more correct to compare the achievements of secondary schools and basic schools separately in rural areas, in the cities, the urban environment and Riga (see Figure 6.34). The greatest difference can be observed particularly in Riga, where the performance of a student attending a secondary school on the average is higher by 30 points in comparison to the student of a basic school. The difference is less pronounced in the respective rural schools and schools of cities – 18–20 points, the performance gap in the town secondary schools and basic schools is very small.

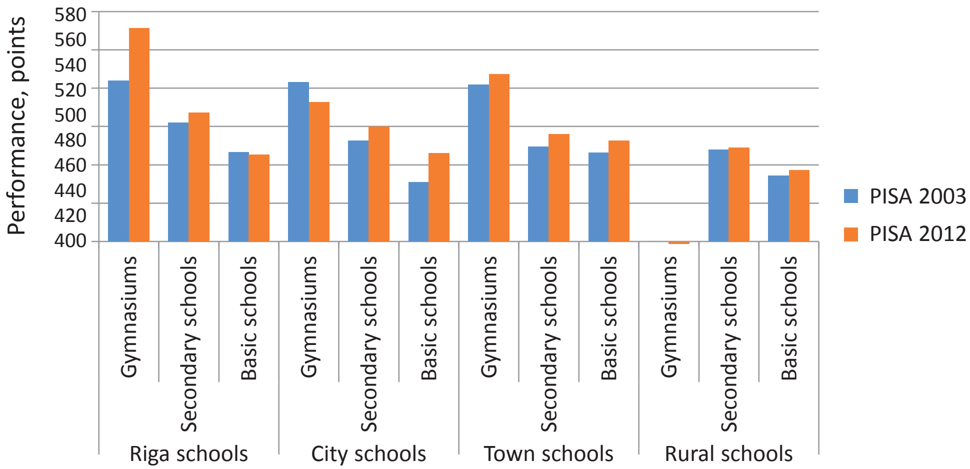


Figure 6.34 The average mathematics performance distribution of Latvian students according to the type of school and its location, PISA 2003 – PISA 2012

Comparing the change in students' performance in mathematics from 2003, both according to the school location and type (see Figure 6.34), the rise in performance can be observed everywhere, except among Riga basic school students and the students of gymnasiums in cities. The largest and statistically significant increase is observed with regard to Riga gymnasium students.

The previous analysis confirms that the equity of education in Latvia has a definite relation to the differences in the SES in rural, urban areas and Riga, and to various types of schools (see Table 6.18).

Table 6.18 Student SES differences in rural schools and schools of major cities

Year of research	Latvia			OECD		
	Rural areas	Large cities	Difference	Rural areas	Large cities	Difference
2012	-0.79	0.12	0.91	-0.33	0.15	0.48
2009	-0.50	0.26	0.76	-0.30	0.19	0.49

Note: The data in the table is presented according to the OECD classification, the group of large cities includes Riga schools, the rural school group – rural schools and schools in the towns with population up to 3000.

According to PISA 2012 data, the average SES index in Riga is 0.12, in large cities of OECD 0.15, whereas in the rural schools of Latvia this index is relatively much lower than in OECD countries, i.e., -0.79, in comparison with -0.33 on average in OECD countries (besides, it complies with the OECD classification, where a school is considered rural, if it is located in a place with less than 3000 inhabitants, therefore a certain number of Latvian small town schools is included in the OECD rural school category). The difference of the SES index value in large cities and rural areas in 2012 on the average in OECD countries was 0.48, while in Latvia – 0.91. The comparison of PISA 2012 and 2009 results shows that this difference has grown in Latvia – in 2009 it was 0.76, in 2012 – 0.91, and 0.49 – an average in OECD countries. The proportion of the rural students in the total number of Latvian fifteen-year-old students is about twice as large as the average in OECD countries. Therefore, it is understandable that the rural students in Latvia due to objective reasons need a lot more support than on the average in OECD countries.

The results given by PISA cycles and other studies (IEA TIMSS, PIRLS, CIVIC– Civic Education Study, ICCS) constantly show lower average student performance levels in the Latvian rural schools with regard to all content areas compared to the performance shown in towns, cities and in Riga. It basically corresponds to the situation in most of the countries participating in PISA. However, PISA 2012 results show that the differences observed in Latvia with regard to performance (especially the disparities between the rural and Riga schools) are relatively large compared to other OECD countries. The differences in performance significantly decrease after accounting for SES differences in rural areas and large cities (in case of Latvia – Riga). The correction means that, using the linear regression, the difference in achievement is computed for an essentially hypothetical situation, in which the SES is the same in urban and rural areas. The measured performance differences in the rural areas and Riga equal 52 points (PISA 2012, mathematics, classification into urban and rural areas according to the OECD scale), after accounting for SES, the difference still remains statistically significant – 21 points. Figure 6.35 shows that the SES differences do not explain everything in the case of Latvia, consequently, there are other factors why rural areas show lower performance. However, in some other countries after correction the performance in rural areas and cities begins to converge (the difference in Estonia decreases from 25 to 8 points), or even improves in rural areas (for example, in Finland, from the prevalence of 8 points in urban areas the situation is changing in favour of rural areas, reaching the prevalence of 11 points).

Admittedly, a rather detailed study of students' achievement in the Latvian countryside and cities (Johansone, 2009) using PIRLS 2006 and TIMSS 2007 data on the fourth grade students, shows that if the class of a rural school has a great share of the students with a low SES (more than 60%), the difference in performance is entirely attributable to the low SES of the class.

Table 6.19 Student SES in various types of schools, Latvia

Type of school	Average SES	Standard deviation
All gymnasiums (state gymnasiums and gymnasiums together)	0.24	0.76
State gymnasiums	0.29	0.76
Gymnasiums	0.14	0.77
Secondary schools	-0.24	0.86
Basic schools	-0.65	0.87
Total	-0.26	0.89

The previously shown differences in performance between different school types (Figure 6.33) to some extent can also be explained with differences in the students' SES. This is clearly shown in Table 6.19 – the SES of gymnasium students is much higher than in secondary schools, and in basic schools it is generally low. The state gymnasiums, in turn, stand out with an even higher SES than gymnasiums.

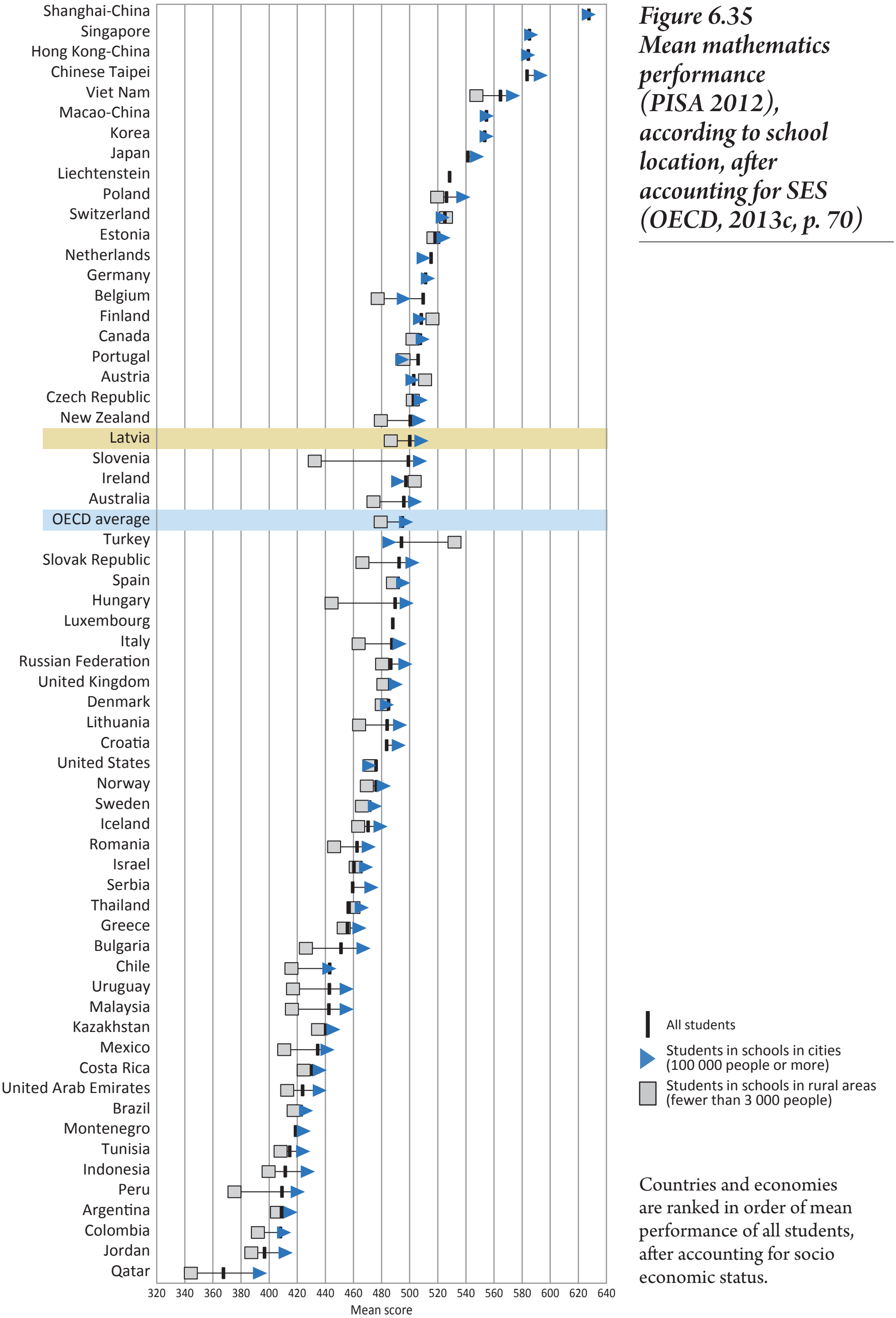


Figure 6.35
Mean mathematics performance (PISA 2012), according to school location, after accounting for SES (OECD, 2013c, p. 70)

Countries and economies are ranked in order of mean performance of all students, after accounting for socio economic status.

Table 6.20 Correlation coefficient R between mathematics performance in PISA 2012 and SES in various types of schools in Latvia

Type of school	*R*. level of students	*R*. level of school	Number of schools in the sample
State gymnasiums	0.29	0.18	18
Gymnasiums	0.22	0.10	9
Secondary schools	0.35	0.21	122
Basic schools	0.31	0.20	56

Obviously, the different types of educational institutions are situated in different locations (e.g., rural areas have no gymnasiums, see Table 6.17), and they have different enrolment procedures, for example, gymnasiums implement the selection of students, and, as a result, the students' SES in different types of schools is quite different (see Chapter 6.5). Also, nowhere within the same type of schools throughout Latvia there is a homogeneous students' SES and performance, therefore the relation of student performance and SES exists both with regard to an individual student and average values of different schools (see the corresponding correlation coefficients in Table 6.20).

The relation of student average performance to the type of education programs implemented by school and to the student's gender

The comparison of average students' performance in Latvia depending on the language of instruction at school was implemented only for Riga and cities' schools, where instruction was carried out in Latvian or which implement minority education programs (with Russian language of instruction), because the sample contains a small number of students from rural and town schools studying according to the minority education programs. As shown in Figure 6.36, across all content areas there is no significant difference in performance of the students who are studying at schools with the Latvian language of instruction, and the students who attend schools implementing the ethnic minority education programs (in the Russian language).

The issue of the difference between the girls' and boys' performance always remains topical (OECD, 2015i). Table 6.21 shows the comparison of boys' and girls' performance in all PISA 2012 content areas.

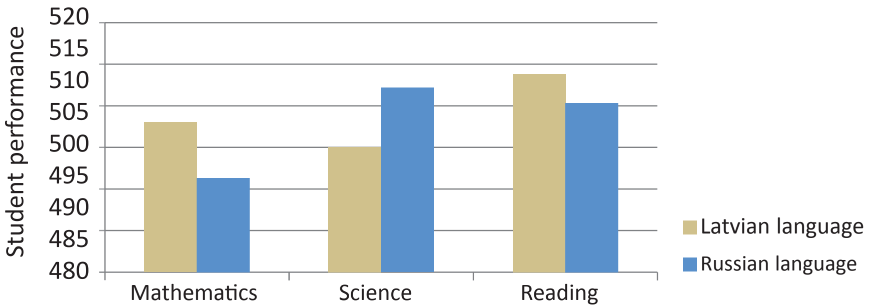


Figure 6.36 Distribution of Latvian students' average performance according to the language of instruction at school, PISA 2012

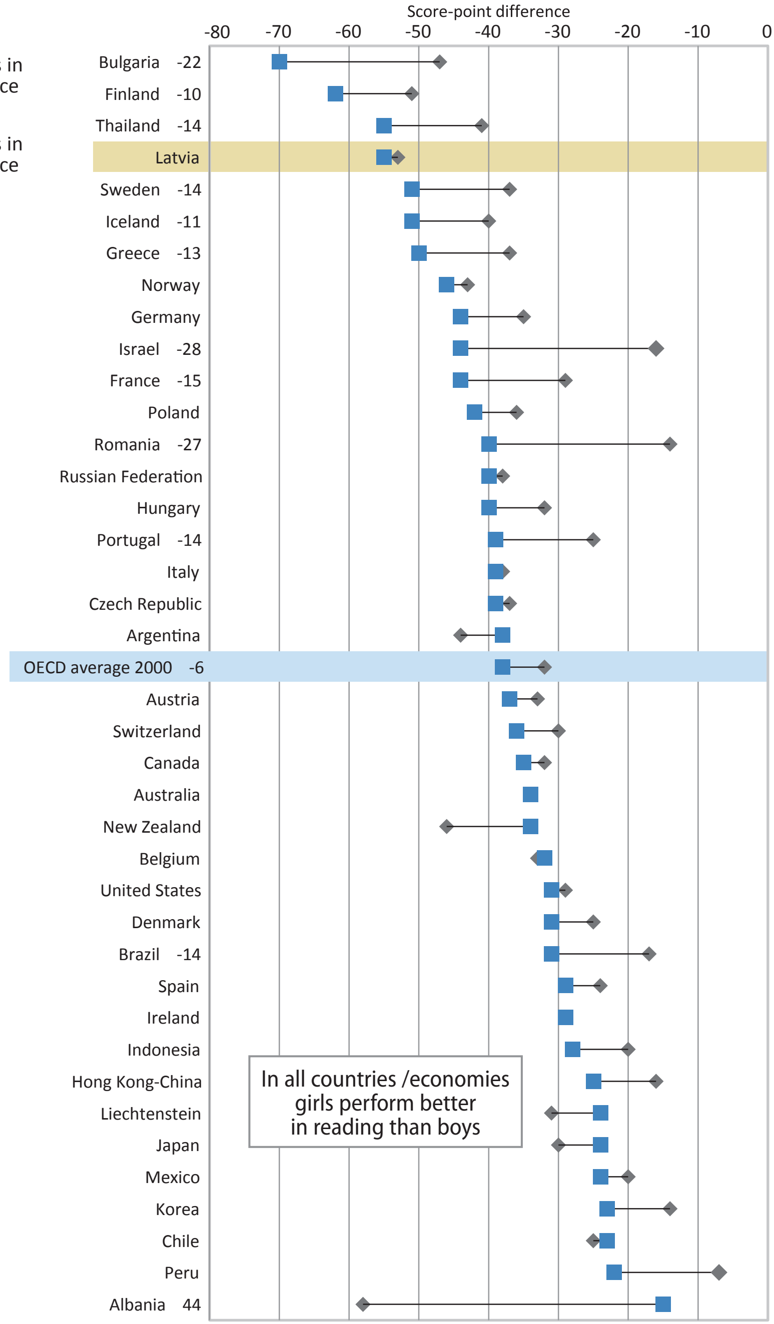
Table 6.21 The average performance of Latvian boys and girls in PISA 2012

	Performance of boys		Performance of girls		Difference (B - G)	
	Points	S. E.*	Points	S. E.	Points	S. E.
Mathematics	489	3.4	493	3.2	-4	3.6
Science	495	3.6	510	2.8	**-15**	3.6
Reading	461	3.3	516	2.7	**-55**	4.0

*S.E. – standard error
Note. Statistically significant differences in the table are marked in darker tone.

The difference in the performance of boys and girls in Latvia varies in PISA content areas. Mathematics is the only area in which, as in previous cycles, the performance of boys and girls in Latvia is not statistically significantly different (although girls' performance in PISA 2012 were higher by four points). Overall, the mathematics performance of most countries' boys in PISA cycles is statistically significantly higher or the differences are not statistically significant, and there are only very few countries where girls' performance in mathematics statistically significantly exceeds the performance of boys. Consequently, so far in all PISA cycles Latvia has been within the group of countries, where the difference between the performance of boys and girls in mathematics is small.

Just like in all participating countries and all previous cycles, the girls' reading performance in Latvia was statistically significantly higher than that of the boys – 55 points, which was the tenth largest difference among PISA 2012 participating countries. Altogether, the primacy of girls in reading literacy in most PISA participating countries has even increased over the period from 2000 to 2012. The advantage of Latvian girls in reading is virtually constantly high in all PISA cycles.



Notes: All gender differences in PISA 2012 are statistically significant.
Statistically significant changes in the score-point difference between boys and girls in reading performance between PISA 2000 and PISA 2012 are shown next to the country/economy name.
OECD average 2000 compares only OECD countries with comparable reading scores since 2000.
Countries and economies are ranked in ascending order of gender differences (boys-girls) in 2012.

Figure 6.37 Change between 2000 and 2012 in gender differences in reading performance (OECD, 2014d, p. 202)

The supremacy of girls in Latvia is also observed in science. It was 23 points in PISA 2000 (the largest difference among participating countries), four points in PISA 2003, which was not statistically significant, in PISA 2006 and PISA 2009 the performance of girls in Latvia again was statistically significantly higher (by seven points), while in 2012 this difference rose by 15 points and was the eighth biggest among the participating countries.

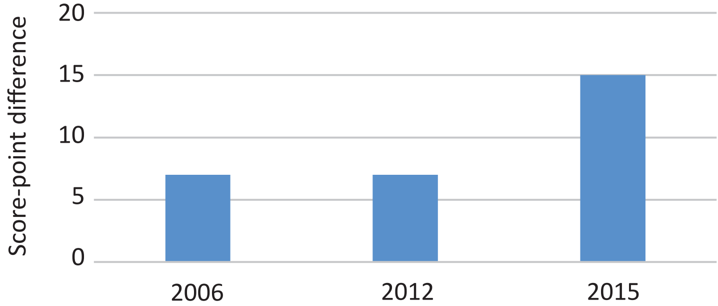


Figure 6.38 The difference in performance of girls and boys in science, Latvia

PISA 2012 shows that the difference in performance in Latvia is quite similar to that of Lithuania (the 9th greatest difference) and Finland (the 7th greatest difference), in Estonia the advantage of girls in science is just by a few points – not statistically significant. On average in OECD countries in PISA 2012 the performance of boys and girls in science is the same, consequently, there is a group of countries, in which boys show a better performance in science than girls. It is possible that in Latvia the higher performance of girls in science is based on their unquestionably higher reading literacy – therefore the girls are able to read and understand the provisions of the task more accurately.

Summary

In PISA 2012, Latvia had one of the smallest variations of students' performance in mathematics compared to the OECD countries, it was virtually the same only in Estonia and even smaller in Mexico. Finland, in turn, has a greater variation than Latvia. Undoubtedly, this positively characterizes the Latvian education system, because it means that the difference in the literacy of our various students (with high, low and average achievements) is generally less distinct than on the average in OECD countries – consequently, Latvia provides a relatively good equity of education quality throughout the education system. A more detailed analysis shows that the differences in performance in Latvia within the same school rather than between schools occur more frequently than on the average in OECD countries. It is also an encouraging phenomenon, because it testifies that the segregation into the good and bad schools in Latvia is relatively less pronounced – the students with the better or weaker achievements in Latvia are relatively more dispersed among different schools than on the average in OECD countries.

The improvement of basic education quality in Latvia, based on the data of international and national monitoring, is an important condition for the development of our national education system – it is necessary to achieve a further overall improvement of the quality, the work with outstanding students must be reinforced, while continuing to devote sufficient attention to the weakest.

The average performance of fifteen-year-old students in mathematics, science and reading in Latvian rural schools still lags behind the performance of their peers in Riga and the schools of other Latvian cities. The analysis shows that this difference in performance is determined both by the objectively lower students' SES in the rural areas, as well as by other relevant factors.

The students' SES in Latvian rural areas is significantly lower than in Riga, the relative differences are much higher than the average in OECD countries and still growing, also the relative number of rural students in Latvia is twice as high as the average in OECD countries. Thus, the role of the regional development policy in providing support to rural development is very significant indeed. Without the rural development, the education system alone will definitely not be able to ensure the equity of education throughout the country.

In Latvia, PISA 2012 showed that girls outperformed boys in all content areas. In reading and science this difference was statistically significant, while in mathematics it was not so. In all PISA cycles since 2000 the advantage of Latvian girls in reading has been almost consistently high, the girls show a higher performance also in science, although the difference in points is varied. Until now, the performance difference between Latvian girls and boys in mathematics is not statistically significant.

The average performance of Latvian students in all content areas and all PISA cycles does not significantly differ in the schools with the Latvian language of instruction and schools, where ethnic minority educational programs are implemented in Russian.

The average performance of Latvian students differs for students studying in different types of educational institutions. Gymnasium students show the highest performance, followed by that of secondary school students, and then - the average performance of basic school students. An analogous relationship between Latvian student performance and type of attended educational institution has been observed in all PISA cycles since 2000, and in other international studies. For example, PISA 2012 showed that the performance of Riga gymnasium students in mathematics was almost 570 points, which places them immediately after the average performance of Shanghai (China) and Singapore, relatively the 3rd place in the international performance table, all the rest of the PISA 2012 participating countries had achieved lower average results in mathematics. Admittedly, it must be understood that thereby we compare only the best and relatively small segment of the Latvian education to other countries' average. It is well-known that the gymnasiums implement selection of students, also by entrance examinations, the students prepare for entering the gymnasiums (with private tutors, in-depth classes in interest groups, etc.), the average student SES there is quite high, and the atmosphere is achievement-oriented. It clearly shows that such a high result in Latvia is not unattainable. At the same time, the results of students in Latvian basic schools are much lower, for example, in PISA 2012 mathematics they were within the range from 480 to 455 points (depending on the location of the school), which is below the OECD average. However, for the sake of comparison it can be mentioned that the average performance in mathematics of such countries as the United States, Lithuania, Sweden, Hungary and Greece were also within this interval. Striving for equity of education, particular attention must be focused on the inferior performance of Latvian basic school students compared to those of secondary schools. This phenomenon is particularly pronounced in Riga, a little less – in the cities and in the rural areas, but almost non-existent in towns. Perhaps it also has to do with a certain selection of students.

When comparing the performance in different types of school, one must also take into account the data provided in this chapter on the students' SES in different types of school. The SES is very high in gymnasiums, especially in the state gymnasiums, followed by secondary schools and basic schools, where this indicator is the lowest. Consequently, the performance differences in various types of school to a certain extent can be explained by the difference in the SES, which, in turn, depends on the location of the school, the student selection procedures and other factors.

6.5. Governance of schools and school network, and other characteristics: impact on student performance

School autonomy

The degree of autonomy is of particular importance in school governance and operation. In this respect, PISA summarizes the school principals' views in two groups of questions – school autonomy over resource allocation (the responsibility for formulating the school budget, deciding on budget allocations within the school, selecting teachers for recruitment and hiring teachers, establishing teachers' starting salaries, determining teachers' salary increases) and school autonomy over curriculum and assessment (textbook selection, selection of subjects and defining the content thereof, choice of student assessment methods). The principals expressed their opinion, whether the respective issues are decided upon by principals and/or teachers, or the decision-making also involves regional and/or national education authority and the school governing board, or whether it is entirely decided by the regional and/or national education authority.

In view of the school principals in Latvia, the autonomy of schools with regard to resources is much stronger than over curriculum and student assessment. In terms of resources Latvia occupies the 10th position from the top in the chart of countries, which is significantly higher than the OECD average, the schools in Lithuania have a still slightly higher degree of autonomy, Estonia – lower, while Finland in the matters of school resources' autonomy is actually below the OECD average. On the other hand, in the matters of determining curriculum content, in PISA 2012 Latvia was below the OECD average level, Finland was practically on the OECD average level, while Estonia and Lithuania had a higher degree of autonomy than the OECD average. Also in PISA 2009, our principals observed a significantly higher degree of autonomy in resource matters, admittedly, the relative indices were lower than in 2012 – in terms of resources Latvia was practically on the average OECD level, while in curriculum content – below the OECD average level and also with a relatively lower autonomy than in 2012.

In the cross-national comparison, the school autonomy in terms of resources practically does not affect the students' performance, while a greater autonomy in curriculum matters has an overall positive influence on performance. However, in certain countries, the relationship between school performance and curriculum autonomy most often is not statistically significant, and it is also the case in Latvia.

The fact that there is no direct relationship between performance and study autonomy in the country may also be explained by the school performance evaluation and control methods (examinations, centralized examinations, disclosure of school examination results, school evaluation, etc.), which in different countries are handled differently. Often, the national education policy shows a tendency to link a greater autonomy allowed in school operation to a more pronounced assessment of the outcomes – competencies acquired by students.

Latvia has a greater interest in the results related to differences of opinion in the matters of governance autonomy between Riga and other school groups (PISA 2009 data, see PISA in FOCUS, No. 28). The principals of Riga schools see less autonomy in the issues of resources and curriculum governance than the rest of the school management in Latvia. In most countries, the situation is reversed – either the degree of autonomy in the big cities is higher or there is no significant difference. Perhaps the principals' views regarding a greater degree of autonomy in the schools of rural areas, cities and towns of Latvia than in Riga are based on the phenomenon of closer co-operation between the school principals and the smaller municipalities, and the resulting impact on their decisions. For example, the school principals are often elected as officials in these municipalities (or even heads of municipalities), and in this capacity may have a decisive voice in passing municipal decisions regarding education in the interests of their schools. This, on the one hand, could be a positive tendency, as the principals in Riga apparently feel more distanced from their municipality, with less possibility to influence decisions directly and with relatively fewer opportunities to thus ensure their operational autonomy. However, a seemingly greater degree of school autonomy in this sense in the Latvian countryside and smaller towns can also have a negative role, for example, in relation to the possible reform of the school network (see further below) – the principals generally want to retain their school at all costs, and the local authorities support them.

Decrease in the number of students in Latvia, and relation of class and school size to student performance

OECD PISA data show a very significant reduction in the number of students in Latvia. The main cause of this process is the demographic trend as well as the fact that people are leaving for other countries together with their school-age children. The number of fifteen-year-old students (forming the OECD PISA participant sample) in the Latvian educational institutions has decreased by 50.5% in the period from 2003 to 2012 (see Figure 6.39). It is the greatest decrease among PISA participating countries, followed by Russia (-46.4%), Poland (-27.9%), Slovakia (-27.6%), and the Czech Republic (-26.2%).

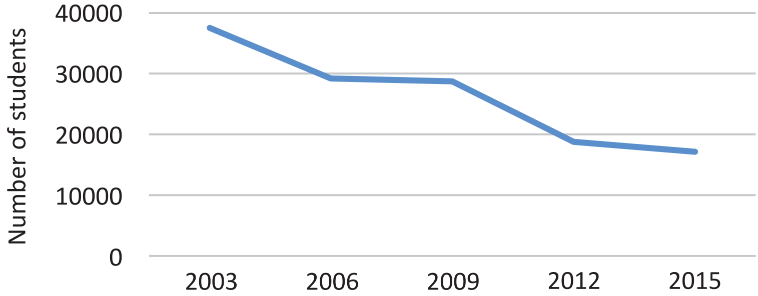


Figure 6.39 ***The number of fifteen-year-old students in Latvia (according to PISA data)***

The statistics published by the Republic of Latvia Ministry of Education and Science (*http://www.izm.gov.lv/lv/publikacijas-un-statistika/statistika-par-visparejo-izglitibu*), Figure 6.40 shows in relative units, the number of students, schools and teachers in the school year 1998/1999 taken as 100%. The decline in the number of students continues. For example, in the period from the school year 1998/1999 to 2013/2014 the number of students has dropped by 43.2%. At the same time, the number of general day schools in Latvia over these 15 years has fallen only from 1074 to 807, that is, by 24.9% (the least decrease is seen in the secondary schools – by 6.8%), the number of teachers has dropped from 29 838 to 22 421, also constituting 24.9%. The authors do not feel that the decline in the number of schools and teachers should necessarily be relatively the same size as the decline in the number of students, but a significant disproportion poses problems.

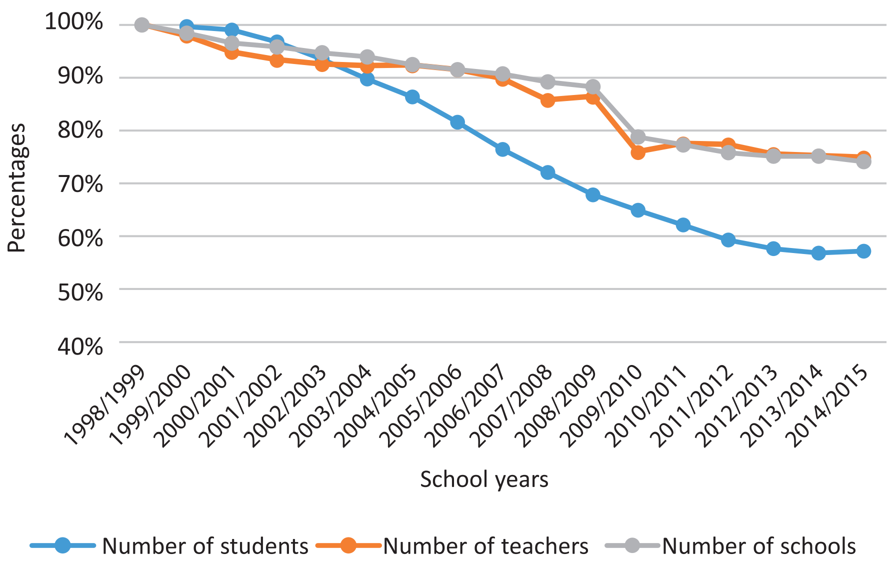


Figure 6.40 Percentage of general day schools, students and teachers in Latvia

Consequently, in Latvia over 15 years the number of students has dropped by 43.2%, while the number of schools has decreased by 24.9%, thus, the average number of students per school and class has also shrunk, albeit differently within different urbanization groups. The correlation between the number of students at school and in class in Latvia and the students' performance in international studies (PISA, TIMSS, PIRLS) is usually positive – hence, higher performance is achieved by those students who attend schools and classes with a greater number of students. Table 6.22 shows such vivid correlation in PISA 2012 and PISA 2009.

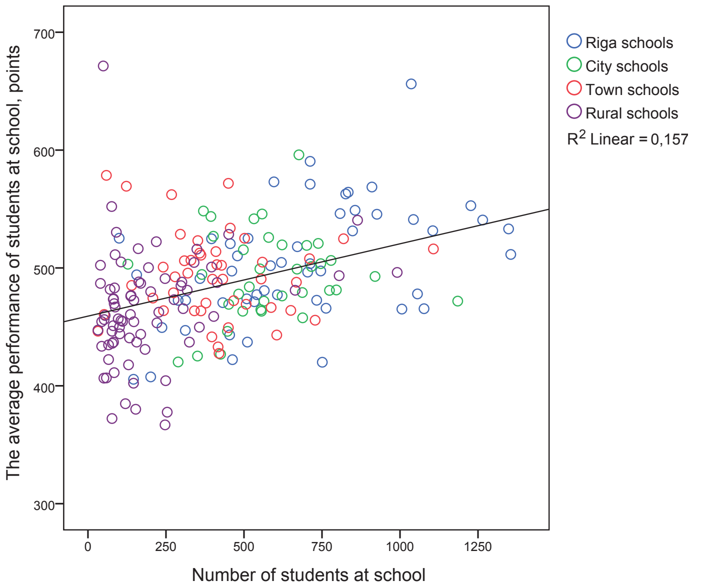
Table 6.22 The correlation coefficient between the school and class size, and the Latvian students' performance in mathematics

	Correlation of school size (number of students in school) and student average performance	Correlation of class size (number of students in class) and student average performance
PISA 2012	0.397**	0.309**
PISA 2009	0.335**	No data available

No data available – PISA 2009 did not include a question regarding the size of class.
**A statistically significant correlation, at 99% confidence level.

However, by analysing the correlation relationships, it should be taken into account that the correlation does not automatically prove causal relationship. This particular relationship also does not mean that a sufficiently large school or class itself is the reason of a higher student performance. This is well illustrated by two further figures, – in each of them the school participating in PISA 2012 is shown in terms of average performance of its students in mathematics and in terms of the number of students in the school. Overall, the relationship between these two variables is considerable – the correlation coefficient is 0.397. However, the colour codes in Figure 6.41 show that the rural schools are generally smaller than Riga schools and, on the average, their performance is poorer. We have already compared the average performance of rural and urban schools (Chapter 6.4) and found that one of the causes of lower performance in rural areas is the substantially lower SES. Lower performance of students with lower SES is confirmed by numerous studies. However, in Chapter 6.4 we also found that SES is not the only cause of low performance in rural schools. Therefore, if we assume that the education process in small rural schools and classes is characterised by certain pedagogical and psychological or other positive features in comparison with the larger urban schools, yet they cannot yield a similar student performance level (even after accounting for equal student SES).

Figures 6.41 and 6.42 also show the great disparity in the size of Latvia's schools, the number of schools with fewer than 100 students is relatively large, there are schools with over 1000 students. It can be observed, how the above correlations work on the average statistically, because, at the same time, the figures show individual rural schools with outstanding performance, as well as small yet underperforming schools in Riga. The gymnasium superiority can also be noted.



Note: Classification of school locations: Riga – the capital city of Latvia (approximately 700 thousand inhabitants); cities of national importance – Daugavpils, Jelgava, Jūrmala, Jēkabpils, Liepāja, Rēzekne, Valmiera and Ventspils, number of inhabitants ranging from 98 thousand to 25 thousand; other towns, rural areas.

Figure 6.41 ***The relation of student number at school and mathematics performance in PISA 2012 according to school location***

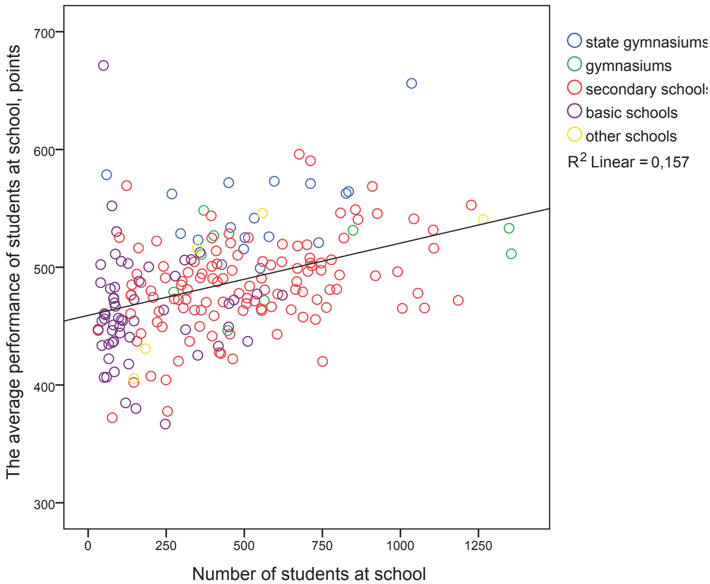


Figure 6.42 ***The relation of student number at school and mathematics performance in PISA 2012 according to school type***

According to the student survey data within PISA 2012, the average number of fifteen-year-old students in a class during language lessons (i.e., Latvian or Russian language) in Latvia was 18.7. This is one of the lowest averages, only Liechtenstein with 17.6 and Finland with 18.3 have slightly lower averages. Less than an average of 20 pupils in the class is in Belgium – 18.8, Switzerland – 19.0, Iceland – 19.2, Kazakhstan – 19.5, Denmark – 19.7. The average class size in OECD countries is 23.9 pupils. The Asian countries with very high student performance traditionally have a really big average number of students in a class: Taipei – 39.0, Shanghai (China) – 35.9, Japan – 37.2, Korea – 30.5, Singapore – 33.0. The student performance comparison in these and other Asian and European countries, however, does not support the assertion that larger class sizes are the basis for higher student performance. Here one must take into account the learning traditions and culture in various countries, possibly, the use of an assistant teacher in the classroom work and other factors. In any case, such an statement would be contrary to the indisputable pedagogical truth about the attention required by each individual student – in a very big class the opportunity of individual approach is minimal. PISA 2012 did not show any relationship between the class size and student performance in mathematics in cross-national analyses comparing EU countries (Isac, Costa Araujo, Calvo, Albergaria-Almeida, 2015).

However, in Latvia (see Table 6.20) there is a correlation – on the average, higher performance is shown by schools with a greater number of students per class. In order to analyze this relationship, one should take into account that the average number of students per class in Latvia differs greatly: in Riga – 22 students, in other cities – 19.9, in rural areas – 12.5 (calculations made according to OECD classification: including among the rural areas also the small towns with population up to 3000). The size of class in the rural schools of Latvia is the smallest of all PISA 2012 participating countries, it is similar to that of Russia – 12.6, followed by Estonia – 14.9, Finland and Iceland – 16.1. The large cities in OECD countries have 24.6 students per average class, and the rural areas – 20.1. Another important aspect is the distribution of class size by the school's SES. In Latvia, it is essentially close to the distribution by urbanization (Riga and rural areas). The schools, where the average student SES is statistically significantly higher than the national average, the average number of students per class is 22.8. The schools, where the average student SES is lower than the national average, the average number of students per class is only 13.5. The respective class sizes in OECD countries on the average are 25.6 and 21.9, for example, in Estonia – 25.4 and 17.5. To a certain extent, the number of students in a class is also related to the student-teacher ratio in school. In PISA it is determined according to the data provided by the school principal in the questionnaire. In Latvia, it is 10.0, which is below the OECD average – 13. In the rural schools, on the average, it is even lower: in Latvia – 7.5, in OECD countries – 11.7. According to other research results (Baltic Institute of Social Sciences, 2013), in many rural schools of Latvia this ratio is much lower.

Just like in the analysis of the correlation between the student performance and the school size given above, in the context of the class size we return to Riga and rural schools, to the striking differences in the SES and student performance. The situation is clearly also affected by other factors, such as student selection procedures (if any), focus on learning outcomes at school and in class, etc. As a result, the potential pedagogic benefits of a small number of students in the small schools and classes of Latvia are unable to compensate for the influence of the negative factors, and the student performance in these schools on the average is lower (also after accounting for SES).

On the other hand, the relationship between students and teachers in the learning process, the disciplinary climate, the provision of learning materials and teachers, after-school activities are evaluated by principals as equally good throughout the urban and rural schools of Latvia (see also PISA in FOCUS, No. 28).

Competition among schools and SES impact

In comparison to the average index of the OECD countries, in Latvia there is a considerably higher competition among schools to attract students from the same area, which certainly has been intensified by the declining number of students. 74% of the fifteen-year-old students in Latvia attend schools whose principals believe that the school competes for attracting students with two or more schools in the same area, 19.5% believe that they compete with one school, and only 6.5% admit that they have no competition with other schools (OECD, 2013, p. 386). The competition degree in Latvia – the relative number of fifteen-year-old students who attend schools that compete with one or more schools in their area for student attraction is 93.5%, the OECD average – 76.2%, in Estonia – 81.4%, in Lithuania – 74%, while in Finland only 47.0% (see Table 6.23).

Table 6.23 Competition among schools in the same area

Country	Percentage of students in competing schools
Latvia	93.5
Estonia	81.4
Lithuania	74.0
Finland	47.9
OECD average	76.2

In Latvia, only 1% of students attend secondary schools, whose principals believe that there is no competition with other schools. On the other hand, only 20.5% principals consider that residence in particular area "always" results in admission to school, 79.5% of principals respond "sometimes" or "never".

The relationship between the degree of competition between schools and the national average performance in mathematics within PISA 2012 is very weak – a positive correlation is quite small, and its size is not statistically significant. Consequently, according to the research data, we cannot argue that the degree of competition between schools to enrol students is a factor that determines a higher student performance on the average. Admittedly, the schools that do not compete for students with any schools in the area have lower performance in mathematics in almost all countries participating in the study, in comparison with the competing schools, for example, on the average in OECD by 17 points, in Latvia – by eight points. Further analysis shows that accounting for student SES and especially for school SES makes this difference in performance completely opposite in very many countries participating in the study – including Latvia. Therefore, after accounting for SES, for example, in Latvia, in these non-competitive schools the performance in mathematics becomes higher by 21 points compared with the schools, which compete with two or more schools for the student enrolment. In other words, it means that in Latvia and other countries with similar SES correction results most of the students in these non-competitive schools have relatively very low SES.

It is believed that in general a free choice of school in the country increases the parents' and students' opportunities to satisfy their educational needs and motivates the schools to diversify and improve the education they offer. On the other hand, the question arises, what information about the schools is available to the public and parents, and how competently it is used in the selection of school, whether a school stratification is taking place, for example, according to the parents' SES or other characteristics.

Accordingly, PISA 2012 survey data show that a relatively free choice of school exists in Latvia, the student is not guaranteed a place in any particular school chosen by himself / herself and the family in their area (although the local government at the request of parents provides the child a place in one of the schools selected by the municipality from the schools within the area), schools apply marketing ploys to attract students, the local governments try to draw students to their schools, because "money from the Ministry of Education and Science follows the student to the local government". Consequently, the opportunities for choosing schools are clearly affected by the students' SES, and the school segregation trend according to student SES is rising in Latvia, as demonstrated by PISA data analysis.

Table 6.24 provides a comparison of the relative number of schools in the Baltic Sea region attended by students with the highest SES, that is, 10% of students from the wealthier families in each country. Each country's fifteen-year-old students who participated in PISA were divided into 10 approximately equal groups according to their SES measured in the study. The division was implemented in each country separately, without taking into account the differences in the average values of SES in the countries (see also Chapter 6.3).

Table 6.24 shows the relative percentage of schools attended by the students from the Group 10 with the highest SES in each country. We can see that in 2012 the relative number of such schools in Latvia was the lowest – 55%, while in Finland the relative number was 83%, in Sweden – 77%, in Poland – 76% and in Denmark – 75%. Consequently, in that sense we have the most socially heterogeneous school system in comparison with these countries, and this inequality has a tendency to rise, which is also shown by the data from the previous PISA cycles shown in the table. Since 2006, the number of schools in Latvia chosen by the families with very high SES has decreased from 75–77% to 55%. A similar trend is observed in Russia and Estonia, yet it is not as pronounced as in Latvia.

Table 6.24 Percentage of schools attended by students with a very high SES (10% of students in each country)

Country	PISA 2003	PISA 2006	PISA 2009	PISA 2012
Denmark	72%	78%	74%	75%
Estonia	…	81%	78%	69%
Finland	82%	88%	81%	83%
Germany	56%	73%	60%	64%
Latvia	75%	77%	67%	55%
Lithuania	…	67%	66%	61%
Poland	77%	70%	72%	76%
Russia	74%	71%	63%	60%
Sweden	82%	75%	77%	77%

Optimisation of school network in Latvia

A very significant decrease in the number of students in Latvia calls for a number of measures, including the optimization of the school network, reducing the number of schools, closing, merging or converting some of them (e.g., basic school into primary school, secondary school into primary school, or the like). The issue of school network reform is a very painful and politically undesirable process for the Ministry of Education and Science (MES), and especially for local governments, which, as a rule, are the founders of general education schools. It causes dissatisfaction of the particular schools' principals, teachers, parents and students and loud protests covered by the media.

Of course, the question must be analyzed and addressed in the context of regional development, because the school closures are a possible reason of increased outflow of people from that area. Human resources, education and health networks, roads and availability of various other communications and services are matters essential to the functioning of the region and its development, which certainly cannot be solved only by the MES, it is a cross-cutting policy issue. Preservation of the historical schools in the old manor houses and other buildings in circumstances where the number of students has fallen to a few dozen cannot be the responsibility of the MES.

The strategic documents of the state and the "Declaration of the Intended Activities of the Cabinet of Ministers Headed by Laimdota Straujuma" (*http://www.pkc.gov.lv/images/LS_MK_deklaracija.pdf, paragraph 41*) adopted by the current government in 2014, provides for the development of the regions: "In accordance with "Latvia 2030", "NDP2020" and Regional Policy Guidelines for 2013–2019, we will support national and regional development centres, rural, Baltic Sea coast, Latgale and border area development by promoting accessibility of these areas and access to public services, as well as by improving the business environment in line with their development facilities and priorities, and taking into account the availability of public resources." However, there are some inconsistencies in the implementation of the regional policy. Administrative and territorial reform is long overdue, and probably the adopted solution is not optimal, because it results in a highly fragmented structure. The situation is exacerbated by the radical views predicting the prospective development of Latvia only in the Riga region.

The former president of Latvia Andris Bērziņš in his speech at the Saeima spring session of June 18, 2015 (*http://www.president.lv/pk/content/?cat_id=603&art_id=23124*) referred to the necessity to continue the administrative and territorial reform as one of the state's main tasks: "Administrative territorial reform is the key to many of the pressing issues, in particular those related to the areas of education and health care that need to be addressed urgently in order to ensure accessibility and quality of health care and education in the country, especially in rural areas and small towns."

If there is a clarity about administrative territorial division and regional development of the state, it is possible to implement the task defined in the current government declaration (*http://www.pkc.gov.lv/images/LS_MK_deklaracija.pdf, paragraph 95*): "We shall establish the strategic model of school network development, which will provide the pupils of first six grades with a quality education as close as possible to the pupil's place of residence, while maintaining the Latvian rural schools as important local community centres. Secondary education will be concentrated in schools with developed pedagogical and technical basis." However, besides developing the model of school network, concrete steps should also be taken, as the school network reforms already are in constant progress. It would only be necessary to implement them systemically, also including a well-founded administrative territorial division and a regional development plan.

It is interesting to note that the international research results in Latvia already in 1990s enabled researchers to provide the recommendations that are essentially exactly the same as the above-mentioned current government declaration of 2014, the tasks stated therein regarding the school network development – a primary school close to home, secondary schools well provided with resources and located further from the place of residence, sufficiently high quality of education also in rural areas, the school as a multi-purpose cultural centre. The researchers widely published these recommendations and the data on which they were based as early as in 2000, 2002 and 2004 (see, e.g., Kangro, 2000; Kangro, 2002; Geske, Kangro, 2004).

While implementing the school network optimization process, the quality factor of education must necessarily be taken into account, not only, for example, the costs of the infrastructure of educational institutions, which have far fewer students than in the past and the premises that are intended for a greater number of students. Monitoring the quality of education provided by the particular schools would enable the local authorities and the Ministry of Education and Science to maintain and develop the schools of the best quality. The quality of student performance in secondary schools should be assessed on the basis of the centralized examination results in grade 12. In order to evaluate the quality of basic schools, to some extent the results of examinations in grade 9 can be used, – the content of these examinations is designed centrally, but the marking is carried out at school. In this respect, the governments should at least arrange for the examination papers to be evaluated in a centralised and anonymous manner – in the municipalities. This could help to accumulate a more reliable comparative information on the quality of education at the schools subordinated to municipality. On the other hand, international comparative research to some extent helps to navigate within the education quality level of municipality with regard to the situation in the country in the international context. The research contributing to knowledge about basic and secondary schools with elementary classes are OECD PISA and IEA TIMSS cycles, and to primary schools – IEA PIRLS and IEA TIMSS. In this respect, the inclination of the MES to restore Latvia's participation in the IEA PIRLS is a very positive factor.

The daily and even end-of-the-year marks of the students cannot be used for comparative purposes. The marks given by a teacher (formative assessment) have a very important role in the teaching and learning process, they are the most significant assessment of achievements and progress shown by a particular student and informative to his or her parents, but they are not designed to compare student performance between the schools within a municipality, a region or even across the country. In many countries, particular quality monitoring measures are implemented, and their central element consists of tests for students. In England, such a process is designed also to measure student growth by retesting after a certain period (once a year or even more frequently). Of course, in such a quality monitoring process the student's SES can be easily identified in order to take it into account in the analysis of results (see Chapter 6.4).

The MES currently plans to develop a program dedicated to the education quality monitoring measures for the next EU funding programming period up to 2020. Along with the international studies dedicated to the quality of education, the program could contain a plan for quality evaluation measurements of particular municipal schools to assist them in the school network optimization efforts.

The funds saved by the optimization of school infrastructure (school closure or merging in shared premises) should be earmarked for the education process development and professional growth of teachers in order to ensure an equity of education quality throughout Latvia's education system.

Summary

The work of Latvia's school principals with regard to resource management issues (the responsibility for formulating the school budget and expenditure, selecting teachers to be employed and hiring teachers, establishing teachers' starting salaries, determining teachers' salary increases) are significantly more autonomous than on the average in OECD countries, while the degree of autonomy over curriculum choices and student assessment (textbook selection, selection of subjects and defining the content thereof, choice of student assessment methods) is lower than the OECD average. The relative degree of school autonomy in Latvia has a tendency to rise.

The principals of Riga schools in their activities see less autonomy in the matters of resources and curriculum management issues than the school principals in the rest of Latvia. On the other hand, student and teacher relations, disciplinary climate, supply of learning materials and teachers, after-school classes are valued by the principals as equally good throughout Latvia, both in urban and rural schools. The schools in rural areas on the average are smaller, they have fewer students to a teacher, a smaller number of students in classes.

Compared to the OECD average, there is a higher competition in Latvia between the schools of the same area with regard to attracting students, it certainly has intensified, as the number of students decrease. 74% of principals believe that their school competes for attracting students with two or more other schools, 19.5% – with one school and only 6.5% admit that there is no competition with other schools. On the other hand, only 20.5% principals consider that residence in area near the school "always" results in admission to school, 79.5% of principals respond "sometimes" or "never". The relatively free choice of schools in Latvia promotes the parents' SES impact on the choice of school, and there is a rapid decrease in the relative number of the schools chosen by the most socio-economically favourable families (since 2006, the relative number of schools in Latvia chosen by families with a very high SES has decreased from 75–77 % to 55%).

There is an observation in Latvia that in international studies higher performance is shown by the schools and classes with a greater number of students. However, it should be remembered that the correlation between two variables does not mean a direct causal link. The situation is also greatly influenced by other factors such as student SES, school location, student selection procedure (if any), focus on learning achievements at school and in class, etc. Consequently, the potential pedagogic benefits of a small number of students in the small schools and classes of Latvia are unable to compensate for the influence of negative factors, and student performance in these schools on the average is lower (also after accounting for SES).

The very significant reduction in the number of students in Latvia calls for the optimization of the school network. The number of 15-year-old students in Latvia in the period from 2003 to 2012 has decreased by 50.5%. It is the greatest drop among PISA participating countries.

A greater school governance autonomy in smaller municipalities could be a hindering factor in the optimization of the school network. School principals and some teachers are often elected officials in these municipalities, and they may have a decisive voice in various municipal decision-making processes in the field of education with regard to their school. The result is that the principals usually want to keep their schools alive under any circumstances, and the local governments support them.

The factor of education quality must certainly be taken into account in the optimization process, not only such aspects as infrastructure costs. The funds saved in the optimization of infrastructure should be directed to the improvement of the educational process and the teachers' professional growth. To compare the education quality levels of individual schools, appropriate methods should be chosen – centralized examinations, international comparative education studies, specific activities for monitoring the quality in order to determine both the level of student performance and its growth, etc. A particular effort should be made to take into account the student SES and school SES.

Undoubtedly, the issue of the school network reform is very closely linked to the state administrative territorial division, its possible modification (the continuation of the reform) and the regional development policy as a whole. It is difficult to provide the quality education in the regions with no development, and the regions cannot properly develop without schools. Consequently, it is a cross-cutting policy issue.

If there is a clarity about the administrative territorial division and the regional development, it is possible to implement the task defined in the current government declaration: "We shall establish the strategic model of school network development, which will provide the pupils of first six grades with a quality education as close as possible to the pupil's place of residence, while maintaining the Latvian rural schools as important local community centres. Secondary education will be concentrated in the schools with developed pedagogical and technical basis." This statement exactly matches the recommendations published by researchers as early as in 2000, based on the international comparative education studies implemented in Latvia already in 1990s.

6.6. Student performance in OECD PISA 2012 and truancy

Truancy is a problem encountered by most of the world's education systems. Education researchers in their theoretical and practical studies regularly address this issue (Wagner, Dunkake, Weiss, 2004; Trujillo, 2006; De Witte, Csillag, 2012). The researchers admit that truancy significantly jeopardizes each student's future prospects and hurts society as a whole (Darmody, Smyth, McCoy, 2008).

If the compulsory schooling (basic or secondary) is imposed nationally, it means that the students must participate in it by attending all study-related activities. Regulatory documents contain definitions of absence types, the acceptable amount thereof, schools' institutional responsibilities in registering the absences, as well as cooperation with parents, local authorities or public bodies, if the student without a valid reason fails to attend an educational institution. In Latvia, these matters are regulated by General Education Law, the Cabinet of Ministers Regulation No. 89 (General Education Law, 2013, Cabinet of Ministers Regulation No. 89, 2011), as well as the regulations laid down by the educational institutions.

Truancy is usually not considered by the general public as something extraordinary, although within the meaning of the national legislation, unjustified absenteeism in the compulsory education institutions is deemed to be an administrative offense (Aos, 2002; Wagner, Dunkake, Weiss, 2004).

OECD PISA studies always concentrate on a variety of factors influencing educational performance, including student discipline and attitude, as well as the general climate in class, which could be relevant to the students' achievements. Both students' and school principals' surveys contained questions about truancy, the discipline in the classroom, the number of students repeating the year at school, as well as about various conditions hindering educational progress (OECD, 2013a; 2013b; 2014b).

Henceforth, the analysis of the survey data and test results will be provided regarding the student absences and the possible causal connection of such absences with the performance in mathematics, science and reading.

OECD PISA student survey included several questions about missing lessons. In the study, the missing of lessons was divided into several groups, by the type of absence and by impact on student performance:

- Late arrival for school (for the first lesson);
- Skipping individual classes during a school day,
- Skipping a whole school day.

In OECD PISA 2012 study, the students had to answer the following survey questions regarding unjustified absences from school:

- In the last two full weeks of school, how many times did you arrive late for school?
- In the last two full weeks of school, how many times you skipped some classes?
- In the last two full weeks of school, how many times you skipped whole school day without permission?

In each question, the students had to choose one of the following replies on Likert Scale:

- None
- One or two times
- Three or four times
- Five or more times

Overall, in OECD PISA 28% of students of OECD countries have indicated that at least once within the last two weeks before the survey they have skipped a class (classes). 15% of students indicated that they at least once had skipped the entire school day. In OECD countries, missing individual classes (lessons) is related to the decline in mathematics performance by 32 points, whereas skipping the whole school day – by 52 points. Unjustified absences from school are relatively equally occur among the poor and the high performers (OECD, 2014b).

Given that in Latvia

- almost 20% of all mathematics results (PISA 2012) are on level 1 or even below it, and only
- 1,5% of all mathematics results (PISA 2012) are on level 6,

identifying the possible relation of truancy to student performance in OECD PISA may prove to be even systemically important in planning the work with both underperforming and outstanding students, in order to encourage the former, and increase the overall number of the latter.

Moreover, a common understanding and reliable data on truancy and its relationship with the student performance in various study content areas are essential to establish order in recording of unjustified absences throughout the education system, to regulate the mutual collaboration of the school and the parents, as well as to develop a system of measures to be applied in case of various unjustified absences. The data obtained in OECD PISA about the participating countries' student absences shows that the discipline of Latvian students leaves much to be desired.

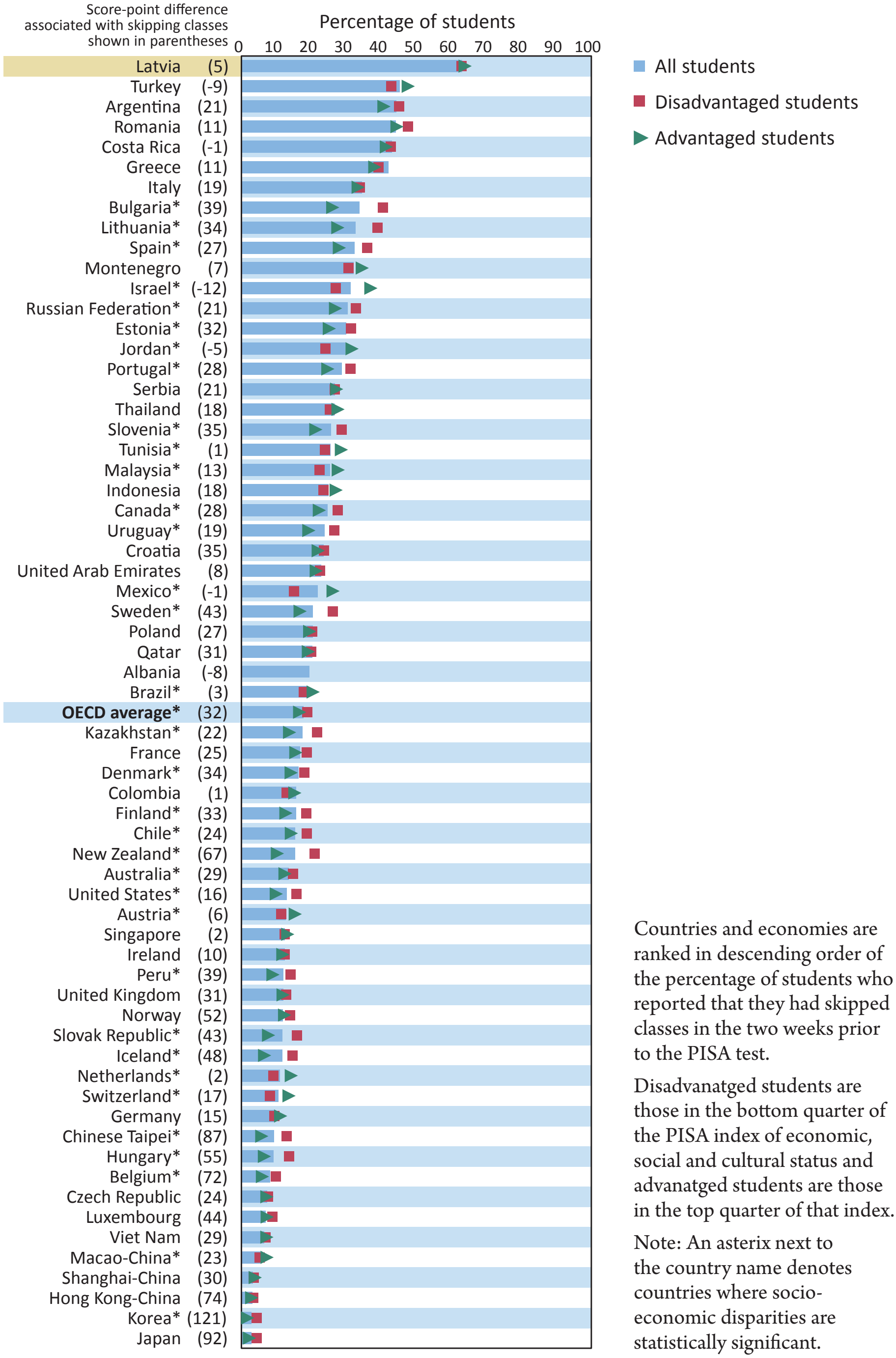
Late arrival at school (missing the beginning of the first lesson) – 66.1% of Latvian students indicated that they had missed the start of school at least once or twice in the last two full weeks of school (12.9% of the students have done it three or four times, but 8.3% – five or more times). Unlike the OECD countries' average, Latvia has no statistically significant relationship between the frequency of late arrival at school and student performance in PISA (see Table 6.25), with the exception of regular latecomers (five or more times in two weeks). It is most conspicuous in the content area of reading. However, the overall Latvian students' performance in this content area also showed a negative trend.

Table 6.25 Frequency of late arrival for school and performance in reading, mathematics and science (OECD PISA 2012)

Country	Frequency of late arrival	%	(%SE)	Reading		Mathematics		Science	
				Average perfor-mance	(SE)	Average perfor-mance	(SE)	Average perfor-mance	(SE)
OECD countries	None	64.48	(0.16)	507	(0.52)	504	(0.51)	512	(0.51)
	One or two times	24.96	(0.12)	487	(0.73)	483	(0.72)	491	(0.72)
	Three or four times	6.18	(0.07)	471	(1.36)	467	(1.28)	472	(1.35)
	Five or more times	3.96	(0.06)	441	(1.82)	449	(1.68)	453	(1.78)
Latvia	None	43.53	(1.20)	497	(3.11)	496	(3.51)	510	(3.13)
	One or two times	34.79	(0.92)	490	(3.74)	494	(3.33)	503	(3.60)
	Three or four times	12.67	(0.64)	486	(4.43)	482	(4.49)	492	(4.56)
	Five or more times	8.51	(0.71)	448	(5.78)	465	(5.94)	477	(6.04)

SE – standard error.

As shown in Figure 6.43, Latvian students were "the leaders" in OECD PISA 2012 with regard to skipping classes within one school day.



Countries and economies are ranked in descending order of the percentage of students who reported that they had skipped classes in the two weeks prior to the PISA test.

Disadvanatged students are those in the bottom quarter of the PISA index of economic, social and cultural status and advanatged students are those in the top quarter of that index.

Note: An asterix next to the country name denotes countries where socio-economic disparities are statistically significant.

Figure 6.43 Percentage of students who skipped classes at least once in the two weeks prior to the PISA test (OECD, 2014b, p. 2)

Skipping a class (classes) within a school day – 62.8% of the surveyed Latvian students indicated that they had skipped a class at least once or twice within the last two full school weeks (or even several classes a day, but not a whole school day). This figure is significantly higher than the OECD average – 18%.

10% of Latvian students have done it three or four times, but 7.1% – five or more times in the last two full school weeks.

It should be noted, however, that the relation between skipping particular classes and student performance in test differs quite widely, for example, in Latvia this type of truancy was associated only with a five-point decline in test performance, while in Estonia the results declined by 32 points and in Lithuania – by 34 points. In several countries, truancy was associated with a drastic decline in performance, for example, in Japan – by 92 points, in Taiwan (China) – by 87 points, and in Korea – by as much as 121 points.

These results clearly show that a similar negative impact of truancy on student performance is not observed on the international level. The correlation across various countries between skipping individual classes and performance in OECD PISA 2012 differs quite widely. Although 62.8% of Latvian students indicated that they had skipped a class or more at least once or twice in the last two full school weeks (or more classes a day, yet not a full school day), this phenomenon could be linked with only a five-point decrease in test performance. Nevertheless, this result should not be considered as a licence for disregarding these types of truancy.

It is also noteworthy that in a number of participating countries (Turkey, Costa Rica, Israel, Jordan, Mexico, Albania), unjustified skipping of classes was associated even with a slight improvement in the results.

Figure 6.43 also shows the extent to with differ the absenteeism habits of students from families with high and low socio-economic status. In most of the participating countries, including Latvia, both the students whose performance was high and those whose performance was low, skipped the classes with almost equal frequency. For example, in OECD countries overall, separate classes were skipped by 17% of students with high results and by 19% of students with low results. In a number of participating countries, such as Bulgaria, Lithuania, Spain and New Zealand, these differences were greater, reaching, respectively, 25–28% and 38–40%.

The increase in intensity of skipping classes within a school day in Latvia is not associated with a statistically significant decrease in performance in OECD PISA content areas, although a weak trend of decrease in the results was nevertheless observed (see Table 6.26).

Table 6.26 Student performance and skipped classes within a school day (OECD PISA 2012)

Country or group of countries	Difference in performance between students who do not skip classes within a school day and those who do it five or more times within two weeks		
	Reading	Mathematics	Science
Latvia	15	9	7
Estonia	47	44	40
Lithuania	91	74	72
Russia	45	47	35
Finland	101	90	93
Sweden	95	72	78
Poland	65	51	58
Denmark	69	82	83
OECD	45	35	39

This result conspicuously differs from both the OECD countries' and the Baltic Sea region countries' averages. Possible explanations:

- Students in Latvia skip classes selectively, choosing the lessons that are not related to the test content areas, while in OECD countries as a whole in response to this question students indicated how often they skipped reading, mathematics and science lessons. This assumption seems unlikely, since the wording of the question was general;
- Skipping individual classes is not associated with test performance, because:
  - nothing particular happens in classes (in terms of education),
  - teachers are so skilful that in the following class they are able to compensate for the material that the students have missed by skipping the lesson,
  - Latvian students are able to compensate the skipped classes' content by working at it independently,
  - There are some other latent circumstances influencing the learning process in Latvia, and to determine these circumstances additional studies are required.

It should be noted, however, that in this respect Latvia is not a unique country. A similar relationship between skipping classes within the school day and performance is also seen in Austria, Brazil, Colombia, Montenegro, the Netherlands, Singapore and Tunisia. By contrast, in countries such as Turkey, Costa Rica, Jordan, Mexico and Albania absenteeism is related to a slight improvement in performance. Generally, it must be admitted that OECD PISA 2012 data do not allow us to draw well-founded conclusions about why skipping particular classes within a school day in Latvia is not associated with a statistically significant decline in achievement in all three test areas – mathematics, science and reading.

Skipping a whole school day – 21% of the surveyed Latvian students indicated that they had at least once or twice in the last two full school weeks missed an entire school day (or even several days). Admittedly, the wording of the question included both unjustified and justified absences. In OECD countries, on the average this question was affirmatively answered by 15% of the students. Unlike skipping one or several classes (but not all day) within a day of school, skipping an entire school day in Latvia is associated with a significant decrease in achievement – the test results of such students are lower by about 53 points. The relation of this kind of absenteeism to the performance in Latvia corresponds to the OECD average (see Figure 6.44). Also, comparing Latvia and other Baltic Sea region countries, the student performance relationship with skipping entire school days has similar trends (decline in test performance by 39 to 64 points). In two countries – Albania and Turkey – skipping a full school day was associated with a strange effect – the performance actually improved (by 10 and 7 points, respectively).

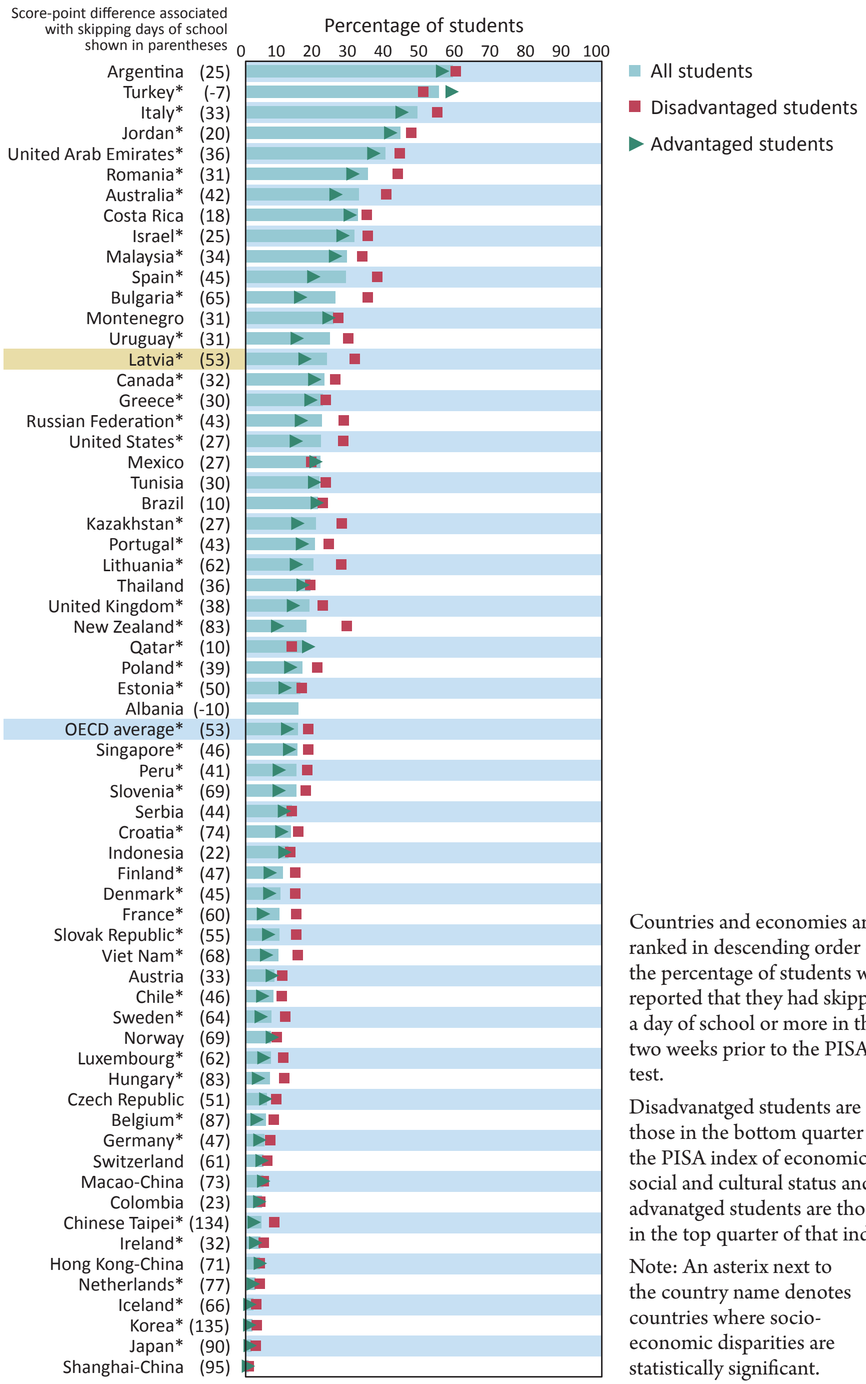
OECD PISA student survey data give an opportunity to explore the relation between school absenteeism and student performance, also taking into account such factors as the gender of the respondents, the language of instruction at school, the type and location of the school.

In terms of gender – even despite a predominant view that girls are more disciplined, including school attendance – the data analysis showed only very slight, statistically insignificant prevalence in the boys' truancy.

Regarding the language of instruction at school and truancy – the average level of truancy in schools with Latvian language of instruction does not differ from the average level of truancy in schools with Russian language of instruction.

Considering the type of school and truancy, also the frequency of skipped classes did not change: there was no statistically significant difference in the truancy habits of basic school, secondary school and gymnasium students. It was found that vocational education institutions had a higher average level of arriving late for school compared to other types of schools. However, this result cannot be considered a notable trend, because only a few vocational education schools took part in the study.

Urbanization and truancy – comparing Latvian urban and rural schools, it was found that the average values of truancy were not statistically significantly different.



Countries and economies are ranked in descending order of the percentage of students who reported that they had skipped a day of school or more in the two weeks prior to the PISA test.

Disadvanatged students are those in the bottom quarter of the PISA index of economic, social and cultural status and advanatged students are those in the top quarter of that index.

Note: An asterix next to the country name denotes countries where socio-economic disparities are statistically significant.

Figure 6. 44 Percentage of students who skipped a day of school or more in the two weeks prior to the PISA test (OECD, 2014b, p. 3)

Latvian student performance in mathematics, science and reading, and its relation to truancy

Given the previous conclusions, Latvian student performance and skipping classes within a school day had no statistically significant correlation. Hereinafter it will be discussed, how Latvian student performance in OECD PISA 2012 relates to the frequency of arriving late for school and skipping an entire school day (Figures 6.45 and 6.46).

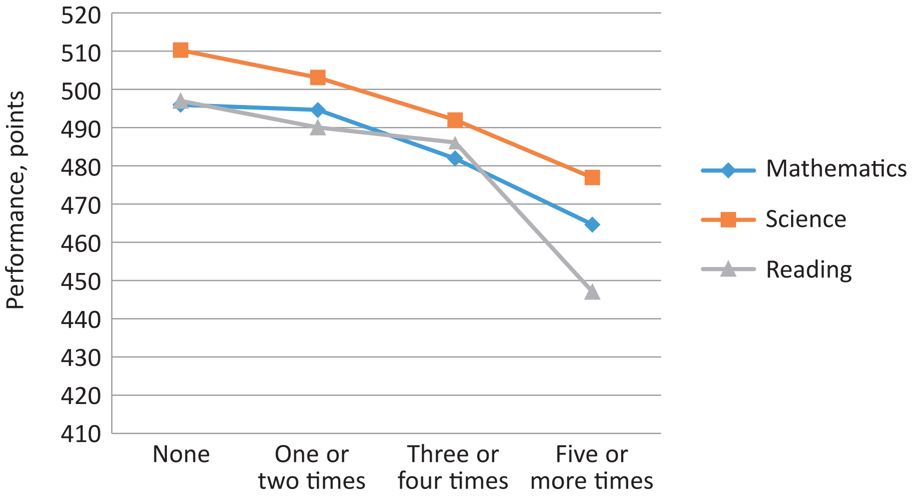


Figure 6.45 ***Relationship between arriving late at school and OECD PISA 2012 results in Latvia***

The correlation between frequency of late arrival at school with student performance was insignificant, if the students pointed out that they had missed the beginning of school only once or twice. However, five or more late arrivals at school within two weeks prior to the PISA test were associated with performance decline in mathematics and science by about 25 points. Hence, it can be concluded that by reducing the frequency of late arrivals, positive changes in mathematics and science proficiency could be achieved. Often late arrivals for school are attributable to the fairly serious student performance drop in reading content area (by more than 40 points, if within two weeks prior to test the beginning of lessons was missed five or more times).

Much more prominent was the relationship between Latvian student performance and skipping a full school day (Figure 6.46). Even skipping one or two full days of school was attributable to a significant decline in performance in all the content areas of the test. If the frequency of absence was five or more days, the student performance fell by as much as 100 points, compared with the performance of students who had indicated that they had not skipped a full school day even once. Such a difference in performance shows that students have not mastered the curriculum that corresponds to nearly two years, and this is unacceptable.

Skipping an entire school day is associated with a significant performance decrease not only in mathematics but also in science and reading. A less pronounced relationship can be observed between arriving late for school and performance in OECD PISA.

These results make it possible:

- to identify potential students at risk,
- to develop and implement a package of measures required to
  - reduce the various types of absenteeism,
  - establish a causal relationship between the absences and performance.

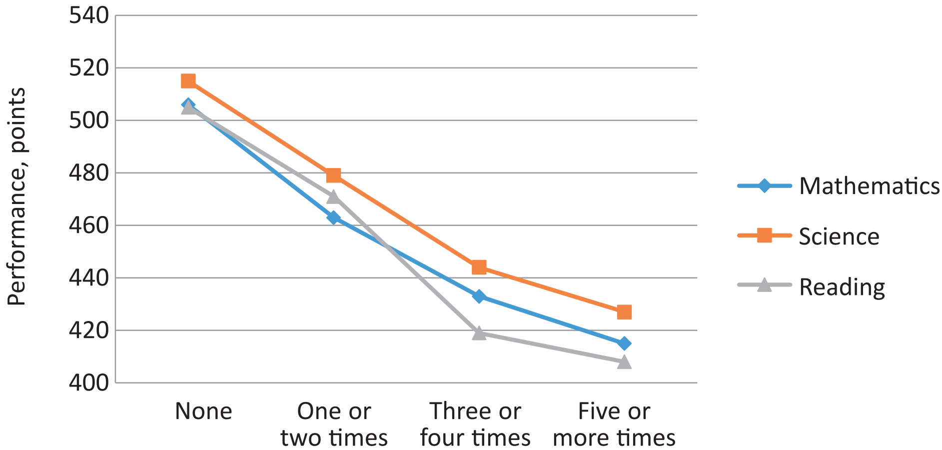


Figure 6.46 Relationship between skipping an entire day of school and OECD PISA results in Latvia

Truancy and student socio-economic status

OECD PISA study always is strongly focussed on student performance relation to the students' social, economic and cultural status.

Hereinafter it is established, whether and to what extent there are the changes in the nature of school absenteeism for students who come from families with high and low socio-economic status (SES index).

Comparing the data in Tables 6.27 and 6.28, it can be observed that in Latvia the students from families with a relatively higher SES (ninth and tenth decile) less frequently skip an entire day of school than the students from families with a low

SES (first and second decile). In the first case, 17.5% of students said that within two weeks before the test they had skipped an entire school day at least once, while in the second case, at least once within the same period an entire school day was skipped by 28.7% of students. Only 0.9% of the students from families with a high SES, and 3.2% of the students from families with a low SES confirmed that they had often skipped the entire school day (five or more times within two weeks prior to the study).

Table 6.27 Skipping an entire day of school: students from families with high SES

	Number	% of the total number	% in group
never	676	15.7	82.5
1 or 2 times	123	2.9	15.0
3 or 4 times	13	0.3	1.6
5 times or more often	7	0.2	0.9
Total	819	19.0	100.0
Other deciles	3487	81.0	
Total	4306	100.0	

Table 6.28 Skipping an entire day of school: students from families with low SES

	Number	% of the total number	% in group
never	597	13.9	71.3
1 or 2 times	175	4.1	20.9
3 or 4 times	38	0.9	4.5
5 times or more often	27	0.6	3.2
Total	837	19.4	100.0
Other deciles	3469	80.6	
Total	4306	100.0	

Also, calculation of the difference in truancy level for students from families with a high and low SES (see Figure 6.47) shows that students from families with a high SES are generally more disciplined. The high SES group, compared with the low SES families, had 11.2% more students indicating that they had never skipped a full day of school. At the same time, as the frequency of skipping school days grows, there are more students from low SES families who confirm that they have skipped school.

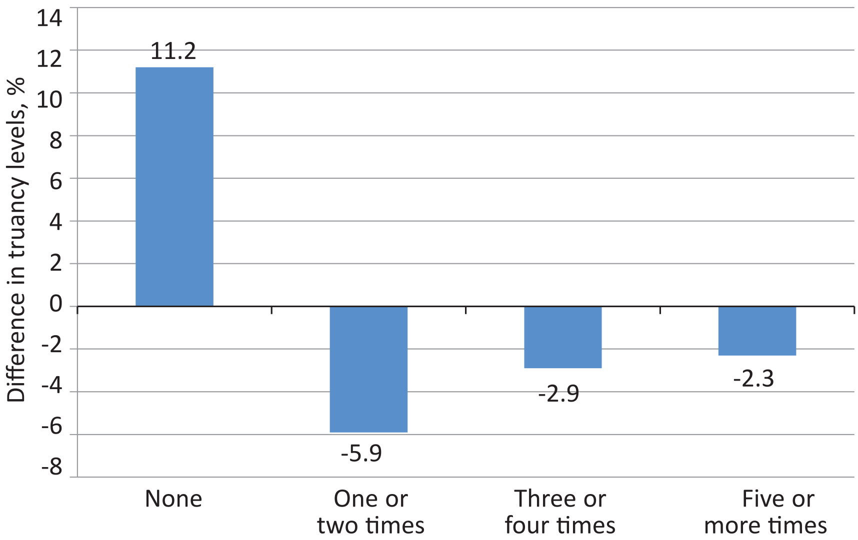


Figure 6.47 Truancy level difference for Latvian students with high and low SES

Classroom climate and truancy of students

One of the OECD PISA indices characterising the schools participating in the research is the classroom climate, which consisted of students' answers to survey questions regarding possible problems in class:

- Students don't listen to what the teacher says;
- There is noise and disorder;
- The teacher has to wait a long time for students to quiet down;
- Students cannot work well;
- Students don't start working for a long time after the lesson begins;

In each question, students had to choose one option from the list of answers according to Likert Scale:

1) Every lesson 2) Most lessons 3) Some lessons 4) Never or hardly ever.

The study found that in OECD countries the students from schools, which had better classroom climate, on average by 5% less skipped classes or the entire school day two weeks before the study (OECD, 2014b).

Figure 6.48 shows how the index characterizing the classroom climate is related to the total school absences in Latvia. As can be seen, in Latvian and OECD schools there is a similar relation between these features – a better classroom climate is associated with a greater number of students who have indicated that two weeks before OECD PISA test they have not skipped school at all.

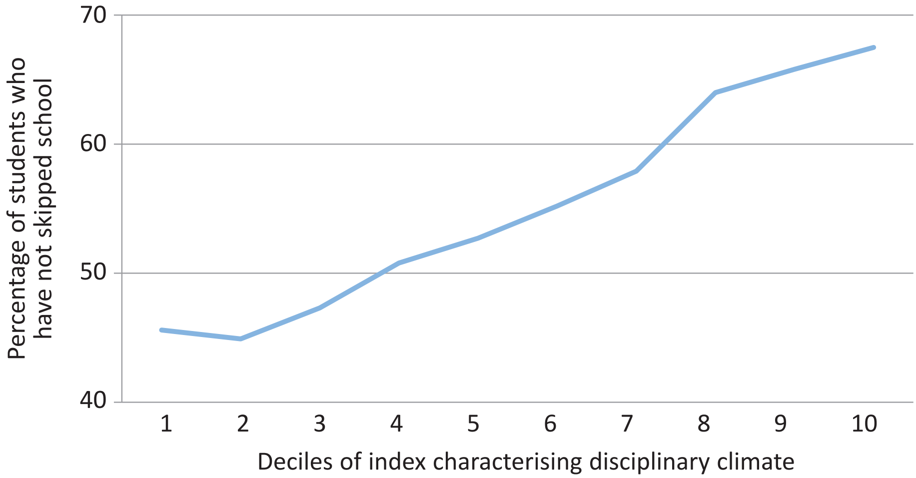


Figure 6.48 ***Relation between the index characterising the disciplinary climate and the percentage of students who have not skipped school in Latvia (OECD PISA 2012)***

Comparing the Latvian students' answers about skipping school in the classes with a relatively low (first and second decile; class is not very disciplined) and high (ninth and tenth decile; class is disciplined) index characterizing the classroom climate, different results were obtained – approximately 45% and 67 % of the students from the respective deciles pointed out that within two weeks before the study they had not skipped school at all.

Overall, OECD PISA 2012 allowed to observe that student performance in mathematics was related to the frequency of skipping classes and the entire days of school two weeks prior to the study: within education systems, the increase in the number of absences was negatively associated with student performance in mathematics (OECD, 2014b).

Summary

Summing up the research of different reasons for truancy and the related factors in different countries, as well as the OECD PISA 2012 results on school absenteeism relationship with student performance, a number of important results were obtained:

- Various types of truancy cannot be considered as a unique phenomenon, observed in a particular country or a group of countries.

- Researchers recognize that the impact of truancy on student performance, education quality and the related quality of life, as well as the individual's competitiveness in the labour market can differ considerably.
- OECD PISA 2012 results permit to assert that:
  - Skipping of separate classes by Latvian students, compared with the OECD average, as well as with the Baltic Sea region countries, on the average is not associated with a significant performance decline in mathematics, science and reading;
  - Latvian student truancy habits do not statistically significantly differ at schools with different language of instruction, urban and rural schools, basic schools, secondary schools, gymnasiums. Girls and boys have similar truancy habits;
  - skipping an entire day of school in Latvian schools is linked to a major decline of performance not only in mathematics but also in science and reading. A less pronounced relationship can be observed between arriving late for school and performance in OECD PISA;
  - Latvian students from families with a higher SES index generally skip school less frequently than the students from families with a low SES index;
  - Latvian schools with a better classroom climate index have a lower occurrence of truancy;
  - overall, OECD PISA study found that skipping classes or entire school days was associated with the decline in performance in mathematics.

OECD PISA 2012 data on the relationship between truancy and performance, as well as the analysis of literature devoted to various aspects of absenteeism permit the authors to express a number of suggestions that may prove systemically important in the planning of work in schools so as to minimize the number of students with low performance and increase the number of outstanding students – this is one of the most important tasks of any education system and, of course, it also is urgent in Latvia, taking into account its intention to join the OECD group of countries. This will increase the topicality of OECD standards for educational achievement in the Latvian education system.

The unjustified absenteeism and truancy is usually not considered by the society as something extraordinary, although the national legislation interprets the truancy within the compulsory education as an administrative offense. To change the indifferent public attitude toward truancy, it is necessary:

- On the state and local government level, to strictly comply with all legislative requirements with regards to recording and reporting absences;
- At the school level, to comply with the school's internal rules and the requirements of other documents regulating school activities, including
  - recording the absences in E-Class electronic system;

- immediate reaction of teachers (class teacher) in case of absences in accordance with the requirements of the regulatory documents;
- improvement of 'the sense of belonging to the school' indicated in OECD PISA study, which is generally positively associated with student performance;
- measures to improve the classroom climate associated with student performance.

Given the fact that the OECD PISA results do not permit to establish a causal link, in each individual case it is necessary to carry out further research in order to identify and clarify the causal link between school absences, the level and change of the classroom climate, and the performance of students in different curriculum content areas.

7. THE RELEVANCE OF LATVIAN STUDENT PERFORMANCE AND OTHER FACTORS TO A POTENTIAL EDUCATIONAL CAREER IN FUTURE

The additional module of Educational Career was included in the student surveys of 2003, 2009 and 2012 PISA. The main goal of this module initially was to obtain information about the student's previous education and related events, the current process of learning and a possible future educational career. Unfortunately, the survey module content was formed differently in each study cycle, for example, PISA 2012 did not include the questions about the student's plans of future education. PISA 2012 Education and Career module included three groups of questions:

- regarding ongoing truancy (two months or more);
- regarding preparation for the future career;
- regarding support with heritage language learning.

The question group dedicated to the native (heritage) language learning content is not relevant in Latvia, because these questions were intended solely for the students whose native language was neither Latvian nor Russian. Only 5% of the PISA 2012 participants corresponded to this criteria, and these questions will not be analyzed here.

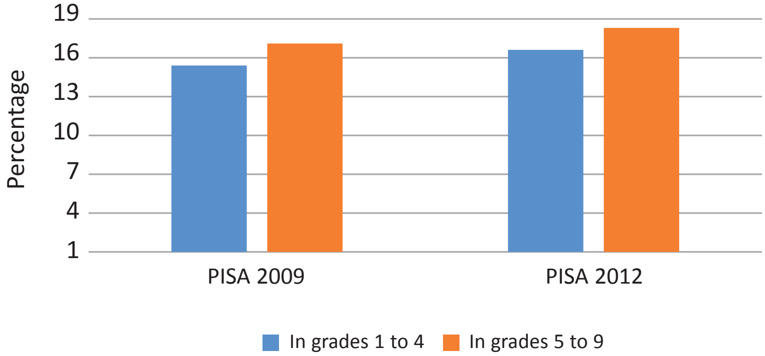


Figure 7.1 The percentage of students in PISA 2009 and PISA 2012, who have missed two or more consecutive months of school

The questions about the long-term truancy were the only ones included in the study for at least two cycles. Students were asked if during the primary school (grades 1 to 4) or basic school (grades 5 to 9) they had ever missed two or more consecutive months of school. Possible answers: No, never; Yes, once; Yes, twice or more. In the further analysis, the positive responses were combined. Figure 7.1 shows the percentage of students in PISA 2009 and PISA 2012, who responded in the affirmative.

As shown in Figure 7.1, the number of students who had missed school for lengthy periods of time, in 2009 and 2012 were similar, and in 2012 slightly increased approaching one fifth of the PISA 2012 participants. 5.6% of the students responded that they had missed school for lengthy periods of time both during the grades 1 to 4 and 5 to 9. Among the students who had not missed school for lengthy periods of time, and students who had done so, there were students with very low (less than 300 points) and very high (over 700 points) achievements, but the average achievements of these student groups were statistically significantly different (see Figures 7.2. and 7.3).

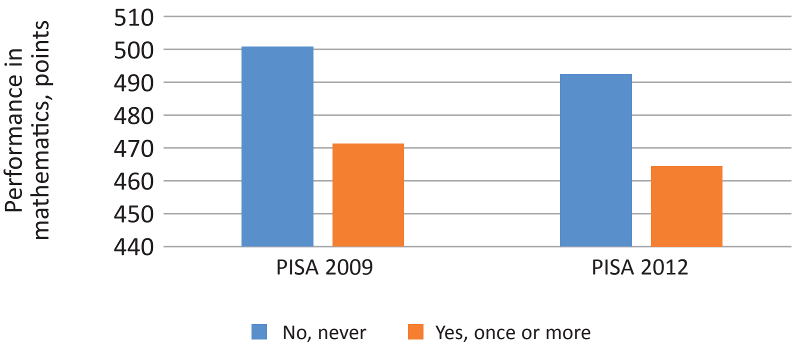


Figure 7.2 ***Students who have and have not missed school for two months or more during grades 1 to 4: comparison of average performance in mathematics***

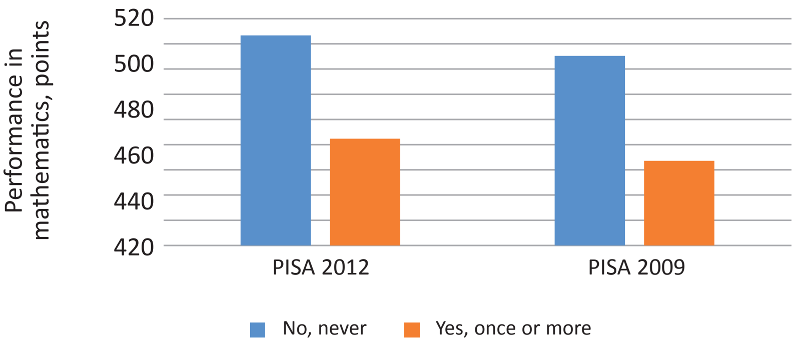


Figure 7.3 ***Students who have and have not missed school for two months or more during grades 5 to 9: comparison of average performance in mathematics***

The group of questions addressing preparation of students for future career included questions about what students had done in order to find out the future study or work prospects (see Table 7.1), and what career-related skills they had learned at school or outside it (see Table 7.2).

Table 7.1 Student activities to find out the future study or employment opportunities

	Yes (%)
I did an internship	21
I attended job shadowing or work-site visits	35
I visited a job fair	35
I spoke to a career advisor at my school	20
I spoke to a career advisor outside of my school	25
I completed a questionnaire to find out about my interests and abilities	73
I researched the Internet for information about careers	79
I went on an organised tour in an secondary school or higher education institution	30
I researched the Internet for information about secondary school or higher education programmes	70
I participated in career school on specific subject	10

Most often, the students responded that they had searched the Internet for information on career opportunities and / or secondary school, college or university programs, they had completed questionnaires to determine their interests and abilities. Figure 7.4 shows that the average performance of these students in mathematics is higher, consequently, either the students with higher performance are more interested in a purposeful building of their careers, or the students who are interested in further studies, are motivated to study well. Notably, among these students only 14% are the students of rural basic schools.

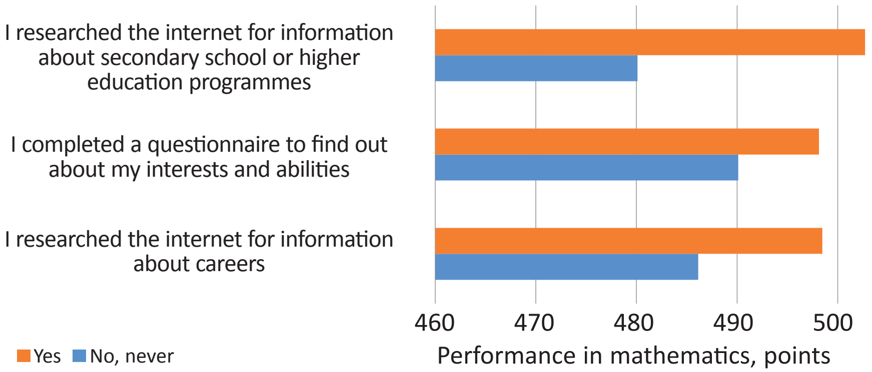


Figure 7.4 The relation of future career-oriented activities to students' performance in mathematics

Table 7.2 Career-related skills

	Yes, at school (%)	Yes, out of school (%)	No, never (%)
How to find information on jobs I am interested in	26	69	5
How to search for a job	19	46	11
How to write a résumé or a summary of my qualifications	65	23	10
How to prepare for a job interview	42	34	23
How to find information on secondary school or higher education programs I am interested in	26	63	12
How to find information on student financing (e.g., student loans or grants)	18	53	11

The students most often acquired the career-related skills outside of school (see Table 7.2). Around two-thirds of the students indicated that they had learned to write a summary of their qualifications at school, and 42% of the students had learned to prepare for a job interview at school.

Comparing the average performance in mathematics shown by the students who have mastered the above-mentioned skills at school, outside of school or have not acquired them anywhere (see Table 7.3), it can be observed that there is no link between performance and students' views on the acquired skills – average performance does not significantly differ for the students who have or have not acquired career-related skills. The exception is the ability to search for information on the secondary and higher education programs that students are interested in. Two thirds of the students admitted that this skill was learned outside of school, and the average performance of those students was statistically significantly higher than that of the students who had mastered this skill at school or had not acquired it at all. Moreover, the performance of the students who use this skill is significantly higher than the performance shown by the rest of the students (see Figure 7.4).

Table 7.3 Career-related skills and their relation to the performance in mathematics (points)

	Yes, at school	Yes, out of school	No, never
How to find information on jobs I am interested in	483	502	496
How to search for a job	494	497	503
How to write a résumé or a summary of my qualifications	506	482	476

	Yes, at school	Yes, out of school	No, never
How to prepare for a job interview	497	488	507
How to find information on secondary school or higher education programs I am interested in	485	505	483
How to find information on student financing (e.g., student loans or grants)	481	500	499

Table 7.4 below shows the trend that the SES index of those students who stated that they had acquired career-related skills at school (see Chapter 2.5) is lower than that of the students who have mastered these skills outside of school. This trend reflects the capacity of schools to motivate students from less affluent families to choose to continue their education.

Table 7.4 Career-related skills and their relation to the student SES index

	Yes, at school	Yes, out of school	No, never
How to find information on jobs I am interested in	-0.26	-0.14	-0.17
How to search for a job	-0.23	-0.16	-0.17
How to write a résumé or a summary of my qualifications	-0.17	-0.10	-0.34
How to prepare for a job interview	-0.22	-0.09	-0.20
How to find information on secondary school or higher education programs I am interested in	-0.25	-0.10	-0.32
How to find information on student financing (e.g., student loans or grants)	-0.28	-0.09	-0.25

Summary

Although the additional module of Educational Career was included in the student surveys of three PISA cycles, the module questions did not allow to establish the trends related to the future educational career of the students (these questions have been different in each cycle). Only the questions about the long-term truancy (two months or more at least once in grades 1 to 4 or 5 to 9) were included in the surveys of two PISA cycles in 2009 and 2012. Students who had missed school for a long period of time at least once every four years, showed statistically significantly poorer average performance in mathematics than the students who responded that they had not missed school for long periods of time. Analysing the students' answers to the questions about the activities focussed on further educational career choices, it can be concluded that the students' activity is low. Most often the students look for information on the Internet regarding the future career opportunities and secondary school, college or university programs, as well as try to define their interests and abilities. However, among these students there are few rural basic school students (14%). The students' interest in their future career can be a motivating factor for better educational achievement, therefore the career education at school is particularly important.

8. INFORMATION AND COMMUNICATIONS TECHNOLOGY AND STUDENT PERFORMANCE IN OECD PISA

8.1. ICT at school 1980–2015 and OECD PISA

The early 80s of the last century saw the world increasingly focussing on rapid development of modern technologies and their growing impact on the various areas in the life of society, including education. Integration of the ICT in education is a complex process that involves changes in teacher education, as well as alterations in curriculum content and objectives, ensuring the availability of special infrastructure at schools. Responding to the complexity of the integration process, uncertainties about the effectiveness of the use of ICT in studies and the need for research dedicated to the practice of innovative teaching with the ICT, in the period from 1990 to 2006, the International Association for Evaluation of Educational Achievement (IEA) organized and implemented a series of full-scale detailed studies to clarify the place and role of modern technology in general school system, as well as to examine various methodological and didactic aspects of ICT use in teaching and learning (COMPED, SITES (Second Information Technology in Education Study) and SITES 2006) (Pelgrum, Plomp, 1991; Pelgrum, Anderson, 2000; Pelgrum, Janssen-Reinen, Plomp, 1993; Grinfelds, Kangro, 1996). In the period up to 2015, at least two more extensive studies on the ICT in education must be mentioned: in 2013, the IEA released the international report of International Computer and Information Literacy Study (ICILS) (Fraillon et al., 2013), and, under the supervision of the European Commission, a study on the ICT in education was implemented (European Commission, 2013).

While there is a prevailing public opinion that takes the use of the ICT in education for granted, it must be remembered that there is still a segregation in society that is not only based on the social, economic and cultural status, but also on the opportunities available for using information resources. In many countries worldwide, even now the role of school in reducing informational inequality impact on young people's further education and career opportunities, efficient and high-quality integration and use of ICT in the learning process is an important factor contributing to the improvement of the quality of education.

The potential relation of the ICT to the student performance has been studied in all the OECD PISA cycles.

In OECD PISA, all the participating countries were offered the opportunity to supplement the students' surveys with an ICT module, designed to find out the research participants' activities in the use of the ICT, as well as the attitude toward the meaning of this content domain in everyday life and learning environment. OECD PISA 2012 cycle module consisted of 12 questions, which had 62 subsidiary questions – in most cases, the students were expected to provide answers in Likert Scale, such as:

How often do you use a computer for the following activities at school? (Please tick one box in each row.)					
	Never or hardly ever	Once or twice a month	Once or twice a week	Almost every day	Every day
Browsing the Internet for schoolwork	☐1	☐2	☐3	☐4	☐5
Posting my work on the school's website	☐1	☐2	☐3	☐4	☐5

OECD PISA school questionnaire also included a number of questions concerning certain aspects of the ICT use at school and at home.

The school questionnaire included questions about:

- the number of computers at school, which were available to the 9th grade students for educational purposes;
- the number of computers connected to the Internet;
- the expected intensity of Internet use at lessons, for homework and projects;
- the potential negative impact of an insufficient number of computers, poor Internet connection or lack of educational software on the educational work at school;
- a written school policy document on the use of computers for learning (the 2012 cycle of the study contained questions about such policy documents regarding mathematics studies).

At the same time, it must be admitted that the ICT module is not considered to be a comprehensive and detailed research instrument to explore the relation of student performance to the use of modern technologies in the learning process, given that OECD PISA focuses on researching mathematics, science and reading performance. The potential relation and impact of ICT on student performance in these content areas were not studied in all participating countries, since the inclusion of the ICT module in the student survey was left to each country's discretion. In OECD PISA 2012 study, the ICT module was included in the surveys of students by 29 OECD countries and 13 partner countries. The questions of this module were analysed in combination with the school survey on ICT, as well as by introducing the indexes on the aspects of ICT use and analysing student performance in mathematics, science and reading in relation to different types and intensity of ICT use, as well as to other factors.

8.2. Computer availability and use at school and at home, and performance in OECD PISA

In OECD PISA, students' socio-economic and cultural status was determined on the basis of a variety of parameters characterizing the family well-being, such as the availability of a computer, software and Internet access at home. Comparing the Latvian students' answers in OECD PISA cycles of 2000, 2003, 2006, 2009 and 2012, a clearly positive trend was observed – with each study cycle, the number of students reporting the availability of a computer at home increased (see Table 8.1). In OECD PISA 2000 survey, only 27.5% of participants in Latvia had stated that they had access to a computer at home, whereas in OECD PISA 2012 92.2% of the participants from Latvia answered this question in the affirmative. When asked about the availability of computers at school, over the past three survey cycles about 90% of participants from Latvia had answered affirmatively. The steady growth of computer access over the decade confirmed both the important role of ICT in the social and educational context and testified to the fact that the SES of the Latvian families had improved.

Table 8.1 Availability of computers at home (OECD PISA 2000–2012)

Percentage of students, who have a computer at home (OECD PISA 2000–2012)					
	2000	2003	2006	2009	2012
Latvia	27.5	43.9	71.9	88.8	92.2
OECD	75.3	78.6	86.2	90.9	92.4

Computers and student socioeconomic status

The SES index in all the OECD PISA survey cycles was an important factor related to the students' performance. Computer access at home was associated with a higher family socio-economic and cultural status.

This is evidenced by the data in Table 8.2, showing a significant difference in the average SES index in the group who had access to a computer, and the group who had no computer at home. Perhaps the next study cycles should simplify the components of the SES index and include the students' answer about computer availability at home. Also, the average results of the OECD PISA test in all content areas were higher in the group of participants who had indicated the possession of a computer at home.

Table 8.2 Relation of average SES index and average performance in OECD PISA test with availability of computers at home of Latvian participants (OECD PISA 2012)

Availability of computer at home	Average SES index	Average performance		
		Reading	Mathematics	Science
Yes	-0.09	498	499	509
No	-0.58	487	481	497

The average performance of OECD PISA 2012 participants varied greatly depending on the answer to the question on the availability of computers for completing school assignments at home (see Table 8.3). The students who had access to a computer at home for doing homework, both in OECD countries as a whole and in Latvia in particular showed significantly higher results in all test content areas. The average difference between the results of the OECD countries was 60 points in all three content areas, while in Latvia – in reading and mathematics – 60 points, and in science – 46 points.

Table 8.3 Average performance of Latvian and OECD students in OECD PISA 2012 in relation to computer access at home for completing school related tasks

	Computer at home for completing school related tasks	OECD PISA 2012		
		Reading	Mathematics	Science
OECD	Yes	502	499	507
	No	433	436	444
Latvia	Yes	494	495	506
	No	436	439	460

Internet use and student performance in OECD PISA

The intensity of Internet use is soaring all over the world. The technology provides a fast broadband Internet connection in various organizations and households. The wireless Internet solutions gain increasing popularity. Thinking about the meaningful use of online resources for education, the questions about the frequency of Internet use at school and at home (homework, information search) become self-evidently important.

OECD PISA 2012 school and student surveys included several questions about the use of the Internet for learning and entertainment.

The school survey included a question:

In all subjects taken together, for how much of the work does the school expect the 9th grade students to access the Internet / World Wide Web?

<10%   10–25%   26–50%   51–75%   >75%

a) Work during lessons
b) Homework
c) Assignments or projects

Table 8.4 Relationship of Internet use forecasted by the participating schools and student performance (OECD PISA 2012)

	Difference of average student performance in OECD PISA 2012 content areas, low intensity (<10%) or high intensity (>75%) Internet use forecasted by schools								
	During lessons			For homework			For projects		
	Reading	Mathematics	Science	Reading	Mathematics	Science	Reading	Mathematics	Science
OECD average	-13	-10	-11	17	10	9	39	32	37
Latvia	-2	-1	-16	43	45	32	12	11	-4

This table summarizes the school survey data about the expected intensity of the Internet use in all subjects in relation with student performance in OECD PISA 2012 content areas.

In Latvia, compared with the OECD countries, several tendencies are observed:

- a greater forecasted intensity of Internet use in lessons both in the OECD countries on average, and in Latvia was associated with lower results in the OECD test in all the content areas;

- a greater forecasted intensity of Internet use in performing homework or working on projects, both in the OECD countries on average and in Latvia was associated with higher achievements in all OECD test content areas.

This is just one of the results showing that the increase in the Internet use intensity in the learning process is not self-evidently linked to student performance growth. In Latvia, compared with the OECD average results, there are considerably fewer students who, according to the school forecast, could use the Internet for completing various assignments in more than 50% of cases (see Table 8.5).

Table 8.5 Number of students forecasted by schools, who could use the Internet for completing various assignments in more than 50% of cases

Participants	Internet use time forecasted by school > 50%		
	During lessons (percentage of students)	For homework (percentage of students)	For projects (percentage of students)
OECD	9.5	16.8	42.1
Latvia	5.9	10.1	33.8

Considering the use of the Internet in relation with student performance in OECD PISA 2012, the focus was on the commencement of the Internet use. Figure 8.1 shows the data characterising the age of the study participants at which they used the Internet for the first time, and its relation to the students' performance in the OECD PISA 2012.

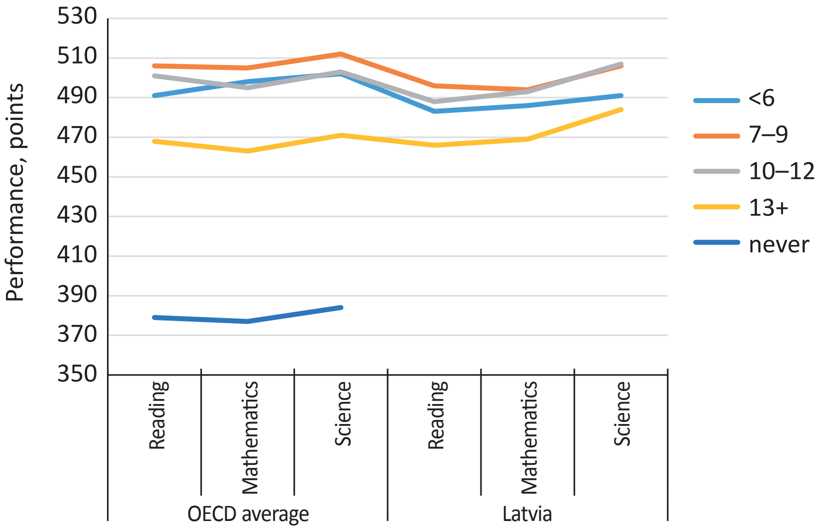


Figure 8.1 Age when Latvian and OECD countries' students start using the Internet and the average performance in OECD PISA 2012

It should be noted that significantly poorer average performance in the test was shown by those OECD countries' students who had indicated that they had never used the Internet. Both Latvian and OECD countries' students' performance did not alter significantly, if the respondents had started using the Internet before 12 years of age. The average performance of those Latvian and OECD countries' students in OECD PISA 2012 test who for the first time had used the Internet by 13 years of age, was approximately 20–30 points below the result of their peers who had began to use the Internet before 12 years of age.

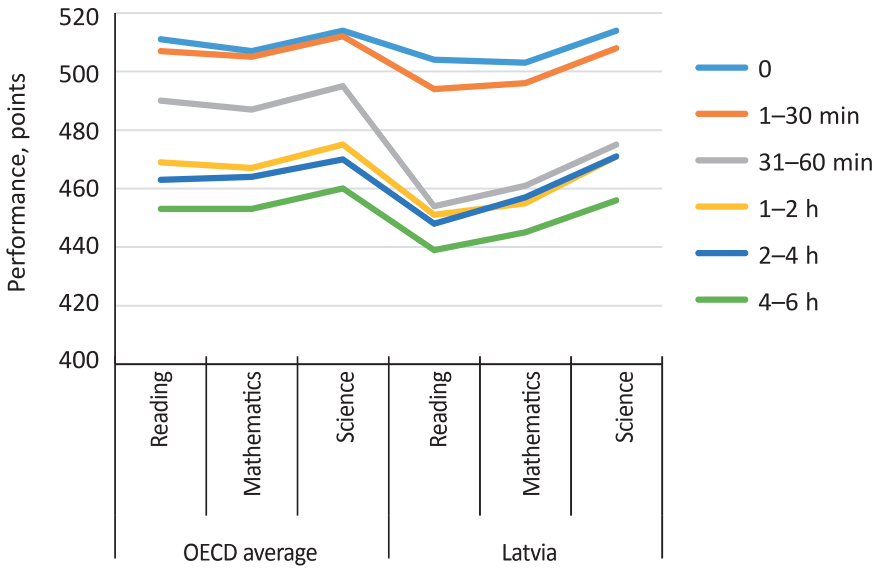


Figure 8.2 Relation of Latvian and OECD countries' students' average performance and the duration of Internet use at school (OECD PISA 2012)

The highest average performance in all the OECD PISA 2012 test content areas was shown by those of the OECD countries' and Latvian students who, in answer to the question:

"During a typical weekday, for how long do you use the Internet at school?"

indicated that they had not used the Internet at all or "for 1–30 minutes". The increase of Internet time was related to a significant drop in performance in all the OECD PISA test content areas (see Figure 8.2).

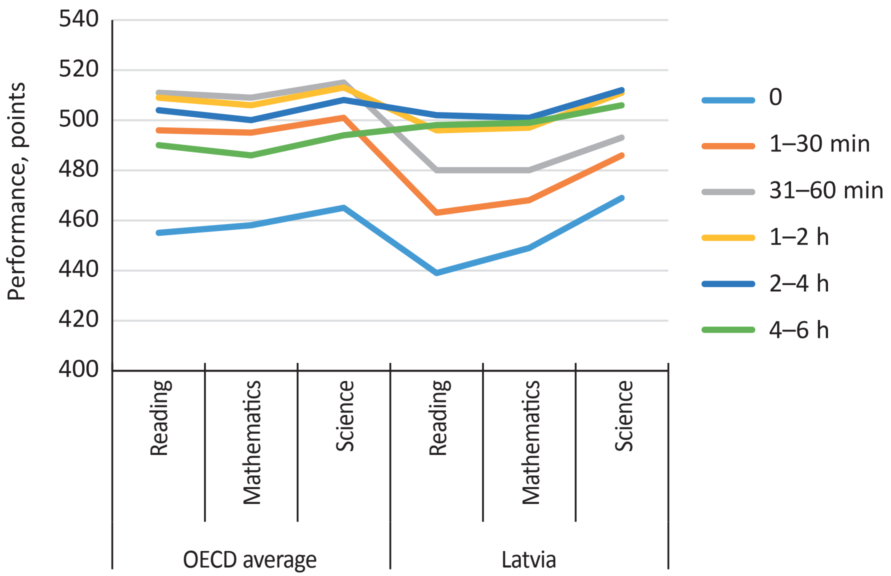


Figure 8.3 Relation of Latvian and OECD countries' students' average performance and the duration of Internet use outside of school (OECD PISA 2012)

A diametrically opposite result (see Figure 8.3) was obtained by summarizing the study participants' answers to the question:

"During a typical weekday, for how long do you use the Internet outside of school?"

The highest average performance in all the OECD PISA 2012 content areas was shown by those of the OECD countries' and Latvian students who had used the Internet quite extensively, while the lowest average performance – if the Internet was not used at all. Similar results were obtained by collecting data on the habits of study participants regarding Internet use outside school on Saturdays or Sundays.

Also in the previous cycle – OECD PISA 2009 – the survey of students had contained the question about the use of computers at school and at home. However, the wording of the question was different then – the students had to answer, for how long within a normal working week they had used the computer. It should be noted that the highest average performance in all content areas of the study was achieved by the group of students, who pointed out that during the week they had not used the computer in the respective subject lessons at all. With the increasing computer time, the average performance of students in all content areas of the study deteriorated (see Table 8.6).

Table 8.6 Average performance of Latvian students in reading, mathematics and science depending on the intensity of computer use at school (OECD PISA 2009)

Subject	Duration of computer use within a study week	Average performance in OECD PISA 2009
Latvian language*	None	494
	1–30 minutes	477
	31–60 minutes	439
	More than 60 minutes	431
Mathematics	None	492
	1–30 minutes	471
	31–60 minutes	450
	More than 60 minutes	460
Science	None	502
	1–30 minutes	490
	31–60 minutes	474
	More than 60 minutes	481

* If the student participated in the survey using the Russian language, the wording here was "Russian language".

Similar results were obtained not only in Latvia, but also in other OECD PISA participating countries, such as Germany, Greece, Japan and Korea. Overall, in a half of the participating countries, a more intensive computer use at school was associated with lower student performance in all content areas of the study. What is the reason behind this? The unequivocal answer cannot be given, because different countries have different educational systems, and they also differ in the respect of the ICT use strategy. Possible explanations:

- the learning strategy requires those students, whose performance is lower, to resort to the computers more,
- the students with lower educational achievement take comparatively longer to perform their work on a computer,
- more time at the computer can be a demotivating factor in learning.

Given the fact that similar results were also obtained in the 2006 survey cycle, it can be argued that the integration of the ICT in the education process and methodology of computer use in comprehensive education schools is not sufficiently well-founded and developed. These results urge to seriously reflect on the issues related to the use of the ICT in the learning process because it can hardly be considered useful to have the intensive computer and Internet use methodology at school, resulting in the decrease in performance in key curriculum areas like mathematics, science and reading. It must be recognized, though, that the OECD PISA study does not implement a detailed and comprehensive research of various ICT use aspects. The obtained results in the sphere of ICT and Internet use are indicative. Therefore, well-founded conclusions are only possible after an additional analysis and comparative examination of the data obtained in other studies.

8.3. Commencement of computer use and performance in OECD PISA

There are intense discussions in the educational environment as to when children should be introduced to the ICT. OECD PISA student survey contained a question, at what age the students had first used a computer. The responses are summarised Table in 8.7. Approximately 75% of Latvian students, who participated in the study, had for the first time used the computer when they were below nine years of age. A little less than 3% of the participants had used the computer for the first time at the age of 13 or later. As shown in the table, the Latvian students' answers to this question were similar to the responses of students in OECD countries.

Comparing the students' performance in the OECD PISA test, depending on the age of the first use of the computer, it was found that starting to use a computer at 6–9 years of age resulted in higher performance in all content areas of the test both in the OECD countries overall, and in Latvia (see Table 8.8). In Latvia, as well as in the OECD countries the students who first used a computer at the age of six or younger, achieved significantly higher average results than those students who had used the computer for the first time only at 10–12 or 13 years of age and even later (Latvian students' difference of results in reading and mathematics areas reached 40–50 points, while in science – 35 points). In OECD countries overall, this difference was even greater – respectively, 67, 79 and 75 points.

Table 8.7 Beginning to use computer in Latvia and OECD countries on the average (OECD PISA 2012)

Age of student beginning to use computer for the first time	Percentage of students who responded in affirmative	
	Latvia	OECD countries' average
6 years or earlier	24.3	31.6
7–9 years	50.1	42.3
10–12 years	21.9	18.8
13 years or later	2.8	4.0

Table 8.8 Relation of beginning to use computer and performance in OECD PISA content areas (OECD PISA 2012)

Age of student beginning to use computer for the first time	Average student performance in OECD PISA 2012					
	Reading	Mathematics	Science	Reading	Mathematics	Science
	Latvia			OECD countries' average		
6 years or earlier	495	499	509	508	513	518
7–9 years	495	493	505	504	499	506
10–12 years	476	482	494	483	473	483
13 years or later	454	450	474	441	434	443

8.4. ICT-related resources available to students at home

Effective and meaningful use of a computer is inconceivable without appropriate software and the use of various external devices. That is why the general part of OECD PISA student survey and its ICT module contained a number of questions regarding a variety of ICT resources at students' homes (the number of computers, software for educational purposes, printer, flash memory).

Number of computers at home

Table 8.9 summarizes the data on the relationship between the number of computers available at home and the student performance in OECD PISA test. The overall trend for both Latvia and OECD countries – a greater number of computers at home is related to higher performance in all the OECD PISA 2012 content areas. The proportion of the students in Latvia and in OECD countries, who had no computer at home, did not exceed 5%. Their performance in the test was significantly lower than that shown by the students who had indicated the possession of a computer at home. There are considerably more students in OECD countries who have three or more computers at home than in Latvia (42% and 20% respectively). The presence of several computers at home quite clearly points to a higher SES index.

Table 8.9 Number of computers at home and student performance in OECD PISA 2012

Number of computers at home	Average student performance in OECD PISA 2012					
	Latvia			OECD		
	Reading	Mathematics	Science	Reading	Mathematics	Science
None	432	442	464	432	426	437
One	481	481	497	481	475	484
Two	497	498	507	498	493	500
Three or more	510	515	520	516	516	521
Difference in performance (no computer – three or more computers)	78	73	56	84	90	84

Software intended for educational purposes

67% of Latvian 15-year old students participating in the study indicated that they had the software designed for educational purposes at home. In OECD countries, this answer was given by almost 53% of the participants. Both the Latvian and the OECD country students' average performance in all content areas was higher when the students had the educational software, while the student performance was by about 13–14 points lower if they had no software for study purposes at home. In Latvia, this difference in performance was twice as large. Hence, it can be assumed that the availability of software for educational purposes at home in Latvia is positively related to performance in all the OECD PISA content areas, and furthermore, this effect is greater than the average for the OECD countries.

Table 8.10 Availability of software for educational purposes at home and student performance in OECD PISA 2012

Software for educational purposes at home	Average student performance in OECD PISA 2012					
	Latvia			OECD		
	Reading	Mathematics	Science	Reading	Mathematics	Science
Yes	500	501	511	506	503	510
No	469	472	487	492	489	497
Difference in results	31	29	24	14	14	13

Tables 8.11 and 8.12 contain the data on 2012 OECD PISA participants' mathematics, science and reading performance in connection with the availability of a printer and flash memory at home, as well as with the use of these devices. In both cases, higher average performance of Latvian and OECD countries' students in all content areas was associated with positive responses about the printer and flash memory use at home.

Table 8.11 Printer use at home and performance in OECD PISA

Printer at home	Average student performance in OECD PISA 2012					
	Latvia			OECD		
	Reading	Mathematics	Science	Reading	Mathematics	Science
Yes, and I use it	499	501	510	509	507	514
Yes, but I don't use it	484	489	498	475	476	483
No	475	473	492	468	462	471
Difference in results	24	28	18	41	45	43

Table 8.12 Flash memory use at home and performance in OECD PISA

Flash memory at home	Average student performance in OECD PISA 2012					
	Latvia			OECD		
	Reading	Mathematics	Science	Reading	Mathematics	Science
Yes, and I use it	494	496	507	504	502	509
Yes, but I don't use it	468	471	485	480	480	486
No	460	457	478	450	446	454
Difference in results	34	39	29	54	56	55

Such or similar relationship of performance with the ICT availability and use by students at home was observed in all the questions about computers and devices available and used by the students in their homes. In general, it can be argued that the availability and use of software for educational purposes and various auxiliary ICT equipment at students' homes was associated with higher average performance in the OECD PISA 2012 in comparison with those students at whose home such devices were not available, or were available but not used. Compared to the OECD countries' students average performance, the Latvian students' average performance differences were less pronounced. In contrast with the availability of software for educational purposes and its use at home, printer and flash memory users at home in Latvia achieved results that were, respectively, by 18–28 points and 29–39 points above the average results in OECD PISA tests in comparison with those students who did not have those devices at home. Compared to the corresponding average student performance in OECD countries (respectively, 41–45 and 54–56 points), it can be concluded that in Latvia the integration of ICT in the educational process is less pronounced than in OECD countries, because in Latvia the average performance of those students who do not use any auxiliary ICT equipment at home does not decline as much as in OECD countries. This result shows that for Latvian students the use of the ICT auxiliary equipment to implement various educational tasks is not as important as for the students of OECD countries. Indirectly, this may also indicate that teachers in Latvia have not integrated the ICT in the educational process to the same extent as it is done in OECD countries as a whole. The relatively minor ICT-use relationship with the decline of performance shows that in Latvia ICT use in the educational process is relatively less important (or less integrated) – obviously, the teachers have not yet found the optimal model for the use of the ICT in learning to ensure the added value of the ICT in the learning process.

8.5. ICT use indices

Using the questions from the student survey ICT module, within the OECD PISA 2012 cycle, a number of ICT-related indices were established, such as:

- availability of the ICT at home,
- availability of the ICT at school,
- use of the ICT at home to complete school-related tasks,
- use of the ICT at school,
- attitudes towards computers: limitations of the computer as a tool for school learning,
- attitudes towards computers: computer as a tool for school learning.

Table 8.13 shows the Latvian students' average performance in the test, depending on the intensity of ICT use at school (index "The use of ICT at school"). The increase of the index by one unit is associated with a significant drop in the test results in all three content areas. Similar results were also obtained in the OECD PISA 2006 and 2009 cycles, however, the substantiated assessment of trends is not possible, because the number of questions included in creation of the index and sometimes the wording in each study cycle slightly changed.

Table 8.13 Dependence of Latvian students' average performance in OECD PISA 2012 on ICT use intensity at school

Content area	Constant	Changes in performance, as the index value increases by one unit
		ICT use at school
Mathematics	491	-16
Science	502	-15
Reading	490	-18

Summary

Latvia, participating in the OECD PISA cycles, has always chosen the option to supplement the students' survey with the ICT module. Inclusion of the module in the subsequent cycles of OECD PISA study provides an opportunity

- to perform a trend analysis within the content areas included in the module regarding the various ICT use-related aspects;
- to continue examining the factors influencing student performance in different contexts in terms of ICT use;
- to carry out a comparative international evaluation of the ICT use in basic education;
- to develop medium and long-term forecasts and recommendations regarding various aspects of ICT integration and use.

The last of these opportunities must be regarded as particularly important for the development of the basic education curriculum content, to balance the proportions of different subjects, as well as to ensure the science-based information technology as a separate subject and ICT integration in learning process. Currently, the meaningful use of the ICT in the learning process is clearly insufficient, particularly regarding the ICT-use related added value in the learning process, rather than submitting to aggressive ICT industry pressures to increase the proportion of information technology lessons. This was also confirmed by the OECD PISA results (OECD, 2015c), in which the highest average performance in all content areas of the study was shown by the group of students who indicated that computers at school in relevant subjects during a study week were not used at all. Furthermore, with an increase of the computer-time, the students' average performance in all content areas of the study actually deteriorated. Hence, already in the second cycle of the OECD PISA it was found that the increase of computer use at school was not linked to student performance improvement in any of the content areas of the study. This raises an important question regarding ICT integration in education – how can the use of computers enhance the learning process, creating an added value directly related to ICT use? It is corroborated by Andreas Schleicher, OECD Director for Education and Skills, who concludes that school technology had raised “too many false hopes” (Coughlan, 2015).

9. STUDENTS – TOP PERFORMERS IN LATVIA

9.1. Students – top performers: definition

The term "top performers" denotes the students who are the highest achievers among their peers in the respective fields. Usually they are the top performers in their class or class group. The term "top performers" is mostly used referring to 10–25% of the students who have attained the best results in the group (Xiang, Dahlin, Cronin, Theaker, Durant, 2011). This definition does not help identify the students' specific characteristics distinguishing them from the rest. The definition only indicates that in any group there are students with high achievements, regardless of the results obtained and their compliance with the maximum obtainable points. Thus, it is reasonable to conclude that such a definition is inaccurate and does not answer the specific needs of the given study.

In the printed sources, the authors tell about the abilities and capabilities of the students – top performers. For example, Lili Allen from Brown University (USA) writes that top performance is ensured by such competencies as problem solving, information management, communication and negotiation skills (Allen, 2000).

Kevin J. Coyle points out that a student- top performer is motivated, inquisitive, even hungry for knowledge. He or she is creative, has problem-solving skills, as well as broad perspective, he or she sees every problem as an intriguing new puzzle to be solved (Coyle, 2010).

Carol Bainbridge, who has a doctorate in linguistics, talking mainly about verbally gifted children, claims that the top performers are those who reach their targets. At school those would be the students receiving high assessments and good grades. They are doing what is necessary, and doing it well. They tend to be organized, with good time management skills enabling them to accomplish tasks accurately and on schedule. They usually behave well. easily fit in the class. and enthusiastically participate in classroom discussions (Bainbridge).

The students – top performers are often mistakenly referred to as gifted. However, they are not always gifted, but may have invested a lot of time and effort in the learning process and their results may have been achieved with hard work; most often these students are highly motivated. Significant achievements in a particular field can also be shown by the students who are interested in this field and the results come easy to them (Kingore, 2004a; Bainbridge).

There is no uniform definition of the term "gifted students" or "gifted people". Most authors, talking about the gifted, also mention the talented.

Psychology professor Françoys Gagné believes that giftedness means that a person has excellent natural abilities, particularly, the abilities in at least one of the ability areas, whereas talent signifies a systematically developed mastery of abilities in one of the areas known as competencies and skills (Gagné, 2008; Gagné, 1985).

Joseph S. Renzulli, the Director of the USA National Research Center on the Gifted and Talented, in 1978 wrote that "giftedness consists of the interaction between the three basic groups of human traits: above-average abilities, high-level implementation of tasks (motivation), a high level of creativity. Gifted and talented children are those who have this composite set of characteristics or those, who could develop and exploit it in any potential area of human performance" (Renzulli, 1978).

Giftedness is like a "label" given to the persons whom we can associate with the type of learning that ensures the supremacy (Ziegler, Stoeger, Vialle, 2012).

Thus, the main difference between the gifted and the talented is that the gifted possess excellent natural abilities (above average) in at least one of the ability areas, whereas the talented have mastered the abilities, systematically developing their skills and competencies.

Although the theories and definitions of giftedness differ, the majority believes that, in order for the gifted children to be able to use their abilities, these abilities must be developed and particular work with these children is required (Kingore, 2004a, Renzulli, 1978; Renzulli, 2012; Ziegler, Stoeger, Vialle, 2012). A lot of effort must be invested by parents as well as teachers. The most appropriate approach would be to use the methods especially developed for work with gifted children and the techniques for the development of these children's special abilities. Hence, teachers should understand and be able to recognize gifted pupils and successfully promote their development in a particular area.

However, the students who achieve high results are often mistaken for gifted students. Usually it is the parents who believe that if their child is a top performer, he or she is gifted or talented whereas most often these children are simply shrewd, advanced and have acquired the ability to learn. The gifted do not always achieve high performance results, because they think and perceive things differently. Bertie Kingore distinguishes among three different types of students, who are often confused for each other at school: students who reach high achievements, gifted students and creative thinkers. Kingore does not preclude exceptions, when a gifted student can also be a creative thinker, or a student who shows high performance can also be gifted, and so on (Kingore, 2004b).

In the PISA study, students performing at level 5 or 6 are frequently referred to as "Top Performers" meaning those who have reached at least the level of competency in one of the content areas (OECD, 2010a).

Consequently, the students with high achievements show good results in a certain area, they are strongly motivated and have the skills and abilities to achieve their goals, such as problem solving, time management, information management and communication skills, and creativity. They can also be the students who are gifted in one area, and to them the tasks of this content area come easy.

9.2. Factors influencing students' top performance in Latvia

The analysis is based on the data from 2000, 2003, 2006, 2009 and 2012 PISA studies. In order to determine the factors, two groups were selected – the students with high achievements (over 600 points, hereinafter – Group 1), and the students who were close to top performance, although did not quite reach it (from 500 to 600 points, hereinafter – Group 2).

As mentioned before, the concept of "students – top performers" in PISA means the students who in one of the content areas of the study have reached at least level 5. To set a threshold of top performance for all content areas and to include in the analysis more students with high achievements, it is assumed that the top performing students are all those students who have obtained at least 600 points (Group 1). The lower limit of Group 2 is determined by reference to the average defined by OECD countries in all content areas, that is, 500 points, while the highest average indicator in the OECD countries is plus one standard error (100 points), that is 600 points.

In order to forecast the opportunity of Group 2 students to join Group 1, the binomial logistic regression method was used. The method was chosen on the basis of the dependent variable specificity and the need to compare two different groups – students with high achievements and those who were most likely to become top performers. Binomial logistic regression is used when it is necessary to model the cases in which the dependent variable is binary or dichotomous (Hosmer, Lemeshow, 2000).

The analysis of the data in each study cycle was carried out, taking as a source data the results shown by students in each given cycle's main content area, and on these grounds Group 1 and Group 2 were formed.

The regression model allows to determine the extent to which the independent variables affect the group and how, as they change, the group will change, too. The chosen independent variables were the indices of the particular PISA cycle, removing beforehand those indices from the model, whose correlation with the dependent variable was low (less than 0.100). Most indices are related to the students' learning habits, interests, motivation to learn and attitudes towards each content area of the study. Therefore, these indices are the factors to be considered in order to determine the students' top performance in PISA.

In the first phase, the analysis included all the indices correlating with the dependent variable. At this stage, the significance of each variable to the corresponding model was considered, as the inclusion of the variable in the model gives a statistically significant benefit. If the importance of the variable is above 0.05. then the corresponding variable is excluded from the model.

In the second phase, all the statistically significant independent variables were simultaneously included in the model. The variable importance was measured also in this stage: if the variable did not produce a statistically significant benefit for the model, then it was excluded and a new model was created.

To ensure the effectiveness of the model and its compliance with the data, *Cox & Snell's* R^2_{CS}, *Nagelkerke's* R^2_N and Hosmer and Lemeshow test are commonly used. Since in the analysis contained in this chapter the regression model is built from a relatively large sample, these indicators have not been taken into consideration when assessing the effectiveness of the model and its compliance with the data (University of Strathclyde).

In the linear regression, the relationship between the dependent (Y) and the independent variable (X) is determined by the equation $Y = A + BX$ where A is the intercept, B – the regression coefficient. The equation demonstrates how the value of the dependent variable changes, following the change in the independent variable. Consequently, the higher the regression coefficient, the greater will be the changes of the dependent variable, as the independent variable changes (Geske, Grīnfelds, 2006). On the other hand, in the interpretation of the results within the logistical regression, a greater importance is given to the regression coefficient exponent (exp B), since it determines what is the probability of the dependent variable (Y), as the independent variable (X) changes (Burns, R., Burns, R.).

Students – top performers in reading

Table 9.1 compares the ratios of the students at the highest competency levels within the study cycles in the countries such as New Zealand, Finland, and Hong Kong (China), starting from the year 2000. These countries are among the strongest average achievers, and the proportion of the students at the highest levels of competency in all content areas of the study is among the largest. Comparison includes

Latvia's neighbouring country Estonia, as the Estonian students' achievements in the OECD PISA studies were better than those of Latvian students, and in the last cycle there was even an increase in the percentage of the students that reached those high levels. The neighbours of Latvia–Lithuania and Russia are also included (these countries are contemplated in the subsequent comparisons, too). The average proportion of OECD countries' students at the highest levels of competency in the previous cycles decreased, but in 2012 it slightly rose both in OECD countries on average, and in Latvia. It can be observed that the proportion of Lithuanian students in the higher levels of competency in all cycles has been slightly lower than those of Latvia. By contrast, in Russia, where until the 2006 cycle the proportion of students in the highest levels of competency was lower than in Latvia, from 2009 onwards the proportion grew larger than in Latvia.

Table 9.1 The comparison of student proportion (%)at the highest levels in the reading competency in all cycles of the study

Year	2000	2003	2006	2009	2012
Hong Kong	9.5	5.7	12.8	12.4	16.8
New Zealand	18.7	16.3	15.9	15.8	13.9
Finland	18.5	14.7	16.7	14.5	13.5
OECD countries' average	9.5	8.1	8.6	7.6	8.4
Estonia	-	-	6	6	8.4
Russia	3.2	1.7	1.7	3.1	4.7
Latvia	4.1	6	4.5	3	4.2
Lithuania	-	-	4.4	2.9	3.3

- – the country did not participate in the study
The countries are arranged according to the proportion of students at the highest levels of competency in 2012
Data from the OECD PISA data base

The distribution of students in top performance groups in reading

In Latvia, more girls than boys showed high results in reading (Figure 9.1) in all PISA cycles. 10% of all girls in 2000 and 11% in 2012, while only 4% of boys in 2000 and in 2012 managed to earn more than 600 points. In 2009, when the reading was the key area of the study, 8% of girls and only 3% of boys managed to show top performance. The boys' share in the highest achievement group tends to decline, while that of the girls – to increase. The drop in the proportion of boys is higher than the increase in the proportion of girls. Although more girls are able to achieve 600 points and get into Group 1, a lot more girls than boys are also in Group 2. In 2012, 51% of girls were capable to get more points than the average of the OECD countries. This could be explained by the fact that girls are greater readers, they are more interested to read for pleasure (Geske, Grīnfelds, Kangro, Kiseļova, 2010). The explanation to the observation that boys read less than girls was also sought by the researcher Antra Ozola in her doctoral thesis "The opportunities for improving boys' text comprehension in the context of education management." The researcher notes that the boys consider reading as a women's pastime, because most children are read to by their mothers (Pottorff, Phelps-Zientarski, Skovera, 1996; Ozola, 2012), and the primary school class teacher is almost always a woman (Delamont, 1990; Ozola, 2012). Furthermore, the boys lack suitable, interesting literature (Ozola, 2011). Schools and parents should devote great attention particularly to encouraging the boys to read. Parents themselves should read a great deal more, focusing on the comprehension of the text, and thus setting a positive example to their offspring. As shown in the OECD study on adult skills (PIAAC), an average of 0.7% countries participating in the study were able to achieve the highest level of competency (OECD, 2013h). Although Latvia did not participate in this study, in the light of PISA results, where the performance of Latvia's students is close to the OECD average, we can assume that there would probably be similar results in Latvia. Teachers and parents should be offered the literature that would also interest the boys, without limiting the choice of the reading material.

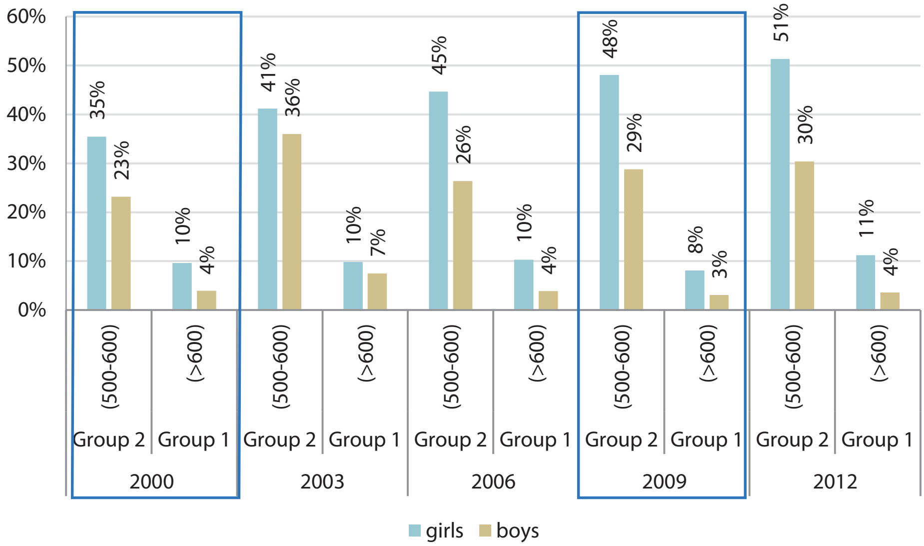


Figure 9.1 The proportion of students (%) in high achievement groups in reading, PISA cycles from 2000 to 2012, according to gender

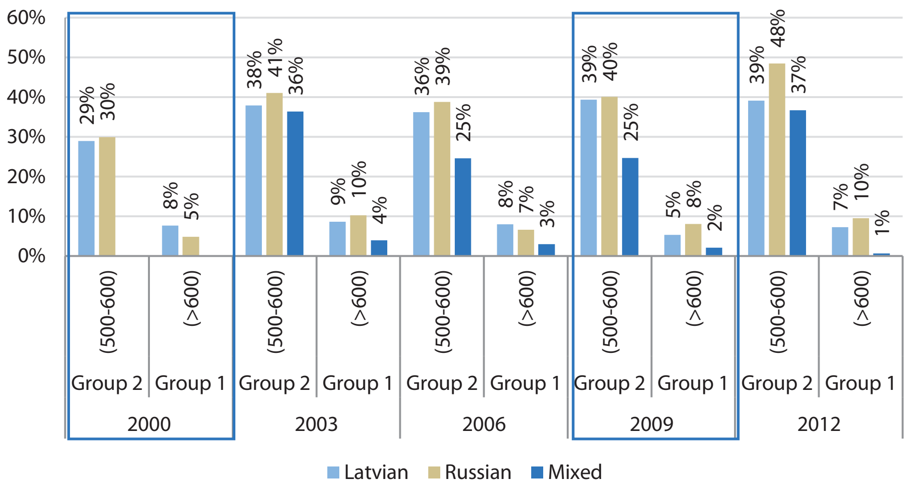


Figure 9.2 The proportion of students (%) in high achievement groups in reading, PISA cycles from 2000 to 2012, according to the language of instruction at school

If we look at the division by group, taking into account the students' language of instruction (Figure 9.2), we see that in 2000, in Group 1 there were more students whose language of instruction was Latvian, 8% of all students who studied in Latvian, and only 5% of all those who were learning in Russian. By contrast, in 2012 – 600 points were obtained by 7% of all students who studied in Latvian and as many as 10% of those who learned in Russian. Even though the students who study in Latvian and in Russian have no statistically significant difference, there is a tendency that the proportion of students studying in Russian in the group of highest achievement increases. In the mixed schools, the number of students able to reach 600 points decreases with each cycle; from 2003 the proportion of these students each year is reduced by one per cent.

In 2012, 80% of the Latvia's state gymnasium students were capable of earning more points than the average for OECD countries' students (see Figure 9.3). By contrast, 22% of the state gymnasium students could obtain more than 600 points. Naturally – to enter the state gymnasiums, the students have to pass entrance examinations. Consequently, these schools enrol the best students who are able to pass the tests, 7% of students studying in secondary schools are able to achieve more than 600 points, while 6% of the students in the regular gymnasiums are able to achieve more than 600 points. In the latest cycles, the secondary school student performance has been rising, and, evidently, more and more students of secondary schools are able to achieve more than 500 points. In the cycle of 2006, there was a drop from 48% in 2003 to 42% in 2006, but in 2012 over 48% of the students could achieve more than the students in the OECD countries on average. The students who study in basic schools every year are observed to be less capable of excelling,

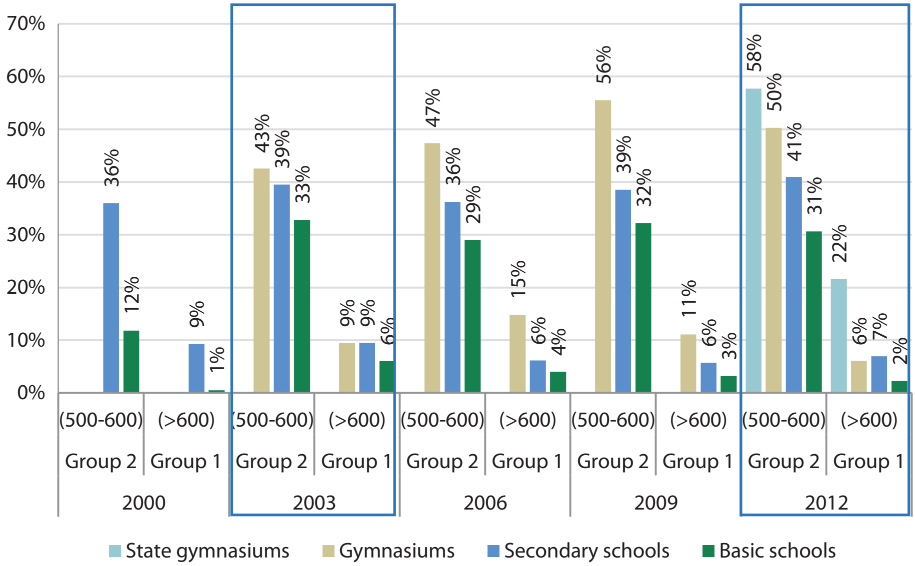
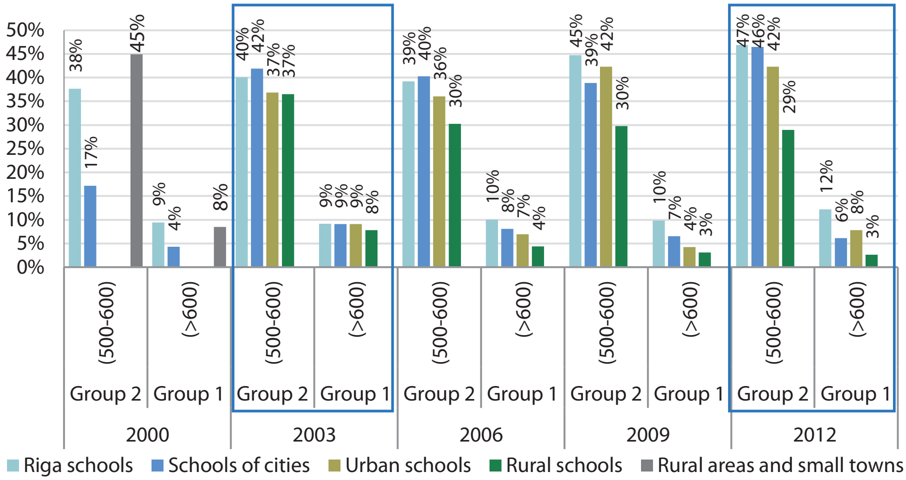


Figure 9.3 The proportion of students (%) in high achievement groups in reading, PISA cycles from 2000 to 2012, depending on the type of school

not only above 600 points, but also above 500 points. This can be explained by the shrinking number of basic schools, as since 2000, nearly 170 basic schools have been closed (527 schools in 1999/2000, and 354 in 2011/2012 (Ministry of Science and Education statistics)). It is likely that many parents prefer their children to learn at local schools, next to the place of residence, while they themselves work in the nearby towns. Commuting with the children to schools in cities and towns means extra costs. And, if there is no local school, it is more practical to move to a city. Consequently, the population in the rural areas declines. There are much more basic schools and fewer secondary schools in the rural areas, as opposed to the urban areas, where secondary schools prevail over basic schools.

With each cycle, the proportion of students in Group 1 in Riga schools is increasing – in contrast to other big city schools, where it decreases (see Figure 9.4). In the schools of other towns the percentage of students in Group 1 particularly increased during the last cycle, compared to the previous cycle, while in the rural schools the percentage of students in Group 1 remained unchanged in the last two cycles. However, reviewing particularly the student achievement in those cycles when the reading has been the main content area of the study, it appears that student achievement compared to 2000 and 2009, when the reading was the main content area, has been on the rise. The number of students able to obtain more than 500 points has increased both in Riga and urban schools, and the number of students who are able to achieve more than 600 points has grown, too.



In 2000 the data of rural areas and small towns were combined in one group.

Figure 9.4 The proportion of students (%) in high achievement groups in reading, PISA cycles from 2000 to 2012, according to the location of the school

Opportunities of Latvian students to achieve high results in reading in PISA

While overall the percentage of Latvia's students who are able to achieve high results in reading tends to decrease when comparing the data in cycles, where reading was the main content area, the number of students who are able to obtain more points than the OECD average, tends to increase (Table 9.2).

Table 9.2 The proportion of students (%) in different performance categories in reading. PISA cycles of 2000 and 2009

Year	Top performing students according to OECD PISA classification	Top performing students, if the threshold is 600 points	Students achieving between 500 and 600 points
2000	4.1	6.8	29.3
2009	3.0	5.6	38.5

Using the binomial logistic regression, the possible factors affecting high achievement in PISA 2000 were identified. The following were recognised as the most important: parental education, family support in learning, reading for pleasure, satisfaction with their mathematical abilities, satisfaction with their academic abilities (see Table 9.3).

Table 9.3 Student performance in reading, PISA 2000: results of logistic regression

	B	Standard error	Significance	Exp(B)
Mother's education	0.721	0.053	<0.001	2.057
Reading for pleasure	0.643	0.035	<0.001	1.903
Satisfaction with own mathematical abilities	0.260	0.032	<0.001	1.296
Satisfaction with own academic abilities	0.248	0.038	<0.001	1.281
Father's education	0.168	0.040	<0.001	1.183
Family support in studies	-0.514	0.034	<0.001	0.598

Then, PISA 2009 questionnaire data were analyzed. However, it is not possible to compare the achievement-influencing factors in PISA 2000 and PISA 2009, because a number of the indices – factors were no longer used in PISA 2009, except for two – parental education and reading for pleasure, which were also included in the PISA 2009 binomial logistic regression model. It was found that student achievement could be positively affected by the changes in the following factors: higher parental education level, presence of cultural possessions at home, availability of educational resources at home, reading for pleasure, as well as the reading strategies used – "Understanding and remembering" and "Summarizing" (see Table 9.4).

The indices "Mother's education" un "Father's education" are formed on the basis of student questionnaire questions as to the higher education obtained by each of the parents, on the basis of national education qualification and ISCED levels. Two questions were asked about each of the parents: "Did your mother / father complete upper secondary education?" The variants of answers: "No, she / he did not go to school"; "No, she / he completed primary education only"; "No, she / he completed lower secondary education only"; "No, she / he completed vocational school without obtaining secondary education"; "Yes, she / he completed upper secondary education (at secondary school, vocational school, technical college)"; and "Has she / he obtained higher education?"

Table 9.4 Student performance in reading, PISA 2009: results of logistic regression

	B	Standard error	Significance	Exp(B)
Reading for pleasure	0.906	0.045	<0.001	2.475
Reading strategy "summarizing"	0.441	0.046	<0.001	1.554
Availability of educational possessions at home	0.441	0.052	<0.001	1.555

	B	Standard error	Significance	Exp(B)
Reading strategy "understand and remember"	0.381	0.040	<0.001	1.464
Presence of cultural possessions at home	0.156	0.048	0.001	1.169
The highest level of parental education	0.118	0.016	<0.001	1.125

The parental education is an important factor that can affect the increase of student achievement – it is confirmed by PISA 2000 and PISA 2009 data. An educated person reads more and thus, both directly and indirectly, affects his or her children's attitude to reading. As shown in Table 9.4, the maternal education is the most influential factor. This means that if the mother has a higher education, then the probability of a child to move from Group 2 into Group 1 increases by 105%, assuming that the rest of the indices' values remain the same. Although PISA 2009 data show that higher parental education level is no longer likely to raise student achievement as testified by PISA 2000 data, one should note, however, that in PISA 2009 the mother's and father's education was combined in one index (OECD, 2012a), thus, it cannot be argued that the impact has decreased.

The index "Family support in studies" is derived from students' responses on how often mother, father, brothers or sisters help with the homework assigned by school. The increase of this index would have a negative impact on the student's achievement. Increasing this index by a single unit, the probability that the student will qualify for Group 1 falls by 59%. Assistance in learning is a lot more vital to those students who have problems in learning or who have difficulties completing a task. The assistance may also undermine the student's reliance on his or her own abilities.

The second of the most influential factors in PISA 2000, and the most influential one in PISA 2009 is "Reading for pleasure". This index is derived from the extent to which the student agrees to the following questions about reading (in creating this index, the negative statements are encoded with the opposite sign) (OECD, 2000):

- I read only if I have to.
- Reading is one of my favourite hobbies.
- I like talking about books with other people.
- I find it hard to finish a book.
- I feel happy if I receive a book as a present.
- For me, reading is a waste of time.
- I enjoy going to a bookstore or a library.
- I read only to get the information I need.
- I cannot sit still and read for more than five minutes.

In PISA 2009, this index was supplied with two questions not included in PISA 2000 questionnaire (OECD, 2012a):

- I like to express my opinion about the books I have read;
- I like to exchange books with my friends.

If the value of this index increases by one unit, the probability that a student will qualify for the Group 1 will increase by 90% according to PISA 2000 data, while PISA 2009 data show that the increase is already by 148%, assuming that the values of the rest of the indices remain the same.

Among PISA 2000 indices that are significant for increasing student performance, there is also the index "Satisfaction with own mathematical abilities" and index "Satisfaction with own academic abilities." The increase of these indices by one unit would increase the likelihood of a student to move from Group 2 to Group 1, by 30% and 28% respectively, provided that other indexes remain unchanged. The index "Satisfaction with own mathematical abilities" is formed on the basis of the extent to which the student agrees to the following statements (OECD, 2000):

- I get good marks in mathematics.
- Mathematics is one of the subjects that I am best at.
- I have always done well in mathematics.

Index "Satisfaction with own academic abilities" is formed on the basis of the extent to which the students agree to the following statements:

- I learn things quickly in most school subjects.
- I'm good at most school subjects.
- I do well in tests in most school subjects.

Mathematics develops the algorithmic thinking, which means that these children have a greater ability to perform precise instructions, consequently, the description of the task is read carefully and fulfilled. These students have stronger logical thinking, reasoning, and, possibly, have a clearer text perception.

PISA 2009 data shows that the student performance levels are affected by the application of appropriate learning strategies. These learning strategies are special indices developed by experts comprised of student responses to questions about the learning habits and of the number of points obtained by the students in various reading items (OECD, 2012a). Reading strategy index "Understanding and remembering" shows, whether the students select the most appropriate strategy to understand and remember the text. This index determines that the most successful strategy would be, as follows: after reading the text to discuss its contents with others, underline the most important parts of the text, summarize the text in one's own words. A less appropriate strategy is described by the students, as follows: I focus on the parts of the text that are easier to understand, I read the text fast twice, I read the text aloud to another person. The increase of this index by one unit would increase the likelihood that student would move from Group 2 to Group 1 by 46%.

By contrast, the strategy index “Summarising” shows whether students select the most appropriate strategy to write a summary of a complex two-page text. The most successful strategy would be to do the following: to read the text, underlining the most important sentences, and then to relate it in one’s own words in a summary; to verify that all the key facts are included in the summary. A moderately successful strategy would be to write a summary; to check whether each paragraph of the text is included in the summary, because that is how it should be; before writing the summary to read the text as many times as possible. The least fruitful strategy included in the index is the student’s attempt to rewrite the summary accurately, using as many sentences as possible from the text. The increase of this index per one unit would increase the likelihood that student could move from Group 2 to Group 1 by 55% provided that other indices remain unchanged.

Several indices were created on the basis of students’ answers to 13 questions about the possessions at home, including the “Educational possessions at home” and “Cultural possessions at home.” Of these two indices, the greatest likelihood of a student to move from Group 2 to Group 1 by 56% is ensured by the increase of index “Educational possessions at home” by one unit. This index was created from students’ responses on whether they have access to the following things: a desk for study, a quiet place to study, a computer that can be used for studies, educational software, the books useful for school assignments, technical manuals, a dictionary (OECD, 2012a). By contrast, the index “Cultural possessions at home” was made up of students’ answers on the availability of the following: classic literature (e.g., Rainis), books of poetry, works of art (e.g., paintings) (OECD, 2012a). The increase of this index only by one unit would increase the opportunity for a student to enter the group of the excellence by 17%, on condition that the other indices remain unchanged.

Students with top performance in mathematics

Table 9.5 shows the comparison between the OECD average indicators and Latvian, as well as selected countries’ proportion of students (as a percentage) in PISA cycles from 2003 to 2012. It demonstrates that the proportion of Latvian students in the highest levels of competency is below the OECD average. It is important to note that the percentage of Estonia’s students in the highest levels of competency in mathematics corresponds to the OECD average proportion of students at these levels.

Table 9.5 The comparison of student proportion (%)in the highest levels of mathematical competency in all cycles of the study

Year / Country	2003	2006	2009	2012
Hong Kong	30.7	28.7	30.7	33.7
Finland	23.4	24.4	21.6	15.2
New Zealand	20.7	18.9	18.9	15
Estonia	-	12.6	12	14.6
OECD countries' average	14.6	13.3	12.7	12.6
Lithuania	-	9.1	7	8.1
Latvia	7.9	6.6	5.7	8
Russia	7	7.4	5.2	7.8

- – the country did not participate in the study
The countries are arranged according to the proportion of students at the highest levels of competency in 2019
Data of the OECD PISA data base

The distribution of students in top performance groups in mathematics

As shown in Figure 9.5, the proportion of boys in Group 1 (achieving top results in mathematics) is greater than that of girls in all cycles, except for 2003, when mathematics was the main content area. In 2003, nearly 50% of girls were able to get more points than the OECD average. By contrast, the proportion of boys and girls in Group 2 during the other cycles was not significantly different, except for 2012, when the mathematics once more was the main content area and again more girls than boys were able to achieve higher results than the OECD average, while the proportion of boys who were able to acquire more than 600 points was higher. Comparing the 2003 and 2012 cycles, when mathematics was the main content area, it must be concluded that the proportion of boys in Group 1 has increased by 3%, while the proportion of girls has dropped by 2%. Comparing the data across cycles, there is a tendency – the proportion of boys achieving more than 600 points is rising faster than the proportion of girls.

Comparing the proportion of students in Group 1 and Group 2, taking into account the language of instruction, there emerges a similar situation as in reading (see Figure 9.6). The percentage of students studying in Russian in Group 1 is increasing, while of those learning in Latvian it is falling, with the exception of the year 2012. Similar to the analysis of the proportion of boys and girls in Group 2, also the Russian and Latvian student proportional division shares similar trends, namely, the Russian and Latvian proportion of students in Group 2 is not significantly

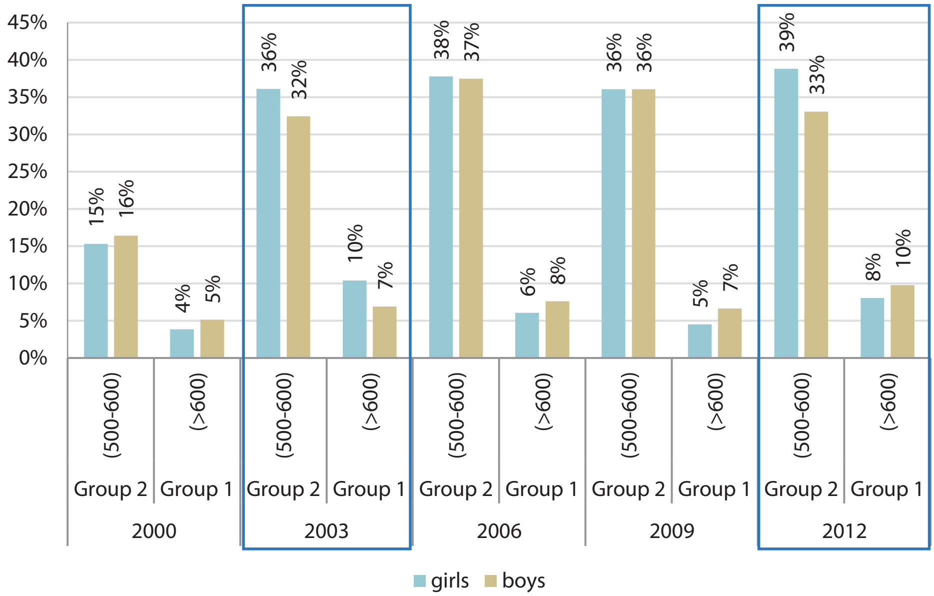


Figure 9.5 The proportion of students (%) in high achievement groups in mathematics, PISA cycles from 2000 to 2012, according to gender

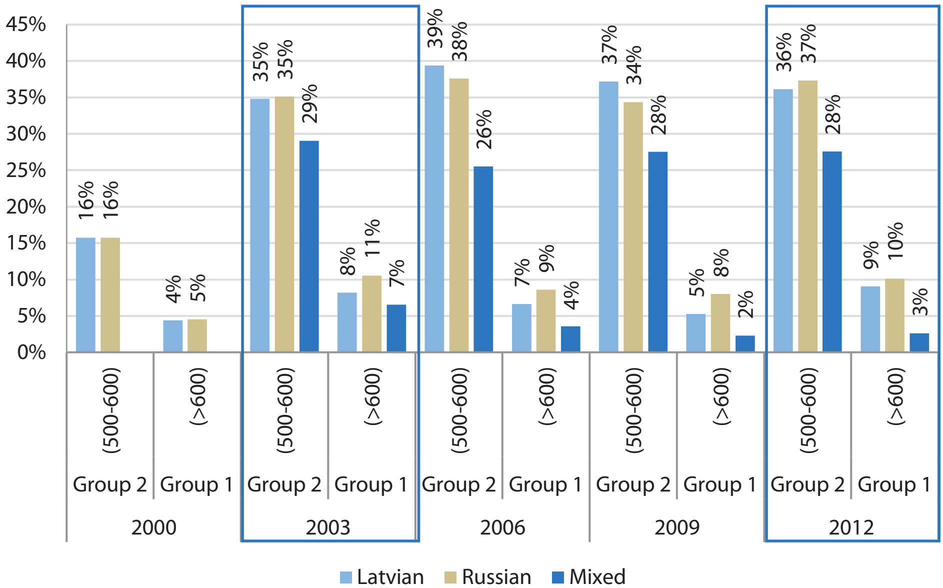


Figure 9.6 The proportion of students (%) in high achievement groups in mathematics, PISA cycles from 2000 to 2012, according to language of instruction at school

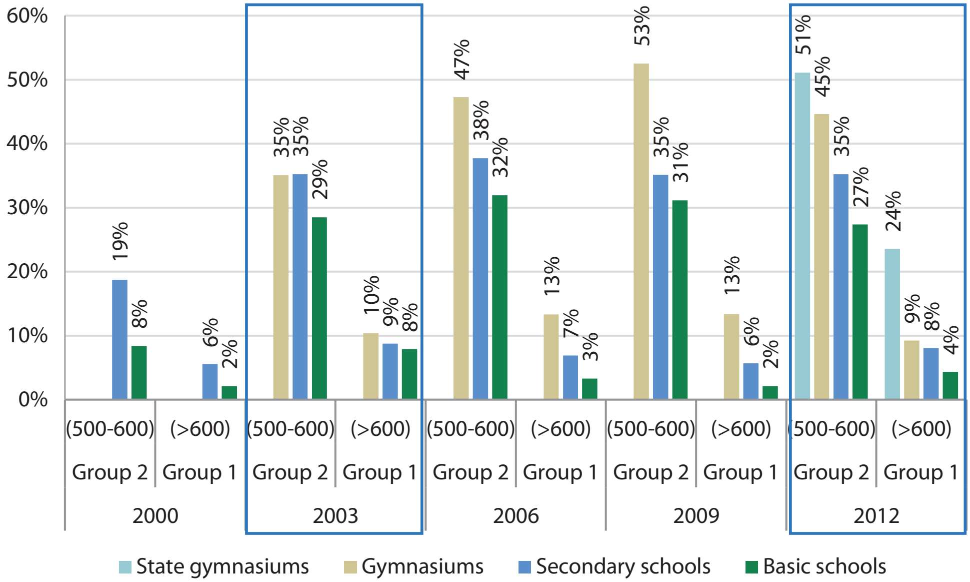
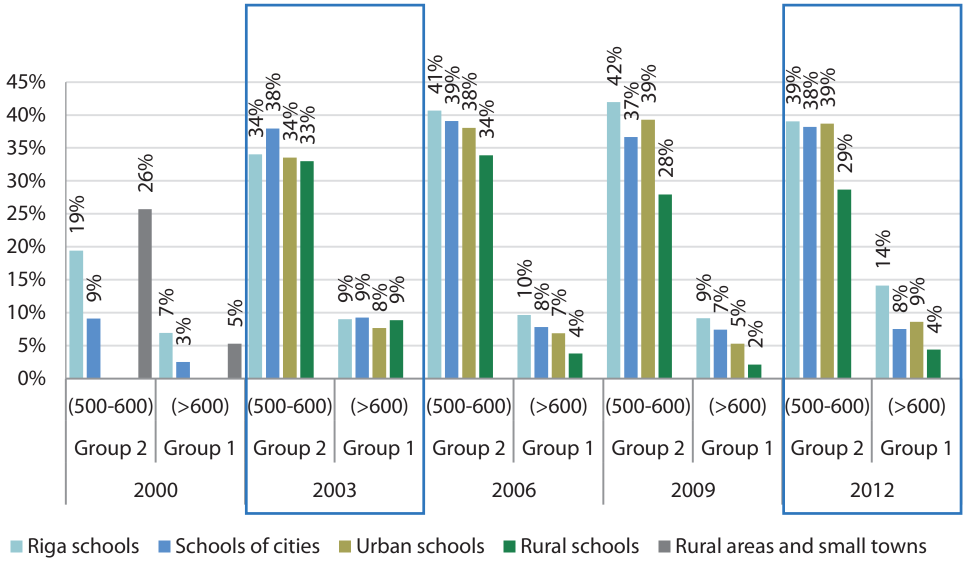


Figure 9.7 The proportion of students (%) in high achievement groups in mathematics, PISA cycles from 2000 to 2012, according to the type of school

different. The comparison of the cycles when mathematics was the main content area shows that the percentage of students in Group 1, whose language of instruction is Latvian, slightly increases, while of those, whose language of instruction is Russian, slightly declines. Consequently, the gap between students with different languages of instruction is narrowing.

Figure 9.7 shows that much higher performance in mathematics in 2012 has been achieved by those students who were studying in state gymnasiums, and, as discussed previously, it is self-evident. Secondary school and gymnasium student percentage in Group 1 is very similar, but the greatest drop in the proportion of students in Group 1 has been observed particularly in basic schools. The comparison of all cycles shows that at secondary schools the situation is very stable, without dramatic falls or rises, yet it can also be a warning sign of stagnation, lack of striving for better results. The fall is observed in the gymnasiums, yet it can be explained by the fact that the state gymnasiums were separated from the gymnasiums.

Looking at the performance of students according to the school location, it can be observed that the percentage of students who are able to reach at least 600 points in Riga schools and other city schools is on the rise (see Figure 9.8). Comparing the cycles when mathematics was the main content area, it was evident that again the rural schools saw a significant decrease in the proportion of students both in Group 1 and Group 2, consequently, the number of students in rural schools who



In 2000 the data of rural areas and small towns were combined in one group

Figure 9.8 The proportion of students (%) in high achievement groups in mathematics, PISA cycles from 2000 to 2012, according to the location of school

were able to achieve such high results continued to decline. Very rapid growth – from 9% to 14% – was observed in Riga schools in Group 1. At the same time, the proportion of students in t Group 2 at the schools of Riga and other cities is equal.

Opportunities of Latvian students to achieve high results in mathematics in PISA

Mathematics was the main content area of PISA in 2003 and 2012. As shown in Table 9.6, the percentage of students in the highest achievement group in both cycles has been almost the same.

Table 9.6 The proportion of students (%) in different achievement groups in mathematics, PISA cycles from 2003 to 2012

Year	Top performing students according to OECD PISA classification	Top performing students, if the threshold is 600 points	Students achieving between 500 and 600 points
2003	7.9	8.7	34.4
2012	8.0	8.9	35.9

Just like in reading, a binomial logistic regression calculations were used to define the factors influencing the student achievement in the cycle, in which mathematics for the first time was the main content area – PISA 2003. Significant possible factors to gain high results in mathematics include the anxiety when solving mathematics tasks, higher parental education level, attitude to computers (Table 9.7).

Table 9.7 Student achievements in mathematics, PISA 2003: results of logistic regression

2003	B	Standard error	Significance	Exp(B)
Anxiety when solving mathematics tasks	0.197	0.029	<0.001	1.218
Higher parental education level	0.194	0.024	<0.001	1.214
Attitude to computers	-0.134	0.023	<0.001	0.875

Subsequently, these same factors – indices were examined also by the PISA 2012 data to see if changes had occurred since 2003 (Table 9.8).

As shown in Tables 9.7 and 9.8, parental education is an important factor affecting also the achievement of students in mathematics. According to PISA 2003 data analysis results, increasing this index by one unit, the likelihood of students to move from Group 2 to Group 1 would be 21%, while PISA 2012 data analysis results show that this likelihood would already be 35%, other indices remaining unchanged. The index "Higher parental education level" is created from student responses on parental education (OECD, 2005a), similarly to 2000 and 2009.

Table 9.8 Student achievements in mathematics (OECD PISA 2012), using the regression obtained in PISA 2003: results of logistic regression

2012	B	Standard error	Significance	Exp(B)
Higher parental education level	0.301	0.042	<0.001	1.351
Limitation of computer use in studies	-0.237	0.048	<0.001	0.789
Anxiety when solving mathematics tasks	-0.977	0.052	<0.001	0.376

The index "Anxiety when solving mathematics tasks" or "Mathematics anxiety" is built on the basis of affirmative students' responses to five items about learning mathematics (OECD, 2005a):

- I often worry that I may have difficulties in mathematics classes.
- I get very tense when I have to do mathematics homework.
- I get very nervous doing mathematics problems.
- I feel helpless when doing a mathematics problem.
- I worry that I will get poor marks in mathematics.

PISA 2003 data show that anxiety positively affects student achievement, whereas PISA 2012 data, on the contrary, testify to negative influence, respectively, the opportunity for a student to transfer from Group 2 to Group 1, would be increased by 22% (PISA 2003) with an increase in index value for one unit, provided that the values of the other indices remain unchanged, while the probability of a student from Group 2 to enter Group 1 would be reduced by 36% (PISA 2012).

PISA 2003 data analysis shows that the worries and anxiety about their success and failure are experienced a lot more by the students whose achievements are higher, while PISA 2012 data analysis shows that more concerned are those who are falling a little bit short of the high achievement threshold. The anxiety can create a certain pressure, which can improve the work and raise the creative activity. The mind works faster and perceptual abilities are boosted. Such positive stress is harmless, and even quite necessary (Geisselharts, Hofmane-Burkarta, 2000). Excessive stress may work in the opposite direction, this assertion supported by Yerkes and Dodson Law (1908): If the stress level is low, the achievements are low, too, however, as this level rises, the achievements will increase, but only up to a certain limit, beyond which the performance falls again (Miles, Shevlin, 2001). The student who knows what he or she is doing, does not feel excessive stress and is able to do more. The fact that the students are anxious about their results is a sign of the sense of responsibility for their work.

The index "Attitudes toward computers" is built on the basis of affirmative students' responses to four items below (OECD, 2005a):

- It is very important for me to work with a computer.
- To play or work with a computer is fun.
- I use the computer because I am very interested in it.
- I lose track of time when I am working on the computer.

This index was not created for PISA 2012, but two other indices were made instead – the positive attitude index "Using a computer for studies at school" and negative attitude index "Limitation of computer use in studies". Therefore, these two indices were chosen for the comparison, and the positive attitude index had to be excluded because its significance was not confirmed. Negative attitude index "Limitation of computer use in studies" was made up of students' answers as to whether they agree with the following statements (Bertling, Kyllonen, Hersbach, Lietz, Tobin, 2012):

- Using the computer for learning is troublesome.
- Since anyone can upload information to the Internet, it is in general not suitable to use it for schoolwork.
- Information obtained from the Internet is generally too unreliable to be used for school assignments.

In both years, these computer-related indices show a negative impact on student achievement. With the increase of the indices, the likelihood of students to reach high achievement would be reduced by 88%, according to PISA 2003, and by about 79% according to PISA 2012. It is not possible to compare these two indices, because they include different questions. PISA 2003 statements are about general computer usage, while PISA 2012 addresses the use of the computer, especially the Internet, particularly in studies. Since 2003, the data show that the use of computer for entertainment, games, leading to the loss of the sense of time, results in decreasing student achievement. By contrast, the impact of negative attitude explored in 2012 study means that the students with more positive attitude to the use of a computer and the Internet for studies show higher achievements.

Perhaps, a more negative attitude towards the use of a computer and the Internet for studies is expressed by those students who do not know how to use the opportunities of ICT in the learning process, or who have not learned to do it.

Table 9.9 Student achievements in mathematics (OECD PISA 2012): results of logistic regression

	B	Standard error	Significance	Exp(B)
Experience with applied mathematics tasks	0.303	0.079	<0.001	1.353
Higher parental education level	0.129	0.026	<0.001	1.138
ICT use at school	-0.276	0.061	<0.001	0.759
Anxiety when solving mathematics tasks	-0.994	0.073	<0.001	0.370

A new logistic regression model was created for PISA 2012 data, this time choosing for the raw data all available PISA 2012 indices, and as a result, among the most significant should be noted “Anxiety when solving mathematics tasks”, “Higher parental educational level”, “Experience with applied mathematics tasks” (Table 9.9).

This model also retains two indices from the model reviewed before – “Higher parental education level” and “Anxiety when solving mathematics tasks”. Two new indices have been introduced – “ICT use at school” and “Experience with applied mathematics tasks”. Obviously, if students were given increased opportunity to solve more applied mathematics tasks, then the probability to shift from Group 2 to Group 1 would rise by 35%. This index is formed of student responses to the question "How often have you encountered the following types of mathematics tasks during your time at school?" (OECD, 2014):

- solving an equation like $6x^2 + 5 = 29$
- solving an equation like $2 (x + 3) = (x + 3) (x – 3)$
- solving an equation like $3x + 5 = 17$

It relates to the discussion above, that the ability of students to solve the tasks for which a certain set algorithm should be used, develops their capacity to better solve also the other tasks because they have a more advanced algorithmic thinking – the ability to execute the instructions, to apply the knowledge gained.

The second index – "The use of ICT at school" would have a negative effect on the likelihood of students to gain high results, the probability to leave Group 2 to enter Group 1 would be reduced by 76%. This index was created from student responses to the question "How often do you use a computer for the following activities at school?" (OECD, 2014a):

- Chatting online at school
- Using email at school
- Browsing the Internet for schoolwork
- Downloading, uploading or browsing materials from the school's website (e.g. Intranet)
- Posting my work on the school's website
- Playing simulations at school
- Practicing and drilling, such as for foreign languages or mathematics
- Doing homework on a school computer
- Using school computers for group work and communication with other students

Students with top performance in science

Table 9.10 summarizes the comparison of the proportion of students (as a percentage) in Latvia and the countries selected for comparison with regard to science proficiency at the highest levels from 2006 to 2012 cycle. The percentage of Latvian students in these levels is twice as low as the OECD average. By contrast, Estonia's proportion of students at the highest levels is above the OECD average, and even three times higher than the proportion of Latvian students at these levels. It should be emphasized that from the countries considered in Table 9.10, only in Latvia, Russia and Lithuania the students' top performance in science is below the OECD average. In Latvia and Russia the proportion of students who reach the highest levels of competency is almost two times smaller in comparison with the OECD average.

Table 9.10 The comparison of student proportion (%)in the highest levels of science competency in all cycles of the study

Year	2006	2009	2012
Finland	20.9	18.7	17.1
Hong Kong	16	16.2	16.7
New Zealand	17.6	17.6	13.4
Estonia	11.5	10.4	12.8
OECD countries' average	9	8.5	8.4
Lithuania	4.9	4.7	5.1
Latvia	4.1	3.1	4.3
Russia	4.2	4.3	4.2

The countries are arranged according to the proportion of students at the highest levels of competency in 2012
Data of the OECD PISA data base

The distribution of students in top performance groups in science

When comparing the achievements in science among girls and boys, Figure 9.9 shows that in the 2000 and 2003 cycles of the study the proportion of girls in Group 1 was higher than that of boys, in 2006 (science was the main content area) and 2009 cycles of the study the proportion of boys was higher in Group 1, but in 2012 the proportion of girls was slightly higher again. Although the proportion of boys and girls at the highest achievement group generally tends to increase with each cycle, the proportion of boys is rapidly rising. In all study cycles, the proportion of girls who obtain more points than the OECD average is higher than the proportion of boys.

The proportion of students in Group 1 with Latvian or Russian instruction language, starting from the cycle of 2006 onwards remains the same (Figure 9.10). In 2000, Group 1 had a higher proportion of students studying in Latvian, while in 2003 the percentage of students studying in Russian was higher. Although in the latest cycles the percentage of the students whose performance exceeds 600 points is observed to decline, in the last cycle a slight increase was seen; however, the number of students achieving more points than the OECD average increases. As shown in Figure 9.10, in mixed schools the proportion of students in the high achievement groups is small, and the proportion of students who are able to exceed the OECD average is much lower in comparison with the students who study in schools with the Latvian or Russian language of instruction.

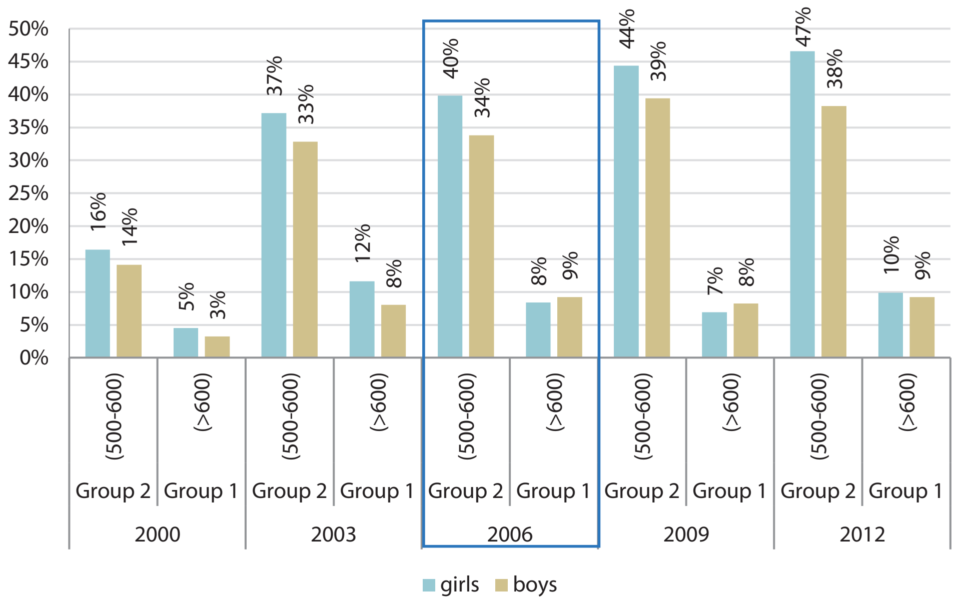


Figure 9.9 *The proportion of students (%) in high achievement groups in science, PISA cycles from 2000 to 2012, according to gender*

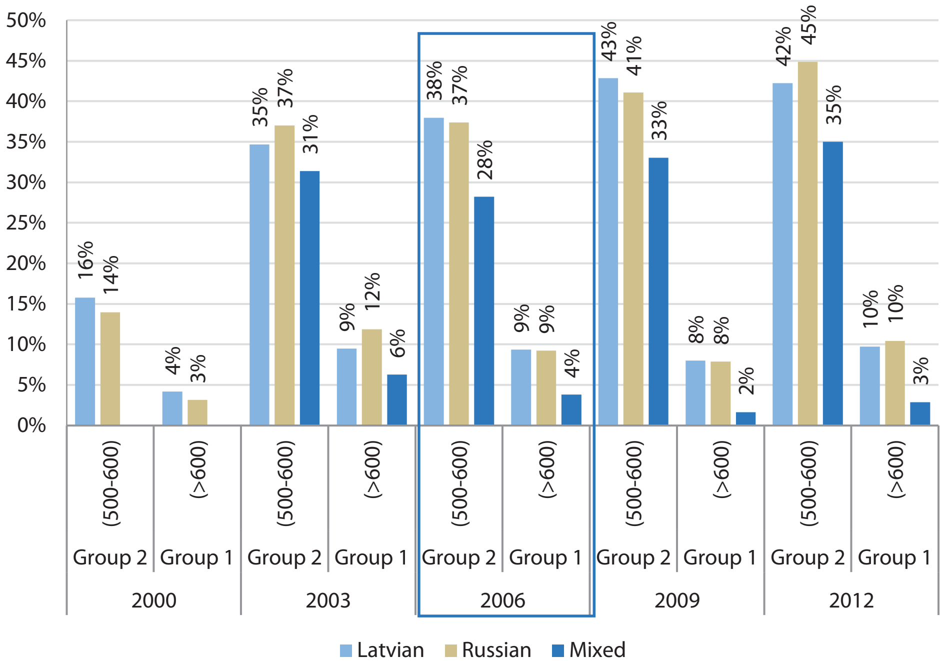


Figure 9.10 *The proportion of students (%) in high achievement groups in science, PISA cycles from 2000 to 2012, according to language of instruction at school*

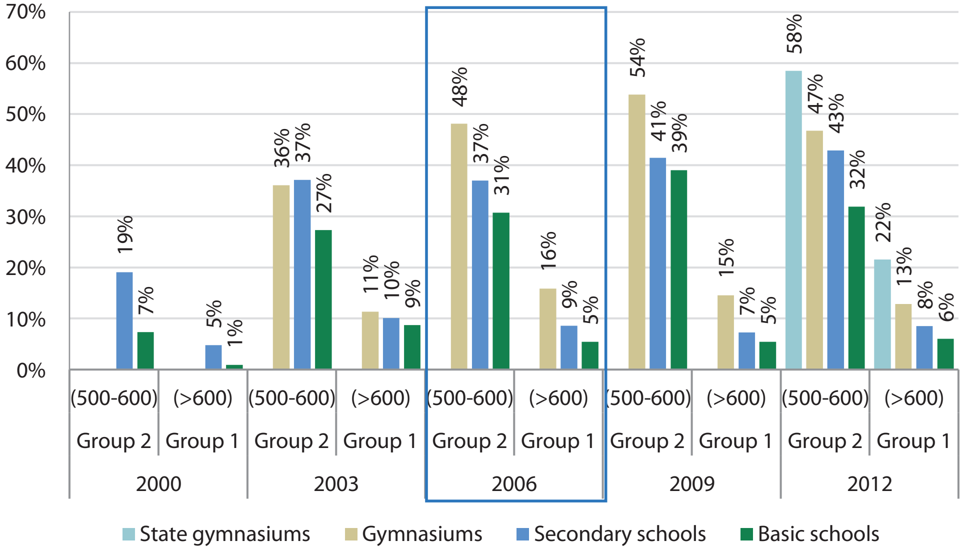
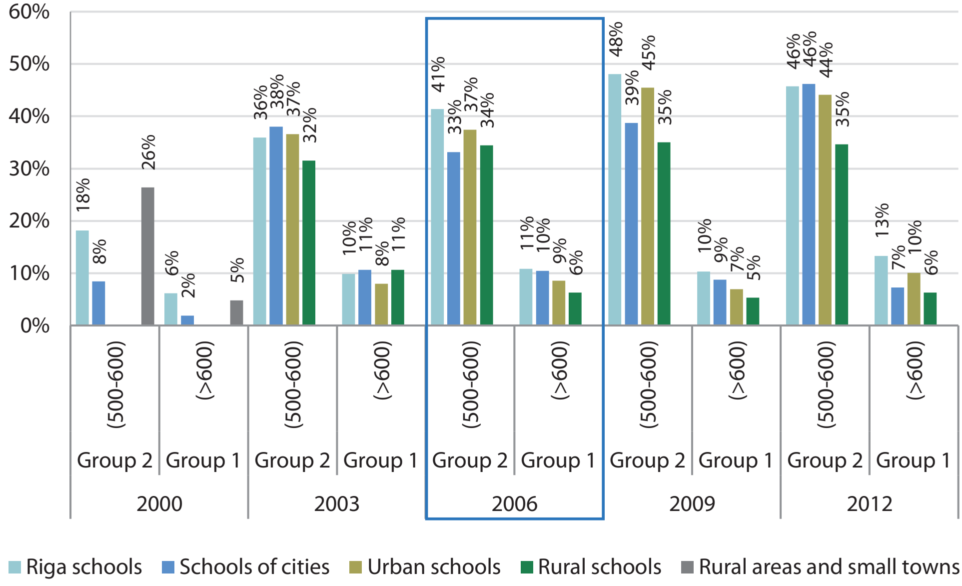


Figure 9.11 The proportion of students (%) in high achievement groups in science, PISA cycles from 2000 to 2012, according to the type of school



In 2000 the data of rural areas and small towns were combined in one group

Figure 9.12 The proportion of students (%) in high achievement groups in science, PISA cycles from 2000 to 2012, according to the location of school

It is also evident that most of the students who are able to reach the highest level of competency in science, are studying in state gymnasiums. The least proportion of top-performing students attend primary schools, where there are no sharp declines, and the proportion of students at the highest achievement group has been constant since 2006 cycle, when science was the main content area of the study. Similarly to mathematics, a stable situation is observed in secondary schools (see Figure 9.11).

As seen in Figure 9.12, the performance in science in rural schools is characterised by stability. The greatest decline in the proportion of students in the highest achievement group is observed in the big cities, where, however, an increase is seen in the proportion of the students, who are able to reach at least 500 points, yet do not exceed 600 points. After previous reductions, there is an increase in the proportion of these students in Riga and other cities.

Opportunities of Latvian students to achieve high results in science in PISA

The main content area of PISA 2006 cycle was science. As seen in Table 9.11, the number of students who achieved high results according to the OECD classification decreased, yet, by changing the threshold, increased.

Table 9.11 The proportion of students (%) in different achievement groups in sciences, PISA cycle of 2006

Year	Top performing students according to OECD PISA classification	Top performing students, if the threshold is 600 points	Students achieving between 500 and 600 points
2006	6.6	6.8	37.6

The likelihood of Group 2 students to achieve higher results in science or to enter Group 1, according to binomial logistic regression calculations, is determined by the following factors: higher parental education level, future-oriented motivation to study science, confidence in the results in science, satisfaction with the results in science, general attitude towards science, awareness of environmental issues (see Table 9.12).

Table 9.12 Student achievements in science, PISA 2000: results of logistic regression

	B	Standard error	Significance	Exp(B)
Awareness of environmental issues	0.518	0.036	<0.001	1.679
Confidence in the results in science	0.416	0.034	<0.001	1.516

	B	Standard error	Significance	Exp(B)
Satisfaction with the results in science	0.185	0.038	<0.001	1.203
General attitude towards science	0.152	0.030	<0.001	1.165
Future-oriented motivation to study science	0.101	0.030	0.001	1.106
Higher parental education level	0.084	0.010	<0.001	1.088

The index "Students' awareness of environmental issues" is made up of students' responses to five environment-related items. The goal was to observe the students' awareness about (OECD, 2009a):

- The increase of greenhouse gases in the atmosphere.
- Use of genetically modified organisms.
- Acid rain.
- Nuclear waste.
- The consequences of clearing forests (to use the land for other purposes).

With the increase of this index by a single unit, the likelihood of students to enter Group 1 would increase by 68%. Of the factors included in the equation, it is the most influential. The second most influential factor is the index "Confidence in the results in science". If this index increased by one unit, the likelihood of students to enter Group 1 would increase by 52%, if the values of other indices remained unchanged. The index is created of the students' answers to questions about the extent to which they are confident of being able to fulfil the science-related tasks (OECD, 2009a).

The increase of the rest of the indices by one unit would increase the likelihood of students to passing from Group 2 to Group 1 by 20% ("Satisfaction with the results in science"), 17% ("General value of science") and 10% ("Future-oriented science motivation"), if the values of other indices remained unchanged. The index "Satisfaction with the results in science" is formed by the students' responses as to the extent to which they agree with the following statements (OECD, 2009a):

- Learning advanced science topics would be easy for me.
- I can usually give good answers to test questions on science topics.
- I learn science topics quickly.
- Science topics are easy for me.
- When I am being taught science, I can understand the concepts very well.
- I can easily understand new ideas in science.

The index "General value of science" is created of the students' answers to what extent they agree with the following assertions (OECD, 2009a):

- Advances in science and technology usually improve people's living conditions.
- Science is important for helping us understand the surrounding world.
- Advances in science and technology usually help improve the economy.
- Science is valuable to society.

- Advances in science and technology usually bring social benefits.

The index "Future-oriented science motivation" is created of the students' answers to what extent they agree with the following assertions (OECD, 2009a):

- I would like to make a career ing science.
- I would like to study science after secondary school.
- I would like to spend my life doing advanced science.
- I would like to work on science projects as an adult.

Clearly, the students' knowledge about nature and the environment is associated with the students' performance in science. Consequently, raising public awareness of environmental matters is a topical issue. By promoting the public education in this area, the students' motivation to link their future with science will also increase, which is an essential development in the light of Latvia's National Education Development Guidelines 2014–2020.

9.3. Possible reasons for students' top performance in other countries in OECD PISA

This chapter reviews the possible reasons for the high achievements of such countries as Estonia, Finland, Hong Kong (China), and New Zealand. These countries are selected on the basis of their excellence in all content areas of OECD PISA, as well as the large proportion of students particularly in the highest achievement groups.

"Money alone can't buy a good education system. Strong performers in PISA are those countries and economies that believe – and act on the belief – that all children can succeed in school. Among wealthier economies, those that prioritise the quality of teachers over smaller classes tend to show better performance. When it comes to money and education, the question is not "how much?" but rather "for what?"" (OECD, 2012c).

Estonia

Maie Kitsing, External Evaluation Department consultant, Estonian Ministry of Education and Science, writes that the possible reasons why the Estonian students in the PISA study are top performers, are (Kitsing, 2011a):

1. Decentralised education system:
   a) schools are autonomous, and the head of the school has the right to organize the daily school life,

   b) teachers are free to choose the teaching methods and textbooks.
2. Clear qualification requirements for teachers:
   a) education:
      i) a master's degree,
      ii) 160-hour practice within five years;
   b) support:
      i) to new teachers – a year to adjust to school,
      ii) the state ensures 3% of the wagefund for professional courses,
      iii) benefits to new teachers.
3. Children's pre-school development :
   a) requirement to teachers – higher education,
   b) 93% of the children in the country attend pre-school, although it is not a mandatory requirement,
   c) the state educational standard for pre-school has been developed,
   d) pre-school education is state-funded.

Performance variations between Estonian schools in PISA are large. There are schools, where almost 50% of students do not reach the base level either in reading, or mathematics or science, and where the school average in all content areas does not reach 440 points. This shows that the study activity of these schools is different from that of the schools where students achieve high results (Kitsing, 2011b). The best schools are those where the students' potential is used to the maximum (Toomela, Kikas, Mõttus, 2006).

Perhaps the reason for differences in results between those countries that have better social and political circumstances lies within the political and social situation in the country. In such countries, the students have greater personal motivation to gain knowledge (Täht, Must, 2010).

It is possible that structured cognitive approach is the reason for the good results in science and reasoning abilities (Kask, 2009).

Finland

Finnish fifteen-year-old students in the OECD PISA are among the best in all content areas, although in 1970 the Finnish education system was not one of the most successful in the world, at that time USA being the leading country in education.

Pasi Sahlberg, a former Director General of CIMO (Centre for International Mobility and Cooperation) at the Finland's Ministry of Education and Culture, emphasises that a fundamental reasons of changes in education policy were geographical and historical – the geographical position between the great kingdom in the west and the great empire in the east – the national interests were set as the priority, not allowing education policy to become a victim of partisan policy:

"We are a small nation that the rest of the world sees as a strange place that speaks a language nobody else understands. Over the past half-century Finns have adopted an understanding that the only way to survive as a small, independent nation is by educating all people. This is the only hope amid the competition between bigger nations and all those who have other benefits Finns don't have" (OECD, 2010b).

In 1970s, the Finnish education policy makers decided that if the investment was made in skilful teachers, the local schools could be allowed a greater autonomy to decide what and how to teach (Darling-Hamond, 2010; Sahlberg, 2012).

Several main reasons of the Finnish students' high performance are named:

- Others have better experience.

The creators of the Finnish education system have learned from the experience of others in relation to education and have adopted the best ideas on how to most effectively improve the educational system. For example, the teaching methods borrowed from the USA – cooperative learning (Sahlberg, 2012).

- High qualification of teachers.

Teachers in Finland must necessarily have a master's degree. The Finnish schools recruit the best candidates who have obtained a master's degree in education in one or two subjects and completed a teacher training program, focussing on problem solving, research, development of standards, evaluation of results, methods, how to work with students who learn differently (Authors and Institute for Educational Research, 2007; Darling-Hamond, 2010; Haahr, 2005; Sahlberg, 2010; OECD, 2010b; Välijärvi, 2005).

- Autonomy of schools.

Investment in teacher education has enabled Finland to move from a centralized school system, based on external tests to many localized systems. Quality assurance is largely based on trust. There is a perception that the academically educated teacher is the best expert to freely operate in relation to the national standard, using it to develop his or her own standard. The national basic standard of education provides teachers with recommendations, evaluation criteria for each subject, each level and for the total final evaluation of each student's annual progress. In the light of these guidelines, each local school's teachers develop more detailed standards and deliverables for each school according to the students' needs. Once a week, the teachers in Finland come together to jointly plan and develop the standard, the schools within the same municipality are encouraged to share their materials (Darling-Hamond, 2010; Bjorkvist, 2005; Haahr, 2005; Välijärvi, 2005).

Olli Luukkainen, the President of the Trade Union of Education in Finland:

"Teachers in Finland are very independent. They can decide almost everything: how they will teach, what they will select from the basic (national) curriculum, when they will teach each particular topic. The fact that teachers have so much independence and respect influences young people as they are deciding what program they will follow in the university. If they choose teacher education, they know they will be entering a profession that enjoys broad trust and respect in the society, one that plays an important role in shaping the country's future" (OECD, 2010b).

- Safety and welfare for all students.

Schools are more than educational institutions. They are full-service schools providing students not only with a hot lunch for everyone, but also with the health and dental services, as well as with a variety of mental health support services that may be needed by the students and parents (OECD, 2010b). Finland does not practice testing of students and school ranking. The teacher helps the student to be responsible for his or her own growth and learning, providing a psychologically and emotionally safe learning environment. Greater emphasis is placed on teachers' preparation and raising their qualification rather than on testing of students. Regardless of the school's location, it is staffed by highly qualified teachers, consequently, all Finnish schools provide equitable and positive learning opportunities for all Finnish students to obtain quality education (Authors and Institute for Educational Research, 2007; Sahlberg, 2012, OECD, 2010b).

- Size of schools.

Finland has relatively small schools, up to 300 students per school and 20 students per class, allowing teachers to know each student and in collaboration with colleagues to find the most suitable learning method for him or her in order to maximize their potential (Hancock, 2011). The teachers are qualified to work also with the students who have special needs. The teachers are qualified in special education. Students with special needs attend ordinary schools, being integrated among other students (Bjorkvist, 2005; Haahr, 2005; OECD, 2010).

- United and sustainable vision for education policy maintained by the society.

Active involvement of the general public in elaboration of education development plan is mentioned as another reason of success. Educational development plans are drawn up for the period of four years; it is a joint work of education authorities, municipalities supervising the schools, the teachers, drawing also on the opinions of business leaders, non-governmental organizations, researchers and parents. The broad based policy-making process ensures the sustainability of reforms and provides a shared vision of the ongoing reforms. Although since 1970 Finland has had more than 20 education ministers, the main principles of educational policy-making have changed only slightly (Sahlberg, 2006; Sahlberg, 2012).

- Teaching methods.

In Finland, the main focus in the learning process is laid on research, while evaluation is used to cultivate the students' active learning skills, ability to ask questions and find their own answers (Darling-Hamond, 2010).

- The simplicity of the Finnish language.

There are researchers who believe that the simplicity of the Finnish language is the reason for high achievements in OECD PISA. This does not mean that the language is easy to learn. The Finnish language that belongs to the Finno-Ugric language group is sufficiently simple and makes it easy to understand instructions, as well as to comprehend the written material and to avoid misunderstandings. The Estonian language also is one of the Finno-Ugric languages, which may also be the reason of their high performance (Bjorkvist, 2005; Nuoret, 2010).

"Modern educational thinking regards learning and studying as a lifelong process. The capability and willingness to flexibly update one's competencies are increasingly relevant assets in the labor market. Basic education can no longer equip students with skills and knowledge that would stay valid throughout their lives. Instead, and more importantly, its task is to develop students' learning skills and promote their positive attitudes toward learning and studying. In this sense, all traditional education systems are faced with great challenges. All too many teenagers get bored and alienated, and just learn to hate learning. According to the PISA results, this is the case also in Finland. The development of a learning culture and climate in schools is a challenging task for all working in the educational sector" (Välijärvi, 2005).

Hong Kong (China)

Given that Hong Kong is a Chinese city, which has long been a British colony, its education system is largely shaped like that of the United Kingdom (OECD, 2010c). However, the Hong Kong students have much better results in international studies.

In the Chinese culture and society, a great emphasis is placed on academic knowledge, which could be the reason why the students reach high results (Cheung, Rudowicz, 2003; Schlecher, 2012). Parental and family influence on student achievement is very significant, furthermore, in China the parents mostly use authoritarian parenting style in bringing up children (Wang, 2004; Sun, Bradley, 2010). This means that children should obey parents, their say is a rule. If parents should want to take the kids to after-school hobby groups in one of the scientific areas, the children will attend these hobby groups. Students in Hong Kong devote a lot less time to non-academic activities, instead they use a lot more time to attend the hobby groups, to do homework in mathematics, science or other subjects, as well as to read for pleasure (Wang, 2004).

Student achievements in Hong Kong are largely influenced by a teacher who is highly respected in China (Chen, 2005). According to the Guide of Hong Kong Basic Education Standards, schools and teachers in Hong Kong, as in Finland, are authorized to develop their own individual school educational standards, based on the national standard (The Curriculum Development Council, 2002).

New Zealand

Like Finland, the New Zealand education system quality is largely dependent on the teacher, where the government assigns a great importance to teacher education and qualification (Schleicher, 2007; Alton-Lee, 2003).

School autonomy is indicated as a reason for good performance, because teachers have the opportunity to adjust the standards to the needs of a particular school and students. The school board consisting of the school community is responsible for the supervision of the school. The board is responsible for the strategic management of the school, school inspection, evaluation of the staff and the principal. The board, together with the school principal and teachers, develop their own educational standard, since the national standard describes only the necessary key competencies and goals to be achieved in each of the eight areas of learning, not describing the content of the program. Schools have a broad discretion in drawing up their programs, taking into account the students' and local area's needs (Nusche, 2012).

A group of New Zealand researchers in a longitudinal study have found that those reading skills that students have obtained at a pre-school age have a decisive impact on student achievement in reading ability in school years (Blaiklock, 2011).

Summary

Top performing students achieve high results in a particular area because they are highly motivated, and have the appropriate skills and abilities to achieve their goals: problem solving, time management skills, creativity, information management skills and communication skills.

In the latest study cycle – PISA 2012, compared with the previous cycle, the proportion of the students who were able to achieve high results (above 600 points) had increased. However, the OECD average proportion of students in this achievement group still has not been reached in any content area.

The proportion of girls in high achievement group, particularly in reading, is much greater, in the latest cycles this difference has only increased. The proportion of boys in high achievement group of mathematics within the last cycles of the study has been slightly higher than that of the girls. However, in science the proportion of top-performing boys and girls in high achievement group is nearly equal. By contrast, the proportion of girls in the group achieving between 500 and 600 points is higher than the proportion of boys, with the exception of mathematics, where in this group there is an equal proportion of boys and girls.

The percentage of students who attend schools where the language of instruction is Russian, in high achievement group of mathematics and reading is much higher compared with students from schools with the Latvian language of instruction. In science, the percentage of students in high achievement group is nearly equal. A very small percentage in high achievement group is constituted by the students who study in the so-called mixed-language schools.

Particular attention should be paid to rural schools, especially basic schools, because the situation there is the worst. Instead of closing these schools, it should be considered how to promote their development. The state must ensure quality education for students by providing equal educational opportunities to all its citizens, regardless of their economic status and place of residence. School development is not likely to contribute to rural prosperity, yet it will reduce rural deterioration. Parents are much more willing to leave the children to study at local schools, next to the place of residence, even though they work in one of the nearby towns. To take children to schools in cities and towns requires additional expenditure. However, if there is no local school, then the best solution is to move to cities.

The factors influencing student performance are divided into two groups – those that can and those that cannot be directly influenced. Parental education, as can be seen in all regression models discussed above, is one of the main factors influencing the students' achievements. Consequently, in order to achieve an improvement in student performance, it is necessary to attain the rise of overall quality and level of public education. The researcher Rita Geske in her thesis "Factors of the national level impacting performance of primary school students in science in the context of education management" writes that the more educated is the society in general, the higher performance is shown by the students (Geske, 2013). Also, the information about such countries as Finland, Estonia and Hong Kong (China) confirms that the public attitude towards education has an important role in students' high achievements in PISA (Mihno, 2013).

Latvia has a relatively small number of students who reach the highest levels of competency, and Latvia's average result is below the OECD average, which shows that the Latvian basic education system does not provide adequate educational opportunities for the best students (Kiseļova, 2011).

It means that a greater emphasis should be placed by education policy-makers on higher education and lifelong learning, as the learning process cannot stop, it must continue throughout life. The country requires an offer of quality education, a greater financial support from the state for implementation of educational process both in general education, higher education as well as further education – teachers' salaries, state-funded study places, scholarships. The state should be interested that as many students as possible continue studies in higher education institutions, consequently, it must provide the education that caters to the society's expectations and needs. The country has a capacity to gain high achievements, if there is assuredness of the necessity for quality education among the public and the national policy-makers, and also if national education policy-makers and the general public have a common vision of the necessity of education and its development concept, the need for reforms and their direction (Mihno, 2013).

The education system quality is largely determined by the teachers working at school. Teachers have a daily contact with students, they know the students, both their weaknesses and strengths. The teachers should be the ones to inspire students, motivate them and help realize their abilities, to teach them how to learn. Consequently, the national education policy makers should ensure that most qualified teachers work at schools, those, who are the best of the best, taking the example of the countries like Hong Kong (China), Finland, New Zealand and Estonia, where the students achieve high levels of competency much more often than in Latvia. The education requirements for teachers are higher in Estonia and Finland, where the teachers must have a master's degree, but also in Hong Kong (China) and New Zealand to become a teacher with a bachelor's degree is not so simple. The prospective teacher has to meet sufficiently many and essential requirements (Mihno, 2013).

For the country to have as many educated people as possible, the state must ensure accessibility of quality education for all the population, including those who are socially disadvantaged, who have emotional, physical or mental health problems requiring a different study approach. Also, the state should take care of those students who are gifted and the regular school programme is not suitable for them to maximize the use of their abilities and potential. This is shown by the education systems recognised as successful, where a great deal of attention is paid to students' needs. These systems devote much greater care to the students who have special needs, usually associated with mental and physical learning restrictions, as well as to the gifted students and their need for studies with a special approach.

If teachers are highly qualified and are the topmost in their field, then it is possible to consider the autonomy of schools. As concluded by the OECD education researchers, great school autonomy in the development of curricula, teaching content and the creation of the evaluation policy at school ensures top performance of schools. The autonomy means that the teachers can develop their own curricula, choose the teaching materials, books, the methods of work in a particular class and with a particular student, the teacher is free to choose the criteria for evaluation of students, evaluation methods and the need for evaluation. The school management, in turn, can decide on the organization of the daily school life and procedures. The autonomy has also a downside – if a student changes school, the problems arise when the study programs do not match. Latvia had this problem in the period from 1991 to 2000 (Mihno, 2013). Therefore, it is essential that the teachers should focus on development of students' abilities and knowledge, rather than on simply fulfilling standards and execution of study programs that do not yield the desired results. It is desirable that the guidelines should be developed, instead of minutely described requirements that restrict the teachers, not allowing them to plan the work according to the needs of the class.

To improve the student performance in reading, the students' positive attitude towards reading should be promoted, the students encouraged to read more for pleasure, not just the literature mandatorily set down by the school, and electronic texts. Special attention should be paid to the reading material that is meant particularly for boys in all age groups, because, looking at the library offers, it appears that much more literature is available for girls, especially in adolescence. A very valuable library activity for children encouraging them to read a book is "Children's Jury". Teenagers, young people and adults also need such activities. The teachers should impart to the children the truth that reading is an interesting and useful activity, allowing the children to choose the books according to their interests and abilities also during the lessons. The compulsory literature must also be compatible with age, students' interests and abilities.

In order to achieve high results in mathematics, students should be responsible for the learning process, and they should be motivated to gain knowledge, not only to get good grades. The education system must be geared to gaining an in-depth knowledge, and not targeted at demonstration of good grades, which do not necessarily mean high knowledge.

There is a general opinion that computer use improves the student performance, particularly in mathematics, just because the computer specialists are associated with high mathematical ability, but, unfortunately, regression equation reveals quite the opposite picture. Frequent use of computers does not improve student performance in mathematics, this suggests that students use computers mostly for entertainment. As mentioned above, studies have shown that intensive use of computer training does not yield higher achievements, therefore it is necessary to develop training methods for ICT use in lessons. The professional qualification development courses for teachers need to include more topics on ICT application opportunities and methods for the use of ICT in specific subjects to make ICT an asset, not an obstacle in mastering the curriculum. Also, students would need to learn the skills to use ICT for improvement of their learning capacities and facilitation of the learning process, making learning more interesting and rewarding.

Student performance in mathematics is also affected by how often students perform the so-called regular mathematical tasks, so that students learn to execute the instructions, developing the algorithmic thinking that helps achieve higher results in other areas, too.

Student performance in science is significantly impacted by students' knowledge of the natural sciences-related issues that contribute to the students' self-confidence and motivation to learn science, and the subsequent decision to have their future career in sience. This means that it is necessary to talk more about environmental issues not only in lessons, because it is still relatively little, but also outside the school. School teachers need a greater variety of methods to attract the students' attention to the questions of science. Science is much more difficult to learn and understand just by reading books or listening to the teacher, the best are the visual examples – demonstrations, videos, photos, excursions and similar methods. In order to facilitate the work of science teachers through the diversification of lesson content, it is recommended to create a database containing a variety of informative material where teachers could select the materials according to the topic of the lesson and the corresponding to the abilities of the respective class and age group. However, it would help the teachers a lot if they could exchange materials and ideas how to build these materials, what methods to use for acquiring the specific themes. Therefore, it is necessary to create virtual environment, where teachers could exchange ideas, as well as to conduct regular seminars and discussions.

Recommendations to educational policy makers:

- To elaborate a common and sustainable education development plan that would be acceptable to the public and which would be implemented irrespective of the change of ministers;
- To develop guidelines for determining the curriculum content direction and targets to be achieved in a longer period of time;
- To establish a tailored educational policy catering to gifted students;
- To dedicate more attention to teacher training, qualification of teachers and the quality of their work. The teachers must be highly esteemed professionals in their field, as they educate children who are our future. The teachers must be responsible for their work. Consequently, the salary should be adequate, although the salary does not confer the quality upon the teacher's work, it is just one aspect that can affect it. Unfortunately, this is not seen in the current processes in the Latvian education – the teachers' role, qualifications and values are undermined, minimizing the requirements set to the teachers'

profession. Selection of future teachers must take place prior to studies, as well as after completing the studies at the recruitment of teachers for work;
- To improve public attitude towards education, creating a respectable, intelligent and positive image of the teacher. If teachers are the best of the best and value their own work, the others will also respect them;
- To ensure the access to quality education to all students regardless of their material situation, their place of residence, schools attended, their physical, mental or emotional capabilities;
- To establish a student assessment procedure, where in parallel to assessment with a grade there would be a descriptive assessment of a student's progress, as well as his or her behavioural evaluation.

Recommendations to school principals:
- To employ only the best candidates as teachers;
- To grant teachers the maximum reasonable autonomy in development of study programmes;
- To ensure student-friendly environment at school;
- To organize student development-oriented interviews, which are also attended by the students' parents. The interviews should be aimed at promoting the students' development, not condemnation;
- To organise and involve the school in various events dedicated to environmental issues;
- To create closer cooperation with libraries, becoming involved in their events, and to organise different reading-related activities proactively, particularly considering the youth auditorium.

Recommendations to teachers:
- Within the framework of the Law on Education and Cabinet of Ministers Regulations to develop own curricula, based on the abilities and needs of specific classes and students;
- To encourage the students to study, learn and acquire education;
- To regularly involve students in self-assessment and evaluation;
- To take care of own qualification by attending various courses and seminars, to raise one's own education level by studying at higher education institutions and at further education levels.

Recommendations to parents:
- To choose for the children a school that is located close to the place of residence, and suitable to their physical, intellectual and emotional needs;

- To lead by example, showing the children that education matters, that education does not cease with obtaining a diploma, but continues throughout life and that the main benefit is knowledge;
- Never to criticise teachers in the presence of children, even if the parents do not agree with the teachers' opinion, thereby not diminishing the teacher's reputation and the children's respect toward the teacher. Never allow the students to speak badly about a teacher, but teach them to defend their opinion without losing composure and becoming disrespectful;
- To take an active part in the events organised by the school, showing the children that the parents are not indifferent to the school and events therein. To support teachers in order to help your children perform better, and to show interest about what goes on at the school not only in problem situations, but on everyday basis;
- To pay serious attention to reading in the family by reading yourselves, urging the children to read, choosing the literature together with the children that is suitable and interesting to them. To focus particularly on the boys' reading habits;
- Not to rebuke children for failures, but to support and help prevent repetition of failures;
- To control the time spent by the children at the computer, tablet or smart phone, using the Internet for entertainment, playing games and watching films. To make sure that the children do not stay up late and that they have completed their homework;
- All family to become involved in various environmental protection events and activities – recycling, joint work to clean the environment and surrounding areas, saving water, decreasing the electricity consumption, the action "Earth Hour", etc.

Recommendations to students:
- To become involved in the school life as much as possible. To learn to contribute one's maximum capacities and capabilities to fulfil the task as well as possible;
- In case of failures not to give up, but study harder, seeking support of teachers, parents and peers who are better at the respective subject;
- To try to understand one's own interests and choose appropriate literature by attending school and municipality libraries. Each day to read at least one page in a book that is not a school textbook;
- To limit computer time spent for entertainment, to complete the assignments and homework first, and only then turn to recreation, not forgetting about sleep and rest;

- Together with the family and school to take part in activities of environment protection and preservation;
- To try to comprehend the true meaning of education: that the main benefit is knowledge, not the mark or assessment. Knowledge is the only asset that nobody can take away, but which we can increase throughout our lifetime both formally and informally.

10. MATHEMATICS CURRICULUM AND THE ANALYSIS OF EVALUATION IN LATVIA IN THE CONTEXT OF PISA STUDY

10.1. Analysis of Latvian student performance depending on the parameters of test items

Each PISA mathematics item corresponds to a certain mathematics content area, the context, the proficiency required to solve the item and the type of item (see Chapter 3.1). Depending on the student's knowledge and skills, any of these parameters pertaining to each item can affect the student's performance.

OECD PISA item content is not adjusted to the standard curriculum content of the respective subjects in participating countries. Before the field trial, the participating countries are required to evaluate the correspondence of new items' content and context to the situation in each country, and these evaluations are taken into account when assembling the items for the field trial. The compliance of items included in the study with the national education standards can have a significant impact on the students' results in PISA tests – it is important that the students have mastered the curriculum content required for solving the items. Although the immediate objective of PISA is to assess the students' ability to apply the acquired knowledge in real everyday situations, the countries tend to use the results of the study to analyse student performance in various subject content areas. Particularly, the mathematics content of PISA items and the national standard are compared quite extensively, particular attention being devoted to this in the United States (Porter, 2002). This approach is also used in Latvia. The doctoral thesis of R. Kiseļova, "International assessment of basic education in Latvia: the results and analysis of informative basis for decisions in education management", is dedicated to reviewing the correspondence of the mathematics knowledge required for solving PISA 2003 and PISA 2006 items to the national basic education standard adopted in 2006. The comparison showed that the knowledge necessary for solving PISA 2006 items actually corresponded to the requirements of national basic education standard (Kiseļova, 2011). Likewise, the evaluation of PISA 2012 new mathematics items proved that all the items were found to be compliant with the national basic education standard.

The analysis of the individual items can be performed by using the relative number of correct answers. The comparison of the link items, which were included in both PISA cycles with mathematics as the main content area – PISA 2003 and PISA 2012, shows that the frequency of correct answers differs only in some items (see Figure 10.1). Latvian students' performance has improved (the difference of 5% or more) in the three items in Quantity area and one item in each of the following areas: Change and relationships, and Uncertainty and data. By contrast, the relative number of correct answers has decreased by 5% or more only in the area of Space and shape items. Traditionally, the worst performance in all PISA cycles is observed with regard to the area of variable and functional relationship items, in which students must transform the given formula to express another variable.

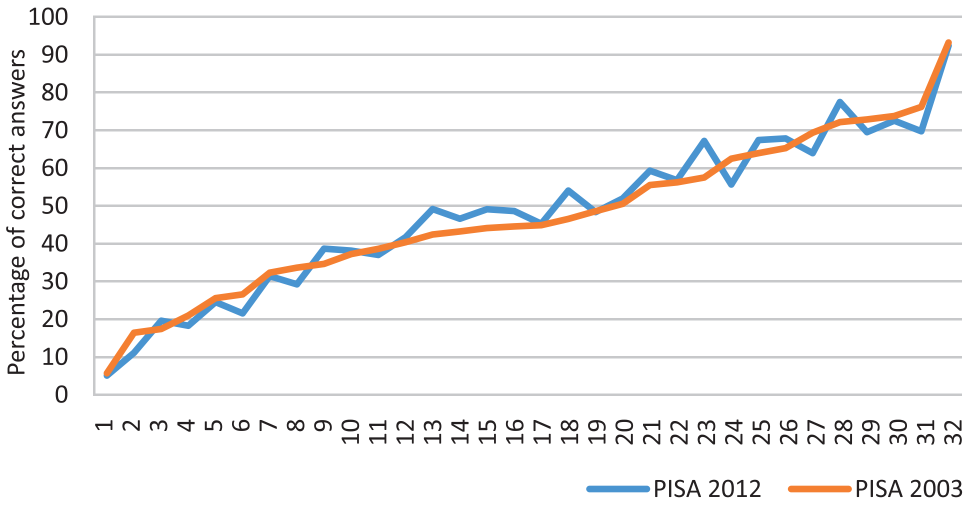


Figure 10.1 ***Percentage of correct answers given by Latvian students in link items, PISA 2003 and PISA 2012***

In this chapter we shall analyse the tasks, which Latvian students have solved statistically significantly better and statistically significantly worse than OECD students. Compared to OECD countries, Latvian students have succeeded at solving 12 items, but statistically significantly worse – 27 of 109 items included in PISA 2012 mathematics items. By comparison, the US students have also been statistically significantly better at solving 12 items (OECD, 2013).

Analysing the items, which proved to be challenging to Latvian students in comparison with the OECD countries' students, it appears that mostly those are the open constructed response items, in which students must carry out mathematical operations and justify their judgments or solution process (see Table 10.1). Those items did not include any, to which students had failed to provide answers. According to the PISA open constructed response item evaluation conditions, the item is judged to be properly resolved, even if there are minor errors in calculations, while the process of reasoning or substantiation of judgments is correct. Consequently, the students have greater difficulties with items that require logical substantiation of one's judgment and drawing conclusions. Difficulties were also caused by items, where students had to choose the correct answer from several options.

Regarding the items, which Latvian students solved better than the OECD students, a classification by type of item is similar (see Table 10.1). We can hardly say that there was one particular type of item that could be resolved more easily by Latvian students.

Table 10.1 Classification of items according to item response formats

	Number of items solved by Latvian students statistically significantly worse than OECD students	Number of items solved by Latvian students statistically significantly better than OECD students
Complex Multiple Choice items	2	4
Open Constructed Response items	16	5
Multiple Choice items	9	3

According to the item context, the group of items that were solved poorly contained most items related to societal and scientific context (see Table 10.2), while among the better-solved items the distribution is similar. The evaluation of items did not reveal any, whose context were alien to Latvian students, therefore this factor was not likely to have a significant effect on student performance.

Among the items that Latvian students had solved worse than the average of the OECD countries' students, prevail the items in which the students must be able to correctly apply their mathematical knowledge to find the right solution (see Table 10.3). These items involve carrying out modifications to the formulas, as well as applying the relevant formulas to the given situation. This goes hand in hand with the previous comparison of the types of items – this competency is most often required in solving the open constructed response items (seven out of 11 are open constructed response items). Virtually all the better-solved items were those, in which students had to apply their mathematical knowledge in a particular situation, but there are fewer open constructed response items among these (five items). In comparison with the poorly solved items, these items do not require modification of the formulas.

Table 10.2 Classification of items according to item context

	Number of items solved by Latvian students statistically significantly worse than OECD students	Number of items solved by Latvian students statistically significantly better than OECD students
Societal	11	2
Occupational	3	4
Personal	4	3
Scientific	9	3

Table 10.3 Classification of items according to competencies required for solving the items

	Number of items solved by Latvian students statistically significantly worse than OECD students	Number of items solved by Latvian students statistically significantly better than OECD students
Interpret	8	1
Employ	11	11
Formulate	8	0

In terms of the item content, the most poorly resolved were the Uncertainty and data items – 10 items (see Table 10.4). Also, the Uncertainty and data items Latvian students generally solved more poorly in relation to the average indicator of Latvia (see Chapter 3.6). In the items of this area, it is mostly required to provide data interpretation displayed in a table or a graph. Among the items solved more successfully there was only one item, which belonged to this category. Latvian students also faced the problems in solving the Quantity items (eight items among the poorly solved, and only two among the better solved ones). Although students can use calculators while solving PISA items, numerical calculations, proportions and percentages present difficulty to our students. The Space and shape items are similarly represented among the better and more poorly solved items. The items of this category also form the best solved area in relation to the Latvian students' average performance (see Chapter 3.6).

Table 10.4 Classification of items according to item content

	Number of items solved by Latvian students statistically significantly worse than OECD students	Number of items solved by Latvian students statistically significantly better than OECD students
Change and relationships	3	4
Uncertainty and data	10	1
Space and shape	6	5
Quantity	8	2

10.2. Comparison of student performance in mathematics, PISA 2012 and 9th grade mathematics final examination of the academic year 2011/2012

Traditionally, the study results in the country are evaluated judging by the final examination results, concluding a particular level of education. In Latvia, at the basic education level, these are the final examinations upon completion of the 9th grade. Examination results are not comparable with those of the previous years. Evaluation of the knowledge acquired at school according to national examination results do not provide sufficient information about the quality of education in the country, because they do not involve an assessment of the students' non-cognitive skills, attitudes and values, which are essential educational goals. In order to obtain objective, comparable information on learning outcomes, in parallel to the examinations, with a few years' intervals, the countries nationally or internationally implement education studies. In Latvia, national education studies so far have not been conducted. The comparison of the main national examination and study differences is shown in Table 10.5 (Kiseļova, 2011).

Table 10.5 Comparison of education studies and school examinations

	Study	Examination
Goal	The education system performance evaluation	Assessment of each individual student's knowledge and skills
Participants	Representative sample	All the students of a particular (in Latvia – 9th) grade

	Study	Examination
Monitoring	Constant sampling conditions, the inclusion of link items	Changes in examination content
Content	Part of the items are not published	Items are published
Contextual information	Factors characterising the level of student and school and their relationship to learning outcomes	Not evaluated
Time	Optimum interval – once every 3–4 years, as the standards of school subjects and programmes do not change often	Yearly
Extent of content	Each student is not assigned the same items – it is possible to include a greater number of items in tests	All students solve the same tasks

The goal of the final mathematics examination at the 9th grade is to assess the entirety of the students' knowledge and skills in mathematics, according to the requirements of Cabinet of Ministers Regulation No 468 of 23 August 2014 "Regulations Regarding the State Basic Education Standard". The examination covers the mandatory content of the mathematics standard for the 1st to 9th grades in Latvia: creation of mathematical instruments, usage of mathematics in the analysis of natural and social processes, development of mathematical models and studies with mathematical methods. The examination consists of two parts. Part 1 is focussed on assessment of learners' knowledge and basic skills, Part 2 – on assessment of knowledge and skills' application in standard situations and problem solving.

The items can have different levels of difficulty in terms of content and form. The first part consists of the items, in which students have to carry out only one operation (arithmetical operations, modifications, calculations, measurements or reading data from a table or a chart) – these are simple standard mathematical exercises. The maximum score for the tasks in Part 1 is 25 points. Part 2 contains the multiple operation tasks – standard mathematical tasks and mathematical texts, as well as tasks of applied mathematics. Solving of the last task of Part 2 requires analysis skills and productive activities. The maximum number of points that can be obtained in Part 2 is 50.

According to mathematics subject content, the proportion of the number of tasks in the examination differs. 74–80% are typical mathematics tasks (numbers and operations with them, algebraic expressions and actions thereof, geometric figures and their study), 10–14% are the tasks, where mathematics must be applied in the analysis of natural and societal processes (values and their measurement, the relationship between them, data processing, statistics and elements of probability theory), 10–14% are the tasks, where mathematical models must be built and studies with mathematical methods carried out.

The distribution of the tasks shows that the examination mainly tests the students' knowledge and skills, and their use in standard situations. The tasks that require the use of mathematical knowledge and skills in real-life situations make up 20–29% of the total number of the examination tasks.

By contrast, the OECD PISA study's main objective is to examine the students' ability to apply mathematical knowledge and skills in real-life situations.

To determine whether there is a link between the examination results, the students' final mark given to the student at the end of the 9th grade and PISA 2012 performance, the data of the National Centre for Education of the Republic of Latvia for school year 2011/2012, 9th grade mathematics examination and PISA 2012 results of 2603 students who took part in the PISA 2012 study and was taking mathematics examination were combined. The distribution of students according to urbanization is shown in Table 10.6.

Table 10.6 Distribution of students (%) according to urbanization

Schools of Riga	34
Schools of cities	24
Schools of towns	24
Rural schools	18

The majority of surveyed students studied at secondary schools, the minor part – at basic schools (Table 10.7).

Table 10.7 Distribution of students (%) according to the type of school

State gymnasiums	15
Gymnasiums	7
Secondary schools	65
Basic schools	12

Both according to the urbanization factor and the type of school, this distribution of students is close to the distribution of all PISA 2012 participants (see Chapter 2.1). Consequently, the performance of these students is comparable with all PISA 2012 participants' performance and contextual factors.

71% of students studied at schools where the basic education programme was implemented in the national language (Latvian), 23% of students – at schools with a minority language, and 6% study in schools, where the education programme was carried out in parallel both in the national and the minority language.

Mathematics examination results are expressed both in points (maximum number – 75) and marks (maximum score – 10). Students' final mark in mathematics is expressed in the 10-point grading system, whereas the OECD PISA results are expressed in points, where the average value is 500 with a standard deviation of 100 (see Chapter 2.3).

The assessment distributions show that there are differences between the students' final marks and the marks received in the examination (see Figure 10.5). At the end of the school year, the most commonly received mark is 4, but in the examination – 5 and 6. The examination also shows a greater number of insufficient assessments – 4.1%, and at the end of the year – 2.6%. Examination assessment distribution is closer to normal, yet the difficulty level of the examination tasks should be higher. The final mark of the school year is somewhat subjective, because the evaluation criteria may differ from school to school. The examination papers are evaluated according to certain uniform criteria, still, these papers too are assessed by the teachers of the respective schools. In the recent years, the examination papers in some regions are centrally corrected, following the initiative of the region's methodical association. Different approaches to correction of the papers does not allow to make a fair comparison of the examination results among schools and regions, and hence also to evaluate the quality of education as a whole. The biased assessment of student's knowledge may adversely affect student's further education. For example, a student who changes schools may face stricter requirements, his or her level of knowledge may be downgraded, and it can affect the student's motivation to learn. The assessment of the 9th grade mathematics examination at the national level would also ensure the objectivity and comparability of the results. Students would get a more objective assessment helping them to choose more suitable further education.

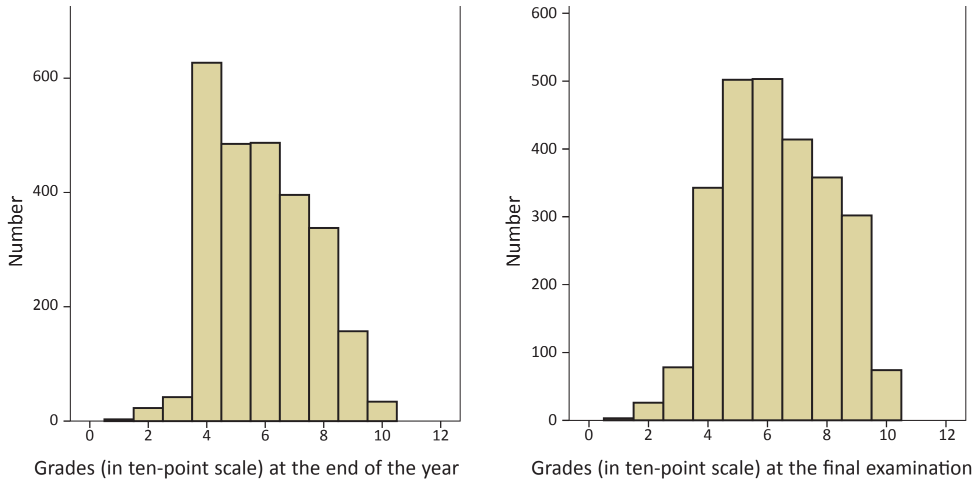


Figure 10.5 ***Distribution of the students' final mark and final mathematics examination assessment***

Table 10.8 Distribution of the students' performance by type of school in the final assessment, final mathematics examination assessment and PISA 2012

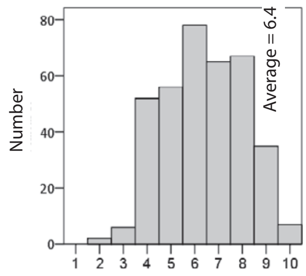
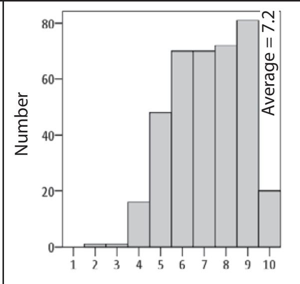
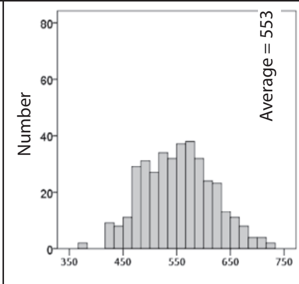
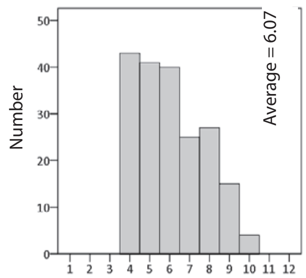
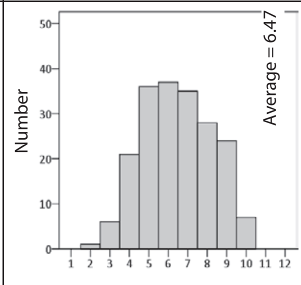
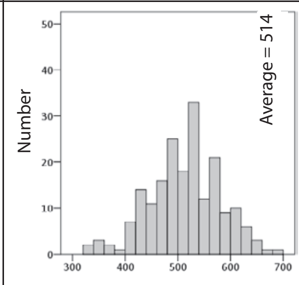
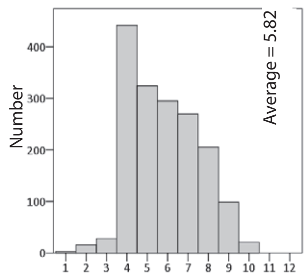
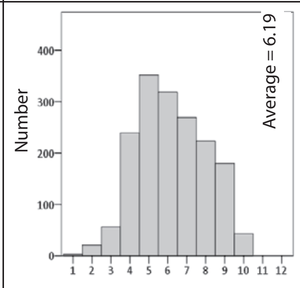
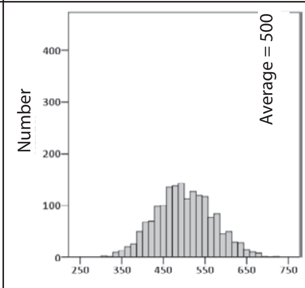
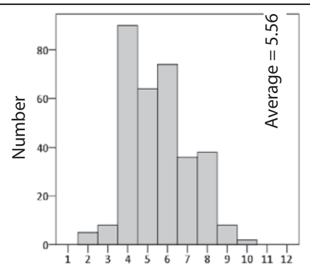
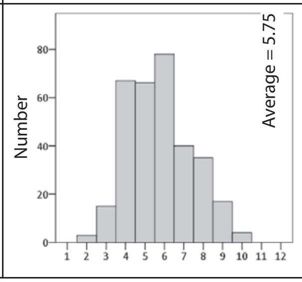
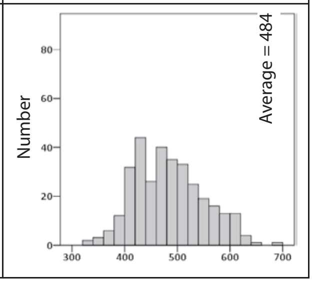
School type	Final assessment grades (in ten-point scale)	Final examination grades (in ten-point scale)	PISA 2012 (points)
State gymnasiums			
Gymnasiums			
Secondary schools			
Basic schools			

Table 10.8 demonstrates the final examination and PISA 2012 student performance distribution according to school types. It shows that PISA 2012 performance distribution is close to normal for basic and secondary schools, gymnasiums and state gymnasiums. Consequently, it can be argued that PISA mathematics test items were appropriate for the Latvian students, regardless of the school attended by the student. Examination assessment distribution is close to normal in case of secondary school and gymnasium students. The state gymnasium students found the examination tasks easy, while the basic school students – more difficult.

There is a statistically significant correlation of 95% confidence level between the students' final mark, the final examination results (in ten-point scale) and PISA performance (Table10.9). It can be observed that the PISA performance has a slightly closer relation to the examination results. For the first time the correlation of PISA mathematics performance with the 9th grade final examination results has been analysed by R. Kalvāns in his doctoral thesis "Role of principal of educational institution in ensuring quality of education in Latvia." The correlation coefficient value at the school level was 0.57, which is statistically significant at 95% confidence level.

Table 10.9 Correlation of the students' performance in the final assessment, final mathematics examination assessment and PISA 2012

	Examination assessment	Final assessment	PISA 2012
Examination assessment	1	0.82	0.65
End of the year assessment		1	0.60
PISA performance in mathematics			1

The correlation of the examination result with PISA performance is shown in Figure 10.6. High assessment in examination was received by the students who had poor results in solving the PISA mathematics items. The students who had got 350–450 points in PISA tests, that equals PISA levels 1 to 3, received marks 8, 9 and 10 (ten point scale) in the examination (see Chapter 3.1). This means that there are students with a very good knowledge of mathematics, yet these students do not know how to use it in real-life situations.

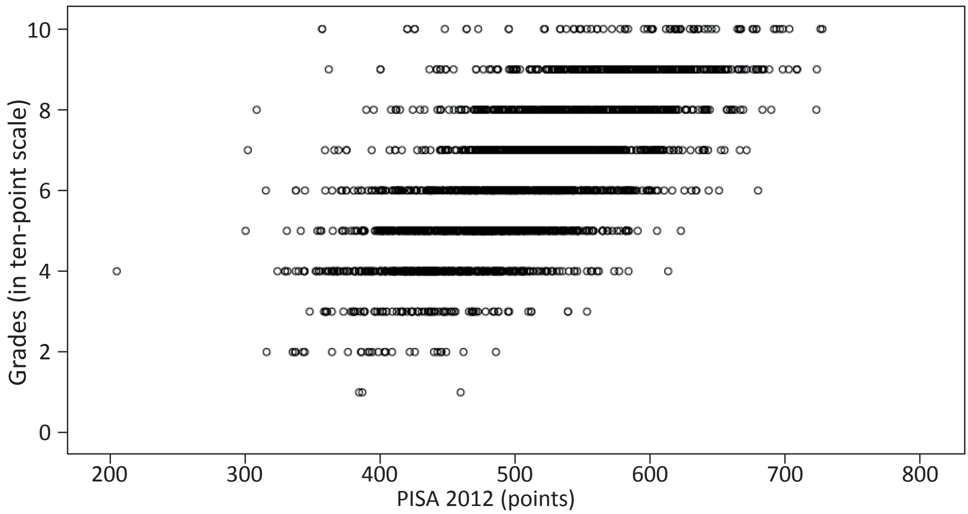


Figure 10.6 Mathematics examination and PISA 2012 mathematics performance relationship

Figure 10.7 also shows that virtually at all the PISA mathematics proficiency levels there are students whose examination marks are close to the maximum possible result (75 points).

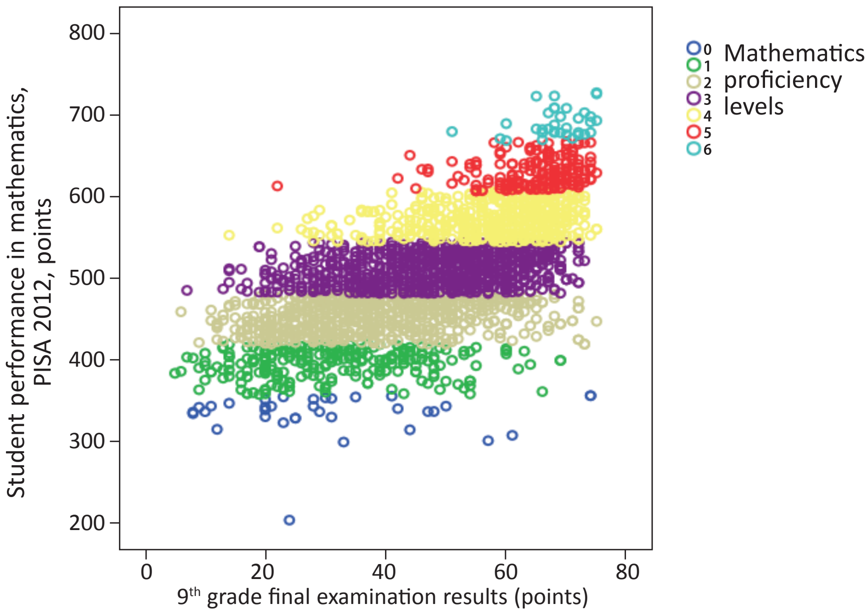


Figure 10.7 Relationship between PISA 2012 mathematics proficiency levels and examination results

In OECD PISA, students' knowledge and skills are considered to be sufficient for successful further education in the future, if his or her performance corresponds at least to the second proficiency level. Table 10.10 shows the distribution of those students' examination marks, whose mathematics performance in PISA 2012 was below the second level. Only 17% of those students also have failed in the examination, while other students have passed. The most common ratings are 4 and 5 points in the ten-point scale, but a fifth of these students have received 6 points and more.

Table 10.10 Distribution of examination grades of the students, whose PISA 2012 performance is below level 2

Examination grade	Number of students	%	Cumulative %
1	2	0.7	0.7
2	17	5.8	6.5
3	31	10.6	17.1
4	101	34.6	51.7
5	76	26.0	77.7
6	42	14.4	92.1
7	11	3.8	95.9
8	7	2.4	98.3
9	3	1.0	99.3
10	2	0.7	100.0

There is a close relationship between the student performance in PISA and their socio-economic status (see Chapter 6.2). Students' results in examination and PISA performance both have a statistically significant correlation with their SES (95% confidence level). Comparatively, SES impact on the examination results is smaller (see Table 10.11). Looking at the constituent components of the SES index, it is evident that the students' performance both in the examination and PISA 2012 is most closely related to their parents' employment – the more prestigious the parents' profession, the higher the student's performance. Higher results in PISA 2012 were achieved by those students who had a greater wealth of household and cultural possessions at home, while the examination marks were less influenced by these factors.

Table 10.11 Relation of examination results and PISA performance to student SES

	Socio-economic status (SES)	Cultural possessions at home	Educational resources at home	Parental education	Parental occupation	Family wealth possessions
Examination	0.265	0.172	0.156	0.185	0.249	0.186
PISA	0.336	0.240	0.190	0.206	0.322	0.249

10.3. Comparison of student mathematics performance in PISA 2009 and the results of 2011/2012 centralised mathematics examination

In Latvia, when graduating from the secondary school, students must pass a number of centralized examinations – one of the mandatory examinations being mathematics (*http://visc.gov.lv/en/exam/gse_in_latvia.pdf*). For the purposes of the study, 1 410 students were selected, who had participated in OECD PISA 2009, and in 2012 sat for the centralized state examination in mathematics, i.e., 31% PISA 2009 participants. According to the urbanization, these students were distributed, as follows: 25% of students from Riga schools, 17% – students from the cities, 35% – from other towns in Latvia, and 23% – students from rural schools. The majority of these students (67%) in 2009 studied at secondary schools, while 17% and 16% of students – at gymnasiums and basic schools, respectively.

The centralised mathematics examination consists of three parts:

1. Knowledge and comprehension (25 points), brief open construction tasks, each task is assessed at 1 or 0 points. The students must know and comprehend concepts, properties, formulas, methods, must use particular basic skills (to solve one task, it is not necessary to use or combine several basic skills).
2. Use of knowledge in standard situations (40 points):
   - to solve equation,
   - to solve inequality,
   - to use the properties of geometric shapes and three-dimensional shapes,
   - to carry out numerical and / or algebraic modifications,
   - to draw the graph of function, to determine and use the properties of functions,
   - to use discrete models' (sets, samples, events, data) characteristics,

- to develop and use a mathematical model appropriate to the situation,
- to perform algebraic modifications. To solve equations, system of equations or inequalities.

3. Use of knowledge in non-standard situations (15 points) – general reasoning skills:
   - to use research skills in a new situation, whose mathematical content is simple,
   - to assess the veracity of the claim and / or use different forms of proof,
   - to analyse and synthesize mathematical models.

The centralized mathematics examination (CME), similarly to the 9th grade final examination, mainly serves to assess the students' ability to apply their knowledge in standard situations. Only one third of the tasks that make up about one fifth of all examination objectives, require using knowledge in non-standard situations. Each part of the examination is evaluated in points, which are added together. In the centralized mathematics examination of 2012, the average number of points is 35 (max. = 80), which is 43% of the maximum result achievable. Depending on the total acquired number of points, the student's level of knowledge is determined, where A is the highest, F – the lowest result.

The correlation of mathematics performance in PISA 2009 and 2012, with the results of the centralized examination is shown in Table 10.12. All correlations are statistically significant at the 95% confidence level.

Table 10.12 Correlation of OECD PISA 2009 mathematics performance and CME results

	CME, part 1	CME, part 2	CME, part 3	CME total result
PISA 2009 average performance	0.523	0.506	0.556	0.561

Somewhat closer is the correlation between the PISA performance and results of the CME Part 3. PISA test items, as well as CME Part 3 tasks are focussed on the students' skills to apply their knowledge and experience in non-standard situations. Students, whose performance in PISA 2009 was higher, received also a higher rating in the centralized examination.

PISA 2009 mathematics performance relationship with CME levels is shown in Figure 10.9. The studies in secondary school were continued both by the students with high performance in PISA 2009, and those with very low results – from 240 to 725 points.

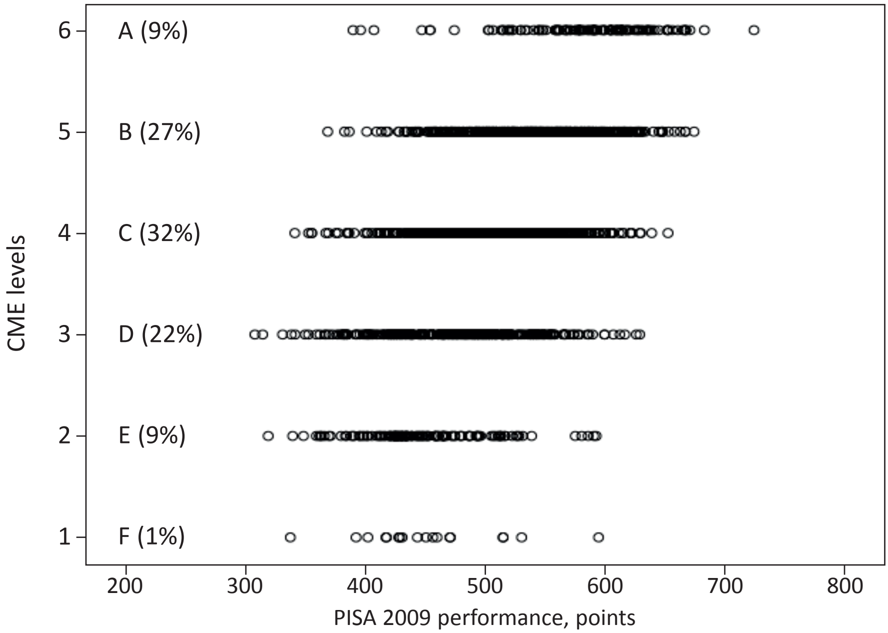


Figure 10.9 CME levels and PISA 2009 performance

The distribution of students in PISA proficiency levels and the average CME score of each CME level is shown in Table 10.13. Around two-thirds of these students in PISA 2009 had reached at least level 4, and their performance in CME was higher than the national average. Consequently, the studies in secondary schools and gymnasiums are mainly continued by students with higher performance in PISA.

Table 10.13 Distribution of students according to PISA 2009 proficiency levels and performance in CME

PISA 2009 mathematics proficiency levels	Percentage of students	CME (points, max. = 80, average = 35)
Level 6	3.5	59
Level 5	24.2	53
Level 4	41.4	42
Level 3	23.7	34
Level 2	6.7	30
Level 1	0.4	26

28% of the students in this sample had reached the highest proficiency levels in PISA 2009 (level 5 and 6). Although one of these students obtained the lowest – F level in CME, most of the students achieved high results – 90% of the students attained A, B and C level (see Table 10.14).

Table 10.14 Students who have attained mathematics proficiency levels 5 and 6 in PISA 2009 and their distribution according to CME levels

CME level	Percentage of students
A	22.5
B	39.6
C	26.9
D	9.5
E	1.3
F	0.3

The mutual correlation of all PISA 2009 participants' mathematics performance and SES is 0.355, which is statistically significant at the 95% confidence level. In case of those PISA 2009 participants, who in 2012 were passing the centralized examination in mathematics, this relationship is weaker – the correlation coefficient is 0.109, however, this is also statistically significant. SES impact on the period of secondary education is weaker, because the secondary school and gymnasium students generally have a higher SES, and it is more homogenous than that of the basic school students. Those PISA 2009 basic school students who continued to study at secondary school, had the average value of SES 0,014, whereas the average SES value of all PISA 2009 participants who studied in primary schools, was -0.429. Consequently, in basic schools, which mainly are rural schools, secondary education is chosen by those students, whose families have a higher SES.

PISA 2009 student survey included a question about the students' future education career. 74% of students intended to acquire higher professional education or a bachelor's or master's degree. Those students had shown higher performance both in PISA 2009 and in the centralized examination (see Table 10.15).

Table 10.15 Relationship of students' further education plans (after basic school) with mathematics performance in PISA 2009 and CME

	Percentage of students	Average points CME	PISA performance (points)
Intend to obtain higher education	74%	45	521
Do not intend to obtain higher education	26%	35	476

At the school level, too, there is a statistically significant correlation (95% confidence level) between the students' performance in mathematics in PISA 2009 and the centralized examination of 2012, (correlation coefficient 0.502), as well as between students' performance in mathematics in PISA 2012 and the centralized examination of 2015, (correlation coefficient 0.528). Consequently, the secondary school and gymnasium students, who achieve high results in PISA tests, are likely to show high results also in the centralized examinations.

Summary

Commencing every PISA cycle, the suitability of the new items to the students is evaluated in each participating country, taking into account each item's content and context. In Latvia, knowledge and skills necessary to resolve PISA mathematics items are in line with the national standard of basic education.

Comparing students' performance in mathematics link items in the two PISA cycles with mathematics as the main content area – PISA 2003 and PISA 2012, different results were observed only in a few items. In general, Latvian students were better at solving the items pertaining to the Quantity area, but less successful – with the items of the Space and shape area. Space and shape items (geometry) have traditionally been an area in which Latvian students show the highest performance, and the fall of performance in the link items may indicate a negative trend in teaching geometry at school.

Compared to OECD countries, Latvian students statistically significantly (at the 95% confidence level) better solved 12, but worse – 27 of 109 mathematics items included in PISA 2012. Latvian students had greater difficulties with the open constructed response items requiring logical substantiation of one's judgments and making conclusions. Regarding the items in which students had to correctly apply their mathematical knowledge to find the right solution, the same number of items (11 items), were both among the ones solved well and badly. The open constructed response items, in which students must transform a formula or must apply the formula to the given situation, were most poorly solved. Among the items solved most successfully, there were less open constructed response items, and these items did not require modification of the formulas. According to the content area, compared with the OECD countries' students, Latvian students faced major difficulties with Uncertainty and data items. Although these two topics have been included in the national basic education standard, the interpretation of data tables and chart content remains a challenge to our students. Latvian students also had difficulties with the items dedicated to the theme of Quantity. Even though students may use calculators in solving PISA items, the numerical calculations, proportions and percentages still present difficulties for our students.

The basic education results in Latvia are evaluated both by the final mark given to the student at the end of the 9th grade and by the final examination results. The 9th grade mathematics examination mainly serves to test students' knowledge and skills, and their use in standard situations. The tasks that require the use of mathematical knowledge and skills in real-life situations make up 20–29% of the total content of the examination. By contrast, the OECD PISA study's main goal is to examine the students' ability to apply mathematical knowledge and skills in real life. Between the 9th grade students' mathematics examination and PISA results there is a statistically significant correlation with 95% confidence level (correlation coefficient 0.656). However, the distributions of student performance at the end of the year, in examination and PISA 2012 are different – only the PISA 2012 performance distribution is close to standard. At the end of the year, the most common mark received is 4, in the final examination – 5 and 6. Comparing the performance distribution by type of school, it can be concluded that the PISA 2012 performance distribution is close to standard in basic and secondary schools, as well as gymnasiums and state gymnasiums. Consequently, it can be argued that the PISA mathematics test items were suitable for Latvian students, regardless of the school attended by the student. Examination assessment distribution is close to standard in case of secondary school and gymnasium students. The students of state gymnasiums found examination tasks easy, while the basic school students – more difficult. Performance distributions in examinations and the end of the year marks cast doubt on the objectivity of assessment. To ensure a more impartial assessment of student performance, it would be advisable to mark the 9th grade mathematics examination papers in a centralised manner.

Comparing PISA 2012 and the examination performance (marks in 10-point scale) dispersion, it can be observed that the students who received relatively low assessment in the examination (4, 5 and 6 points in 10-point scale), had achieved both low and high results in PISA. By contrast, at virtually all the PISA mathematics proficiency levels there were the students who had received the highest assessment in the examination. These are the students who have mastered the school programme well, yet are not able to apply this knowledge in everyday situations.

In OECD PISA, students' knowledge and skills are considered to be sufficient for a successful further education, if the student's performance corresponds at least to the second proficiency level. Only 17% of students whose performance in PISA 2012 is below the second proficiency level, have received a failing assessment in the examination, all the other students have received passing marks – mostly 4, 5 and 6.

Students' performance both in examination and PISA has a statistically significant correlation with their SES. Comparatively, the SES impact on the examination results is weaker. Students' performance in examination and PISA 2012 is most closely related to the students' parents' occupation. The more prestigious the parents' profession, the higher is the student's performance in both the examination and PISA 2012. A higher performance in PISA 2012 was achieved by those students who had more versatile household and cultural possessions at home, while the examination grades were less influenced by these factors.

In order to analyse the PISA participants' further achievements, upon graduation from the secondary school, those students were selected, who had participated in PISA 2009 and took the centralised mathematics examination in 2012 – a total of 1 410 students, or 31% of PISA 2009 participants. There is a statistically significant correlation between these students' mathematics performance in PISA 2009 and in the centralized examination at the 95% confidence level (correlation coefficient 0.561). Studies in secondary school were continued both by the students with a high performance in PISA 2009, and by those who had underperformed – from 240 to 725 points. The students who had reached the highest levels of mathematical proficiency in PISA 2009, received high assessment also in the centralised examination (90% of the students achieved A, B and C levels).

The mutual correlation of all PISA 2009 participants' mathematics performance and SES is 0.355, which is statistically significant at 95% confidence level. In case of those PISA 2009 participants, who in 2012 took the centralized examination in mathematics, this relationship was weaker – the correlation coefficient was 0.109, however, it was also statistically significant. SES impact at the level of secondary education is weaker, because the secondary school and gymnasium students' SES is higher and more homogenous. Those PISA 2009 basic school students who continued to study at secondary school, had the average SES value of 0,014, whereas all PISA 2009 participants who studied at basic schools, had the average SES value of -0.429. Consequently, the education at secondary schools or gymnasiums is continued by those students of basic schools (basic schools being mainly rural schools), whose socio-economic family status is higher.

Student performance in both PISA 2009 and the centralized examination in mathematics is closely related to the students' further education plans after graduating the basic school. The students who in PISA 2009 told about their plans to acquire higher professional education or a bachelor's or master's degree, were better performers.

There is also a statistically significant correlation at the school level (95% confidence level) between the students' performance in mathematics in PISA 2009 and the centralized examination of 2012 (correlation coefficient 0.502), as well as between students' performance in mathematics in PISA 2012 and the centralized examination of 2015 (correlation coefficient 0.528). Consequently, the secondary school and gymnasium students who show high performance in PISA tests, are likely to achieve high results also in the centralized examinations.

11. FINANCIAL LITERACY

Financial literacy is one of the essential life skills, and high on the global policy agenda. It is confirmed by the increasing number of the countries that develop and implement national strategies for financial education, to improve the overall society's financial literacy, often focusing on youth (OECD, 2014c). "Shrinking welfare systems, shifting demographics, and the increased sophistication and expansion of financial services have all contributed to a greater awareness of the importance of ensuring that citizens and consumers of all ages are financially literate" (OECD, 2014c).

The contemporary and future financial choices already are and will be much more complicated than those of the previous generations as more complicated financial products, services and systems emerge. In some of the societies and economies the contemporary youth are the first to access these financial products. Young people are bound to encounter much greater financial risks in their adult life. "Finance is a part of everyday life for many 15-year-olds: they are already consumers of financial services such as bank accounts with access to online payment facilities. As they near the end of compulsory education, students will also face complex and challenging financial choices. One of their first major decisions may be to choose whether to continue with formal education and how to finance such study" (OECD, 2014c).

The financial literacy module in PISA 2012 offered the first international appraisal of 15-year-old student knowledge and skills in finance.

PISA financial literacy assessment was conducted in 13 OECD countries and economies (Australia, the Flemish community of Belgium, the Czech Republic, Estonia, France, Israel, Italy, New Zealand, Poland, the Slovak Republic, Slovenia, Spain and United States) and five partner countries and economies (Colombia, Croatia, Latvia, the Russian Federation and Shanghai (China)).

The financial module was taken by about 29 000 students altogether, representing approximately nine million 15-year-old students in 18 participating countries of the study (13 OECD countries and 5 partner countries.) In Latvia, the study encompassed 970 participants from 215 schools, of which 84% were students of the 9^{th} grade, 12% – of the 8^{th} grade.

Each student participating in the financial module, within two hours had to fill one of the four different financial test booklets (with a different cluster layout).

Each booklet contained four clusters of items: two financial item clusters (a total of 40 items), one mathematics and one reading item cluster, as well as a short questionnaire on students' experience of money matters.

11.1. Evaluation of students' financial literacy

The financial literacy in PISA is defined, as follows: "Financial literacy is knowledge and understanding of financial concepts and risks, and the skills, motivation and confidence to apply such knowledge and understanding in order to make effective decisions across a range of financial contexts, to improve the financial well-being of individuals and society, and to enable participation in economic life." This definition, like other PISA domain definitions, has two parts: the first part refers to the kind of thinking and behaviour that characterises the domain, whereas the second part refers to the use of the particular literacy.

Levels of financial literacy

"PISA test design makes it possible to construct a single scale of proficiency, drawing on all the questions in the financial literacy assessment. Each question is associated with a particular point on the scale that indicates its difficulty, and each student's performance is associated with a particular point on the same scale that indicates his or her estimated financial literacy proficiency" (see Table 11.2) (OECD, 2014c, pp. 54–55).

The relative difficulty of questions in a test is estimated by considering the proportion of students who answer each question correctly: relatively easy questions are answered correctly by a larger proportion of students than more difficult questions. "The relative proficiency of students can be estimated by considering the proportion of questions that they answer correctly. A highly proficient student will answer more questions correctly than his or her less-proficient peers" (OECD, 2014c).

Table 11.2 Proficiency levels in financial literacy

Level	Lowest score threshold	% of students able to perform tasks at each level or above		What students can typically do
		OECD	Latvia	
5	625	9.7	4.6	Understand complex financial concepts, are capable to carry out complicated and precise calculations to solve financial problems that are not routinely encountered at their age.
4	550	31.6	27.4	Understand less common financial concepts more corresponding to adulthood, are capable to take financial decisions based on long-term consequences.
3	475	61.8	63.6	Are conscious of the consequences brought by decisions, can make simple financial plans for solution of problems, are capable to implement complicated calculations.
2	400	84.7	90.3	They can use given information to make financial decisions in contexts that are immediately relevant to them, recognize simple budgets, are capable to make simple calculations in decision making.
1	326	95.2	98.3	They can recognize the difference between needs and wants and can make simple decisions on everyday spending.

11.2. Students' financial literacy

The financial literacy of Latvian students is fully consistent with the OECD country average level in the study – 501 points and 500 points, respectively, Latvian students' average performance is not statistically significantly different from the US and Polish students' performance (see Table 11.3). Latvian student performance standard deviation is 78 points, which is the smallest compared with other participating countries (see Figure 11.1).

The highest-performing group comprises Shanghai (China), Belgium (Flemish), Estonia, Australia, New Zealand, the Czech Republic.

The performance below OECD average was shown by the students of Russian Federation and OECD countries – France, Slovenia, Spain, Israel, Slovak Republic and Italy.

Table 11.3 Comparing student financial literacy performance in different countries

Mean score	Rang	Comparison country / economy	Countries and economies whose mean score is NOT statistically significantly different from the comparison country's / economy's score
603	1.	Shanghai (Chaina)	
541	2.	Flemish Community (Belgium)	
529	3.–4.	Estonia	Australia, New Zealand
526	3.–5.	Australia	Estonia, New Zealand
520	4.–6.	New Zealand	Estonia, Australia, Czech Republic, Poland
513	5.–7.	Czech Republic	New Zealand, Poland
510	6.–7.	Poland	New Zealand, Czech Republic, Latvia
501	8.–9.	Latvia	Poland, United States
492	8.–12.	United States	Latvia, Russian Federation, France, Slovenia, Spain, Croatia, Israel
486	9.–14.	Russian Federation	United States, France, Slovenia, Spain, Croatia, Israel
486	9.–14.	France	United States, Russian Federation, Slovenia, Spain, Croatia, Israel
485	9.–14.	Slovenia	United States, Russian Federation, France, Spain, Croatia, Israel
484	10.–15.	Spain	United States, Russian Federation, France, Slovenia, Croatia, Israel
480	11.–16.	Croatia	United States, Russian Federation, France, Slovenia, Spain, Israel, Slovak Republic
476	11.–17.	Israel	United States, Russian Federation, France, Slovenia, Spain, Croatia, Slovak Republic, Italy
470	15.–17.	Slovak Republic	Croatia, Israel, Italy
466	16.–17.	Italy	Israel, Slovak Republic
379	18.	Colombia	
	Statistically significantly above the OECD average -13		
	Not statistically significantly different from the OECD average -13		
	Statistically significantly below the OECD average -13		

Source: OECD, PISA 2012 Database.

The standard deviation of performance for Latvia is the smallest of all the 18 participating countries of the study. The minimal variance in performance distribution in Latvia shows a more uniform quality of education throughout the country, and, at the same time, it also influences the relative number of students with low and high performance. Compared to the OECD countries' average values, Latvia has a smaller relative number of students with low performance and – less optimistically – also of the students with high performance (see Figure 11.2) (this aspect is also discussed in Chapter 6.4).

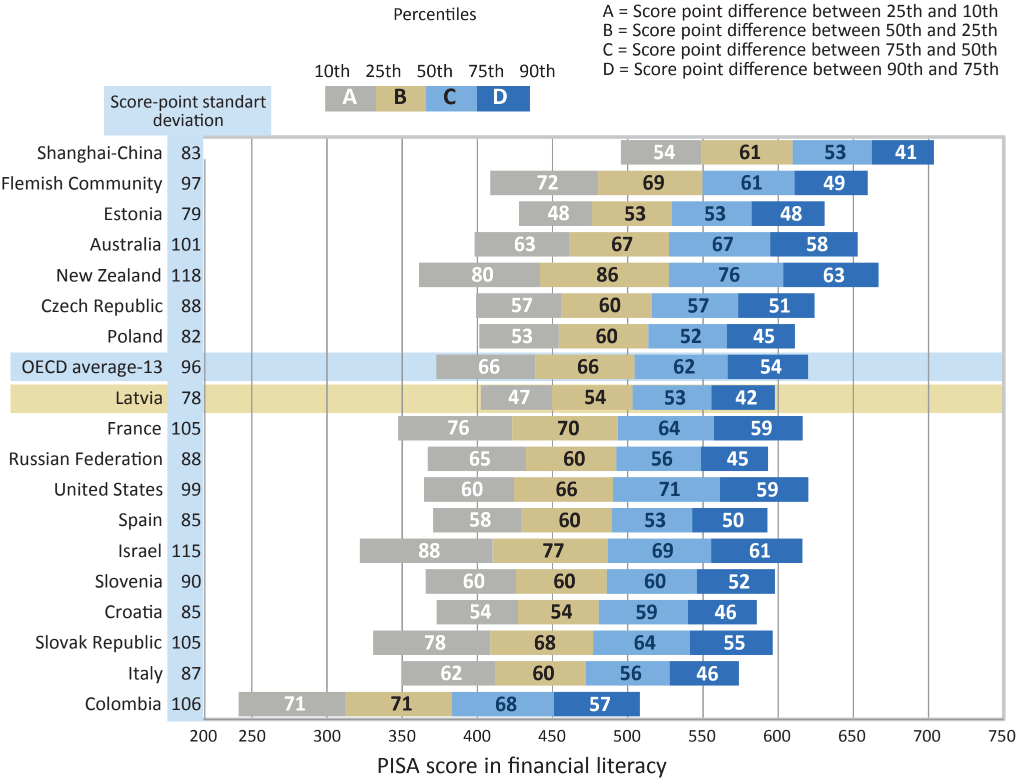


Figure 11.1 ***Student financial literacy performance variation in different countries (%)(OECD, 2014c, p. 66)***

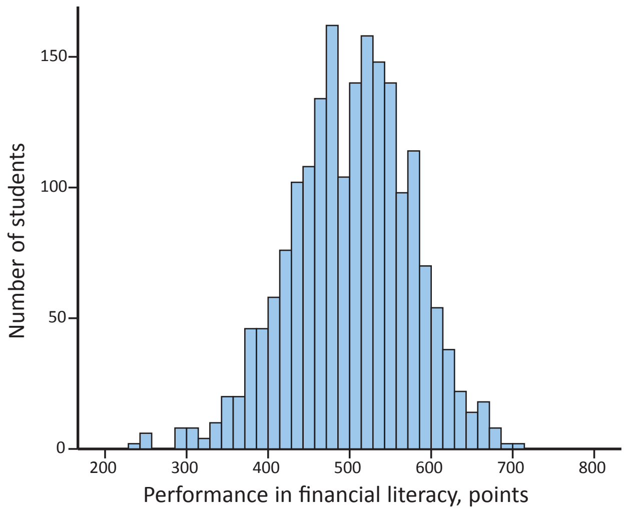


Figure 11.2 ***Diagram of Latvian students' distribution according to performance in financial literacy***

11.3. Distribution of financial performance in proficiency levels

The study defined five levels of financial literacy. Overall, the first level of proficiency was achieved by 95% of students in OECD countries. Of these, 10% of students were unable to reach the second level, while the items of the highest level – 5 were solved by 9.7% of students (see Table 11.4).

Table 11.4 Distribution of financial proficiency in all participating countries of the study (OECD, 2014c, p. 151)

	Levels of financial competency (%)				
	Level 1 and below	Level 2	Level 3	Level 4	Level 5 and above
	%	%	%	%	%
Shanghai (China)	1.6	5.1	18.6	32.2	42.6
Estonia	5.3	19.1	36.0	28.3	11.3
Belgium	8.7	15.1	26.2	30.4	19.7
Latvia	9.7	26.8	36.2	22.7	4.6
Poland	9.8	23.2	34.2	25.6	7.2
Czech Republic	10.1	21.2	32.8	26.0	9.9
Australia	10.4	19.5	29.4	24.9	15.9
OECD average	15.3	22.9	30.2	21.9	9.7
New Zealand	16.1	18.0	23.4	23.3	19.3
Croatia	16.5	30.8	31.6	17.4	3.8
Spain	16.5	26.4	34.6	18.6	3.8
Russia	16.7	25.4	33.1	20.5	4.3
Slovenia	17.6	27.4	31.3	18.0	5.8
USA	17.8	26.2	27.1	19.4	9.4
France	19.4	22.6	30.4	19.4	8.1
Italy	21.7	29.5	31.7	14.9	2.1
Slovakia	22.8	26.5	28.1	16.9	5.7
Israel	23.0	22.9	27.0	18.6	8.5
Columbia	56.5	26.1	13.1	3.7	0.7

In Latvia, the second level was not reached by 10% of the students, thus, we have relatively few students with low performance, and, according to this comparison, Latvia shows the fourth best result – just behind Shanghai (China), Estonia and Belgium. However, the items of the highest degree of difficulty (level 5) were successfully solved by 4.6% of our students, and the relative number of such students in Latvia was lower than the average of OECD countries. These facts remind of an analogous situation in our student literacy distribution in reading, mathematics and science. The study found a relatively strong correlation between student performance in mathematics, reading and finance. PISA data show that 76.9% of the students who in the financial module reach the fifth level of proficiency, have also achieved the fifth level in mathematics, while 58.4% of students who in the financial module reach the fifth level of proficiency, have achieved this level also in reading. Overall, 3.9% of students who filled the financial test brochures, attained the fifth level of proficiency in the financial module and the fifth level of proficiency in mathematics or reading (at least in one of those areas). Thus, the relative increase in the number of students who have high performance is the target of our educational system both in finance and mathematics, as well as in reading and science.

11.4. Relationship of students' financial literacy performance to contextual factors

Student performance is influenced by a number of important factors that must not be overlooked making the policy choices in education. PISA also analyses the relationship between students' performance in the field of finance and the demographic and socio-economic conditions of students and their families (student gender, socio-economic status, parents' education, parents' occupation, language use at home and immigration).

Average performance of boys and girls in financial literacy

In Latvia, as well as in the other countries that took part in the financial module, girls' and boys' average results were not statistically significantly different, yet the girls' performance was slightly higher than the boys' performance (see Figure 11.3).

However, if girls and boys were to have the same performance in reading and mathematics, the boys' performance in the area of finance would be higher than that of the girls.

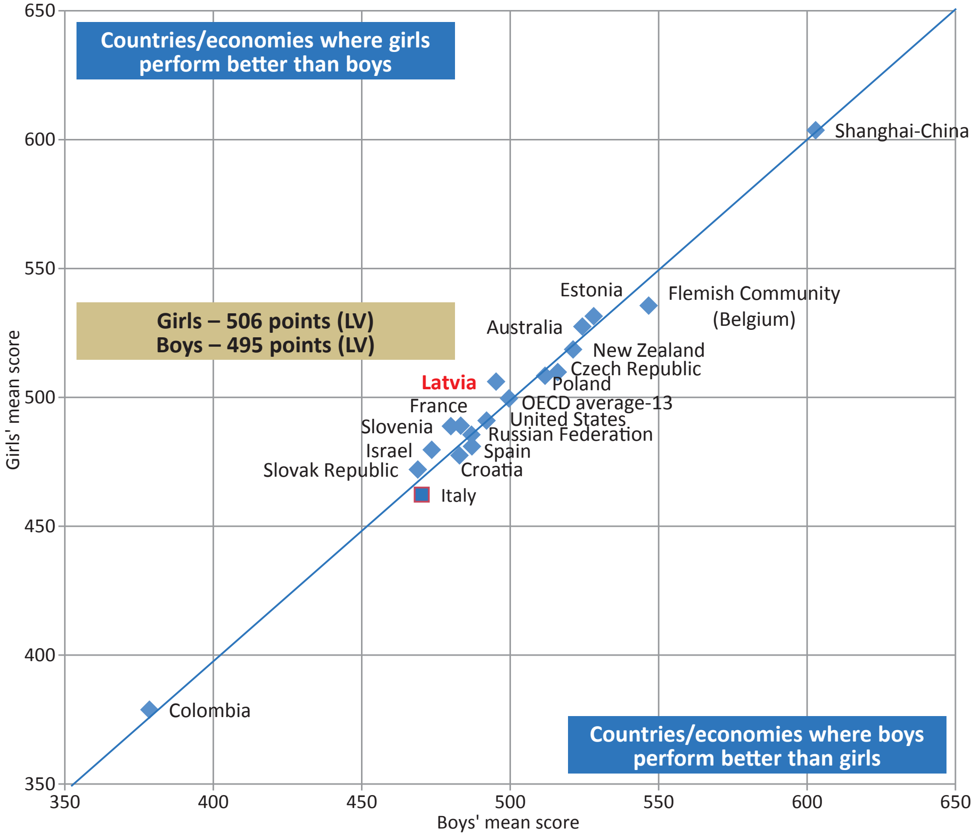


Figure 11.3 Financial literacy performance, according to gender (OECD, 2014c, p. 79)

Comparing the percentage distribution of boys and girls in the highest and lowest level of proficiency, in Latvia there is an equal number of girls and boys that show high performance (4.6% of girls and 4.6% of boys reach the fifth level of proficiency), in the OECD countries, on the average, more boys than girls reach the 5th level, respectively, 11% and 8%. On the other hand, low performance is more characteristic of boys than girls in Latvia (11% of boys and 8% of girls do not reach the second level of proficiency), as well as the OECD average (17% of boys and 14% girls). In mathematics, the boys who solved brochures of the finance module, were more competent than the girls, while the girls performed better in reading, just like the OECD average. The most notable differences between boys' and girls' performance in reading can be observed particularly at the lowest level of proficiency. Almost a quarter of boys (22%) are unable to overcome this low level of proficiency (cf, only 5% of girls), and there are similar differences in the OECD countries.

Consequently, the boys' better performance of financial tasks is hindered by their weak reading ability (i.e., the ability to carefully read and understand the text, see the relevant information that is necessary to solve the item, etc.), and sometimes also by a poorer mathematical literacy than that of the girls.

Relation of student performance in financial literacy with SES indicators

Within OECD PISA study, student SES is assessed with the social, cultural and economic status index, which consists of such indicators as the education of student's parents (level of parental education) and employment (profession), as well as the quantity of resources related to education at the disposal of the family (household items and opportunities).

The average performance of Latvian students in finance fully corresponds to the OECD average level in the study, its dependence on family SES index, as it changes by one unit, is lower than the OECD average, and the performance variation according to SES is on the average level of OECD countries. We can conclude that Latvian education system is quite capable of providing equal educational opportunities for students from different families.

Table 11.5 Student family SES relation to performance in financial literacy (OECD, 2014c, p. 84)

Countries	Mean performance in financial literacy (points)	Strength of the relationship between financial literacy performance and socio-economic status (percentage of explained variance in financial literacy performance)	Performance difference across socio-economic groups (score-point difference in financial literacy associated with one-unit increase in the PISA index of economic. social and cultural status)
OECD average	500	13.6	41
Shanghai (China))	603	12.5	29
Belgium (Flemish)	541	11.3	37
Estonia	529	6.7	24
Australia	526	11.3	42
New Zealand	520	19.0	64
Czech Republic	513	13.3	45

Poland	510	12.2	31
Latvia	501	13.2	32
USA	492	16.6	41
Russia	486	9.6	36
France	486	15.5	50
Slovenia	485	16.3	41
Spain	484	14.6	32
Croatia	480	10.4	33
Israel	476	14.4	50
Slovak Republic	470	18.2	48
Italy	466	7.5	25
Columbia	379	13.0	33

(dark shading)	Countries whose mean performance is above the OECD average
(no shading)	Countries whose mean performance is not statistically different from the OECD average
(light shading)	Countries whose mean performance is below the OECD average

Parental influence

Parental influence on children's knowledge and skills in relation to financial issues is very essential, as parental education and occupation have an impact on the space inhabited by the children. Parental handling of finance matters is an example to the children, whereby they gain the necessary knowledge, especially if the school does not teach how to deal with one's funds.

PISA reveals – the higher the parental level of education, the better the students' performance in the financial literacy. A similar relationship was found between students' performance in the financial literacy and the parental employment – the more skilled the parents' occupation, profession, the better the students' performance in financial literacy. In Latvia, the difference between the performance of students who have at least one parent with a university degree, and those whose parents do not have higher education, is slightly over 40 points, which corresponds to the OECD average (interesting that in Estonia it is only 20 points). Also among those students who have at least one parent with a highly skilled profession, and those, whose parents have a low-skilled profession, the difference in performance is 40 points, which also corresponds with the OECD average (in Estonia, only five points).

In Figures 11.4 and 11.6, OECD average corresponds to 13 OECD countries participating in Financial module.

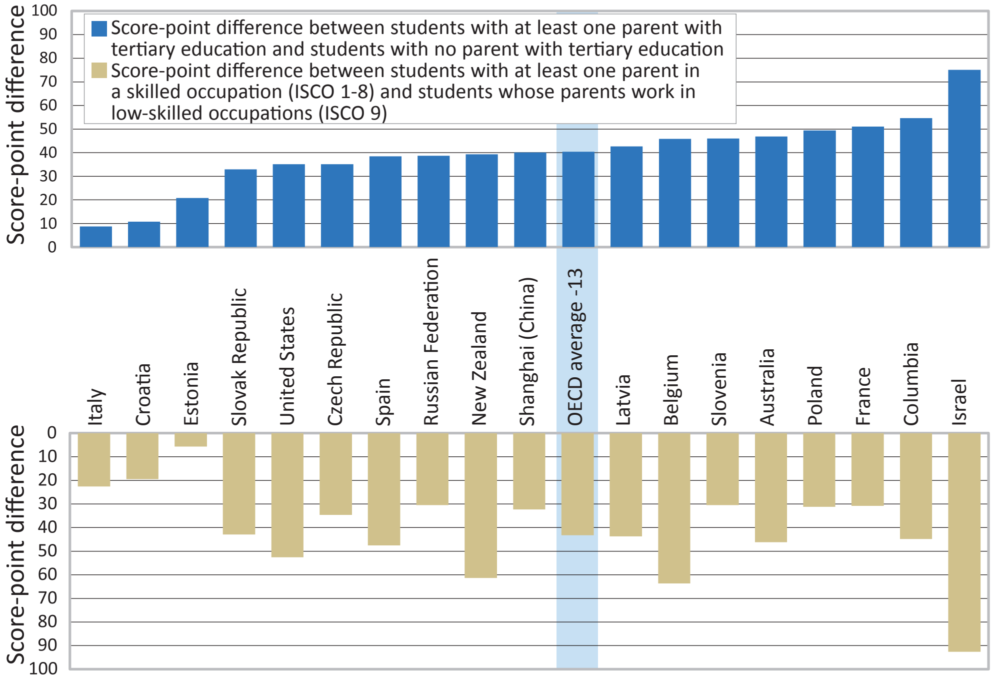


Figure 11.4 Student financial literacy and parental education and occupation

Within PISA 2012 students were asked, how often they discussed money matters with their parents. In Latvia, 11% of students (in OECD countries, the average of 16%) assert that they do not speak with their parents about money matters, 69% (OECD – 69%) say that they discuss money matters with their parents once a week or a month, while 20% (OECD – 15%) say that they discuss these things almost every day (Figure 11.5).

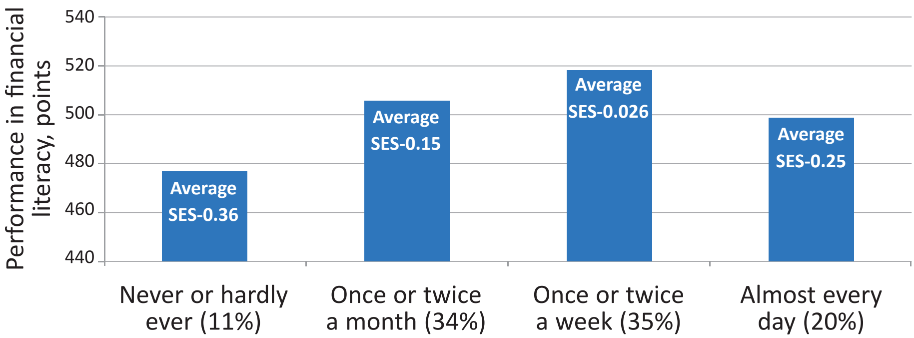


Figure 11.5 Distribution of average financial literacy performance of Latvian students in relation to the answers to the question "How often do you discuss money matters with your parents?"

The relationship between performance and frequent or rare discussions of students and their parents about money is not linear. It can be observed that in Latvia and the OECD countries, on average, higher performance is achieved by those students who discuss money matters with their parents at least once a week or once a month, but lower – by those who do not discuss money matters with their parents at all, and also by those who talk to the parents about money every day, taking into account their SES (Figure 11.6).

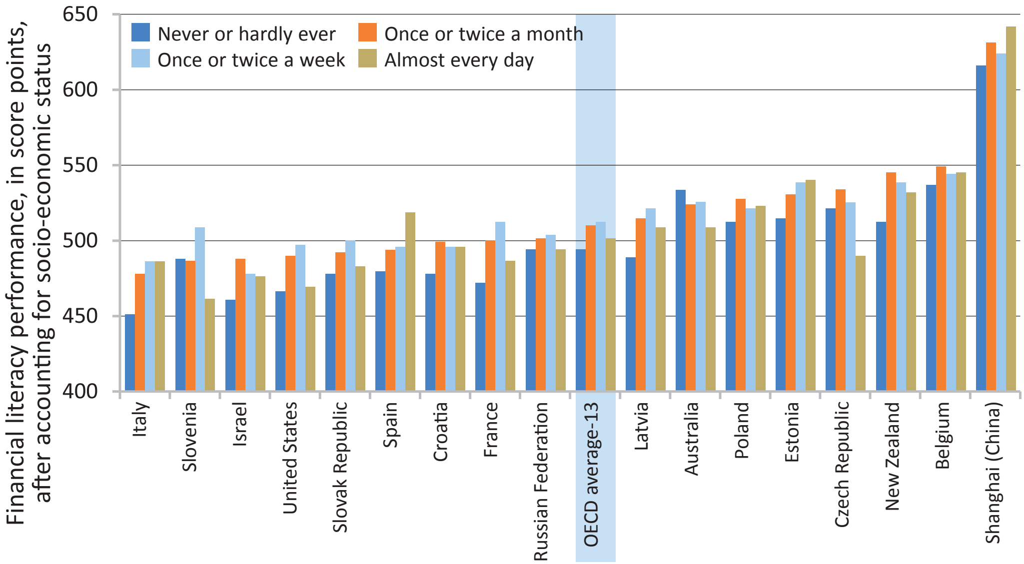


Figure 11.6 Financial literacy performance, by frequency of discussing money matters with parents, after accounting for socio-economic status

11.5. Student experiences, attitudes, behaviour and performance

An important role in financial decisions is played both by knowledge, understanding and skills, and also by students' attitudes, motivation and beliefs that influence their decisions and show their financial competence. The students were asked a few questions about their experience with money, as well as their attitude. It enabled researchers to find out whether the students' experience in money matters or with regard to financial products is linked to their knowledge and skills in money matters, whether there was a relationship between attitudes and behaviour in solving financial issues.

Higher performance of students in this somewhat specific area is also associated with such practical aspects as holding one's own bank account and debit card (and, presumably, also using them). Here, though, one should bear in mind that it is associated with family SES and regulations in the country with regard to handling those financial products at the age of 15. In Latvia, the children may open a bank account with parental permission, starting from 16 years of age (some banks offer this service even from seven years of age), but their actions with the account are limited by various regulations, which, for example, provide that they will be able to operate their account independently only from 18 years of age.

More than a half of Latvia's students have no bank account, or a debit card, a little less than 16% of students have both a bank account and a debit card, a little more than 16% of the students have only a bank account, and 2% of the students have only a debit card. The majority of students (over 65%) have neither a bank account, nor

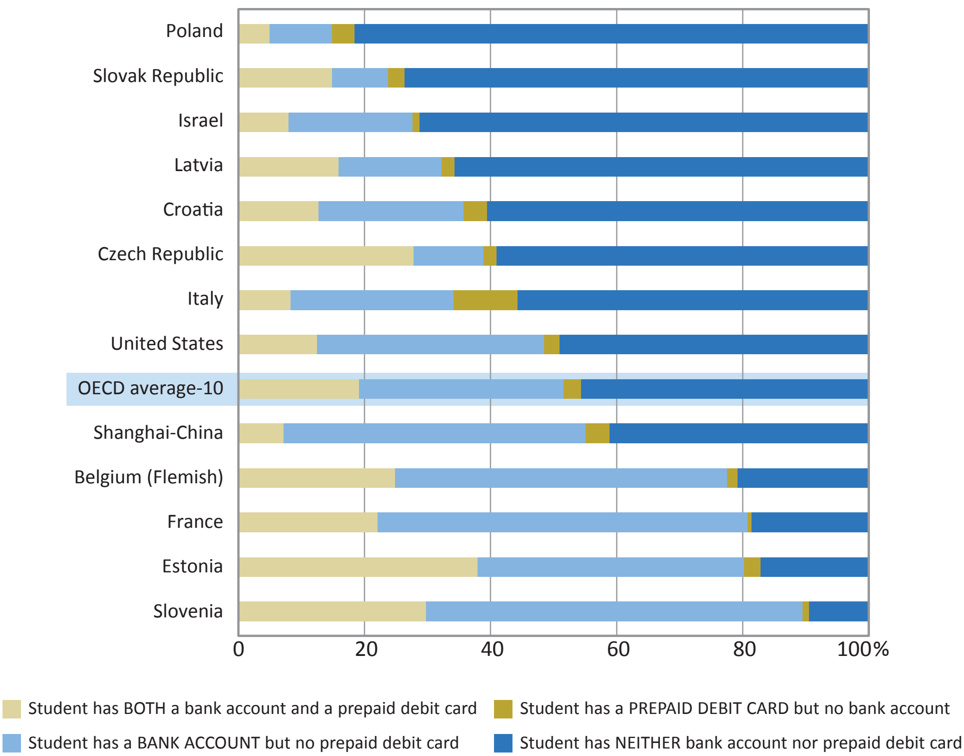


***Figure 11.7** Percentage of students holding a bank account and a prepaid debit card (combined) (OECD, 2014c, p. 103)*

a debit card. It is interesting that in case of our neighbours Estonians, only 17% of students have no bank account or a debit card (Figure 11.7).

As shown in Figures 11.8 and 11.9, in Latvia the students who have a bank account and a debit card also have a higher SES indicator, there is a positive correlation between the possession of a bank account and the socio-economic status. The existence of a bank account does not determine higher performance, yet the performance is higher in case of those students who have a debit card.

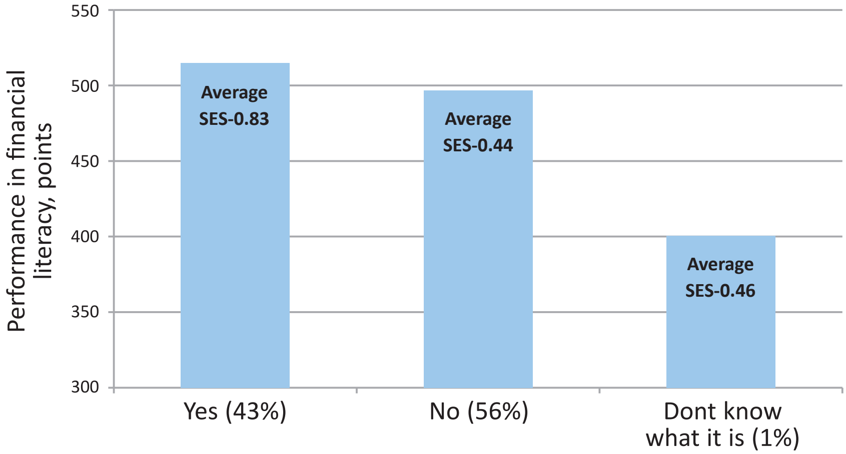


Figure 11.8 Distribution of Latvian students' average performance in financial literacy according to the responses to the question "Do you have a bank account?"

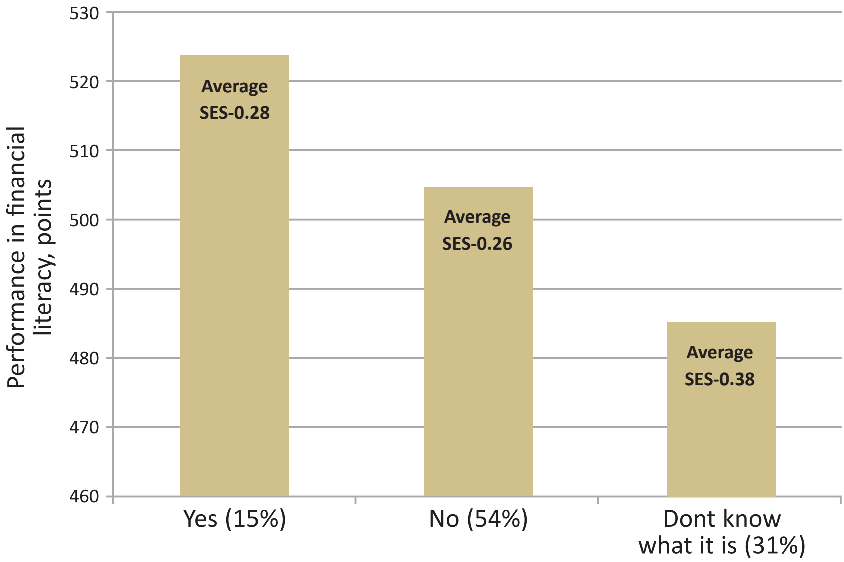


Figure 11.9 Distribution of Latvian students' average performance in financial literacy according to the responses to the question "Do you have a debit card?"

In Latvia, as well as in Estonia and Czech Republic, the students who hold both a bank account and a debit card, show a better performance than the students with the same SES who have only one of the two (see Figure 11.10).

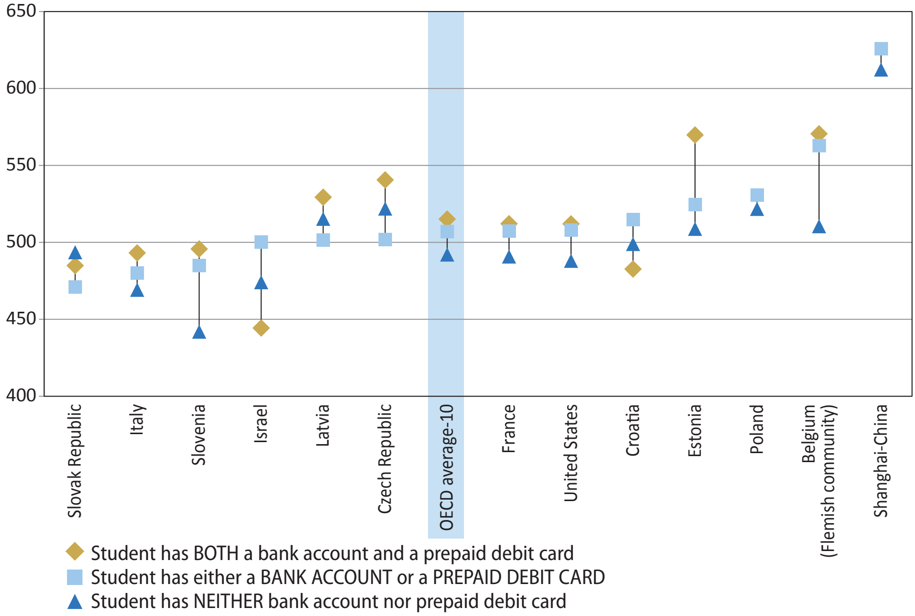


Figure 11.10 Performance in financial literacy, by whether students hold a bank account and a prepaid debit card (after accounting for socio-economic status) (OECD, 2014c, p. 103)

These facts suggest that having a bank account and a debit card allows students to acquire skills and knowledge that contribute to their financial literacy development, and vice versa – the students' low financial literacy does not promote their interest in using these banking products to manage their money, make payments; possibly, the students and their parents do not see the benefits of these products.

Financial education and school

The school questionnaire included a question about the accessibility of financial education to the 9th grade students. As shown in Figure 11.11, almost 30% of students, according to school management's opinion, do not have access to financial education. In Estonia, financial education is not available to nearly 85% of the students, nevertheless, their financial literacy is higher than that of Latvian students. Figure 11.12 shows the providers of financial education to students at school. In all the selected countries, the key role in providing financial education at school is played by the teacher, who is responsible for teaching financial matters in almost 90% of cases. In Latvia, more than in other countries, the financial education at school also involves non-governmental and private financial organizations. In Figure 11.11, the countries are ranked, taking into account the students' average performance in a country.

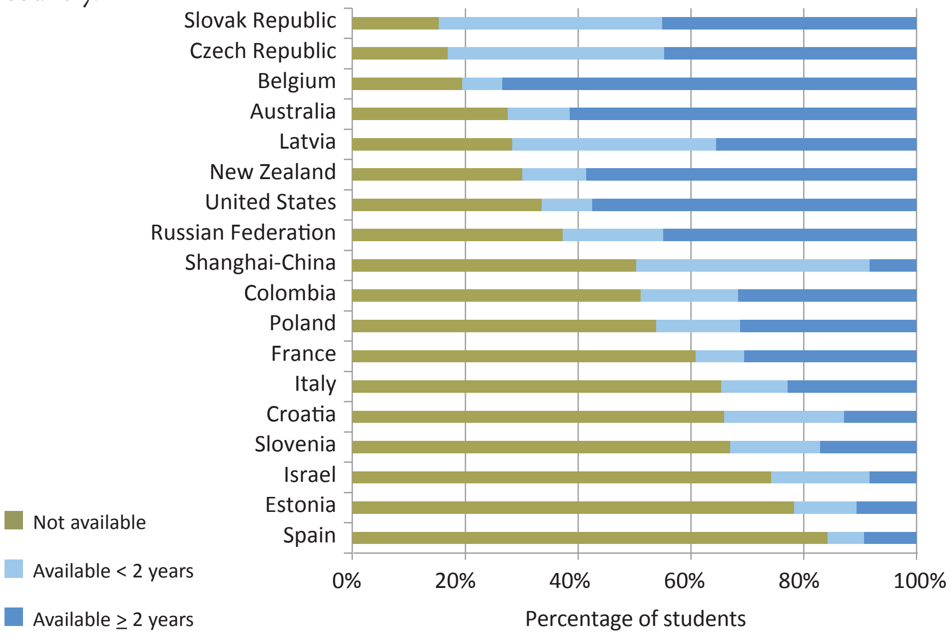


Figure 11.11 Question about the availability of financial education to students of the 9th grade: the distribution of school principals' questionnaire responses (OECD, 2014c, p. 40)

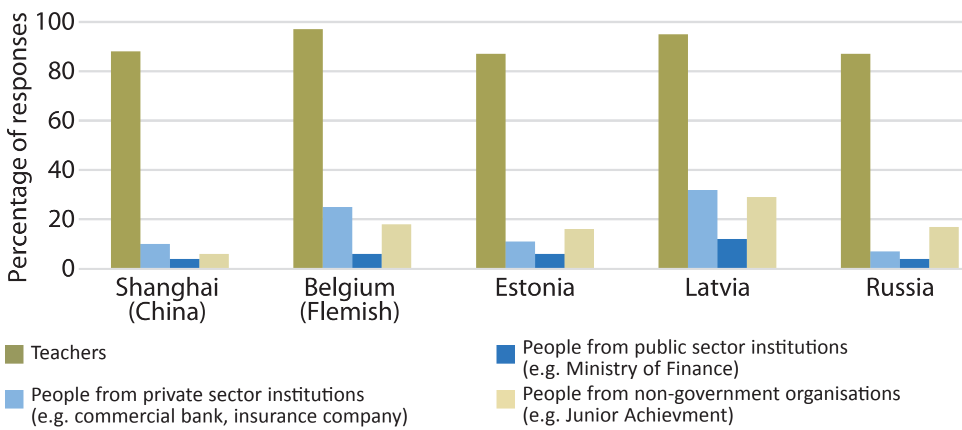


Figure 11.12 The question "Who provides financial education at your school?": the distribution of school principals' questionnaire responses

The students were asked whether they had learned somewhere how to deal with money, 38% of students responded that they had studied this as a separate subject, yet the performance of those students with regard to financial literacy was lower than shown by those who replied that they had not learned it. Also, those students who learned about money matters within any other subject, and those who had mastered the financial matters outside school, had a lower performance in comparison to those who had not studied. 19% of students asserted that they had not learned about money matters within any of the proposed options. It seems surprising that the performance of this particular student group in the financial test was quite high, although one should bear in mind that they also had had a high performance in mathematics and reading (an average of 573 points in the financial literacy, 513 points in reading and 518 points in mathematics), and a relatively high SES. These facts suggest that the financial module, which is contained by the study, at school is provided in an integrated (cross-curricular) manner. Informally acquired knowledge and skills (holding one's own bank account and debit card, discussing money matters and family budget with parents, joint planning of family holiday travel expenses, saving and spending habits, etc.) are also important in the financial sphere.

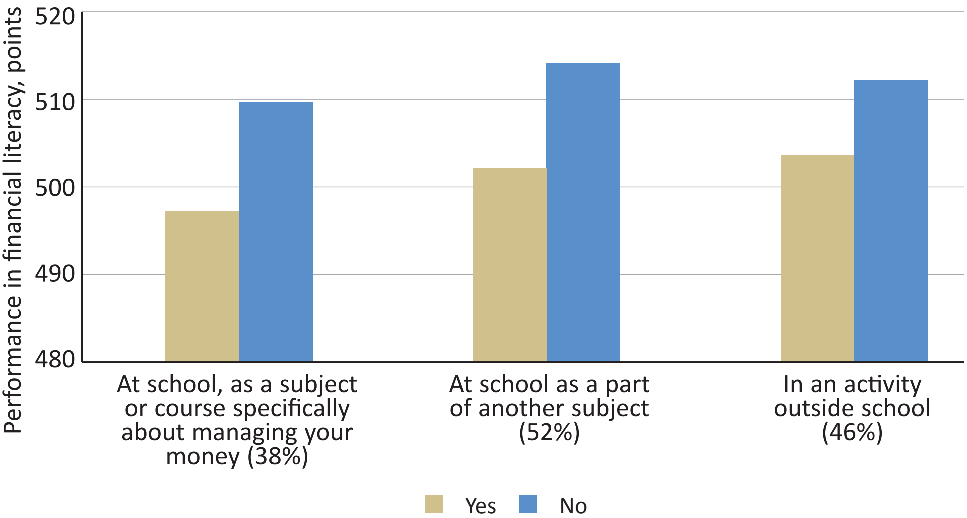


Figure 11.13 Responses to question "Have you sometime, somewhere learned, how to manage money?": distribution of average financial performance by Latvian students

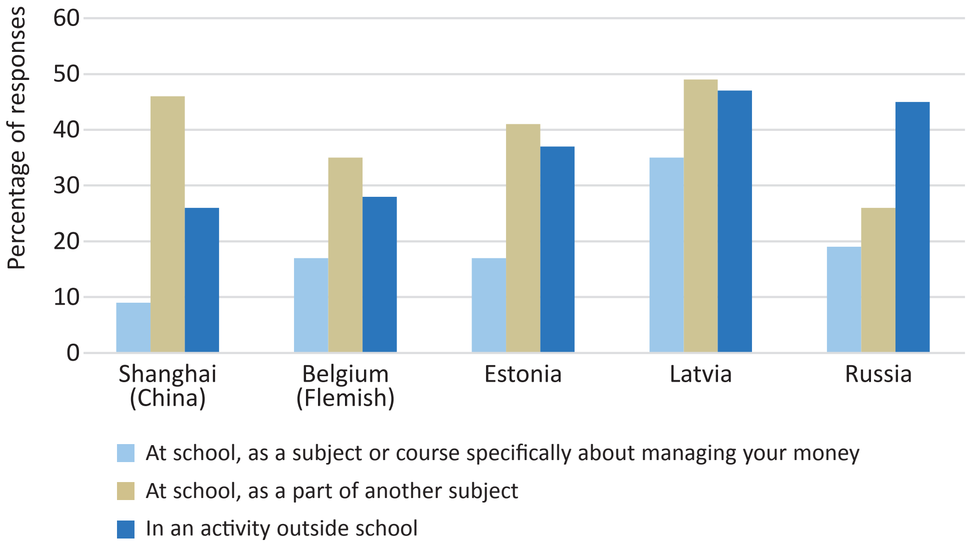


Figure 11.14 Questionnaire question "Have you ever, somewhere learned, how to manage money?": distribution of student responses

Compared with other countries, where student performance on average is higher than in Latvia, as seen in Figure 11.14, a lot more students in Latvia answer that they have learned about money matters. Part of the students in Shanghai (China), Belgium and Estonia respond that they have been studying money management as a subject or outside school at some event or project. All these facts suggest that in countries where students have higher performance, the public is more educated in finance, because students having no special subjects at school still are able to demonstrate knowledge, skills and take appropriate actions in solving financial problems, unlike the Latvian students who more often respond that they have studied money management at school.

Summary

In Latvia, the 15-year-old students' financial literacy in the OECD PISA 2012 was fully in line with the average level of students of the OECD countries, it was no different from the US and Polish students' performance.

There were relatively few students with low performance in the financial module in Latvia, but the relative number of excellent students in Latvia was lower than the average of OECD countries. Therefore, the task of our education system is to achieve an increase in the number of students with high performance.

The education system of Latvia shows better results than the average of OECD countries in terms of ability to provide equal educational opportunities for students from families with different socio-economic status.

The family influence on the students' performance is also reflected in the aspect that the discussion with the parents about money matters is related to higher performance.

The extent of financial education and its place in the basic school curriculum in Latvia is not clearly pronounced and defined.

The informal knowledge and skills (holding one's own bank account and pre-paid debit card, conversations with parents about money matters, family budget, joint planning of family holiday travel, money saving and spending habits, etc.) are also of a great importance in handling one's finances.

The distribution of items at OECD PISA 2012 financial module according to their context shows that 30 items are related to home, family and private situations (how should I manage my money), but only 10 tasks – to public life, education and work situations. This could be another cause of some uncertainty regarding the place of these topics in curricula. In any event, already a first insight into the Latvian social science subject in basic school teaching standard and sample program suggests that the personal finance topic is represented there in a much smaller proportion. Of course, as attested by the questionnaire of students, there are other subjects, where this knowledge can be mastered to a certain extent (perhaps, mathematics, home economics, etc.).

The integration of themes pertaining to the financial sphere in different subjects, development of appropriate training materials, methodological seminars for teachers, inclusion of these topics in basic and further education of teachers is a topical issue.

It is necessary to analyse and improve the training content and methods, to integrate financial themes in different subjects (social studies, mathematics, home economics, etc.), to develop appropriate training materials, organize methodical seminars for teachers, to a greater extent to include these topics in teachers' basic and further education, to involve the specialists from financial institutions and non-governmental organizations in the educational process.

It is important to help young people to understand the financial matters, because the younger generation is increasingly likely to face complex financial products and services. The contemporary students in their adult life will bear greater financial risks than their parents. Therefore, it is necessary to appropriately analyse and improve the school curricula and methods, as well as to involve specialists from financial institutions and non-governmental organizations in the process of education.

SUMMARY

A whole set of education quality evaluation activities are being developed and used globally to improve student learning and teaching, and to achieve the planned results. That includes student, teacher, school principal, school and education system assessment and evaluation. Student assessment, which is also implemented in international comparison globally since 1958 and in Latvia – since 1991, is one of the major education quality assessment activities.

All the developed countries, including Latvia, invest a great effort in improvement and development of their education systems. Therefore, it is necessary to systematically and effectively ensure the participation of Latvia in the global education quality evaluation and advancement processes, maintaining and developing the research potential at an international level in our country, and involvement in relevant OECD, EU and IEA research and education development programmes. Thus, a comprehensive, reliable and internationally comparable information and new knowledge about Latvian education system and its development trends is obtained. It can significantly contribute to development and adopting evidence-based decisions in education management and policy.

"Quality of Education: International Comparison. Latvia in OECD Programme for International Student Assessment", the 8th monograph in the series "Educational Research in Latvia", is dedicated to the analysis of the latest education quality indicators of Latvia and their contextual characteristics in international comparison on the basis of OECD PISA data, in the secondary analysis addressing relevant Latvian educational development issues.

The summary presents the main results of the analysis of Latvian student performance in mathematics, sciences, reading and financial literacy within international comparison, relation of our students' performance with students' socio-economic situation, education process at school (absences, use of ICT, student assessment results in school examinations, etc.), opportunities for increasing the relative number of students with high performance in Latvia. The problem of improving the possibility to obtain education of equally high quality in Latvia is contemplated in various

aspects by analysing the quality of education in urban and rural areas, different types of schools, depending on the gender of students, in small schools and classes, showing the necessity of the school network optimization

Student performance in mathematics, science and reading

For OECD countries in PISA 2012, the average student score in mathematics is 494 points with a standard deviation of 92 points. The highest average performers are the students of Shanghai (China) (613 points), followed by Singapore (573 points), Hong Kong (China) (561 points), Taiwan (China) (560 points) and Korea (554 points). From European countries, the highest performers are the students of Liechtenstein (535 points), Switzerland (531 points) and the Netherlands (523 points).

The mean score of Latvian students – 491 points – is not statistically significantly different from the OECD average, it is seen as a very good achievement of our education system. Latvian students' performance is on the same level as the average student performance in France, Great Britain, Iceland, Luxembourg, Norway, Portugal, Italy and Spain.

In comparison with the PISA 2003, PISA 2012 showed a decrease of the number of students in Latvia who did not reach the second proficiency level in mathematics, which is considered a basic level, where the students begin to demonstrate sufficient mathematical proficiency that allows to successfully apply mathematical knowledge and skills to achieve any objective and in the future to integrate into society and compete in the labour market. This decrease is statistically significant, and is the fifth largest among the European Union countries. By contrast, the perceantage of Latvian students who are able to solve items of the highest difficulty level in 2012 has remained at the level of 2003, and is one of the lowest among European Union countries (overall, 8% in proficiency level 5 and 6).

Invariably, among the countries of European Union the highest performers are the students of Finland and the Netherlands, the lowest – Greek, Bulgarian and Romanian students. Latvian student performance in 2012 has improved in comparison with the previous studies, reaching the average level of EU – the mean score of 492, surpassing countries like Sweden, Portugal, Luxembourg, Italy and Hungary.

PISA 2012 average student performance in science in various countries ranges from 580 to 373 points. The performance of Shanghai (China) students (580 points) is statistically significantly higher than that of students from all other participating countries. With a relatively high performance difference follows Hong Kong (China) (555 points), Singapore (551 points) and Japan (547 points). The highest performance from European countries is demonstrated by the students from Finland (545 points), Estonia (541 points) and Poland (526 points). Statistically significantly above the OECD average (501 points) is the performance of the students from Liechtenstein (525 points), Germany (524 points), the Netherlands (522 points), Ireland (522 points), Switzerland (515 points), Slovenia (514 points), Great Britain (514 points), the Czech Republic (508 points) and Belgium (505 points). Latvia (502 points) together with Austria (506 points), France (499 points), Denmark (498 points) and the USA (497 points) belongs to the group of five countries where the average performance does not statistically significantly differ from the OECD average student performance. Students of Peru, Indonesia, Qatar, Tunisia and Albania show a very low performance in science. The lowest performance among the European countries is achieved by the students from Albania and Montenegro. The students of Cyprus, Romania, Serbia and Bulgaria have a slightly better performance.

The average performance of Latvian students in science does not statistically significantly differ from the OECD average, and that can be perceived as a very good achievement of our education system. However, the comparison of proficiency groups shows that there are too few students in Latvia, whose literacy would correspond to the highest performance level (overall, 4.3% in the 5th and 6th level of proficiency), consequently, in this aspect our education system requires significant improvements.

The greatest increase in science literacy since 2006 PISA cycle is observed in Turkey, Qatar, Romania and Thailand, however, these countries still have a long way to go to reach the level of medium and high performance. Among the countries with relatively high performance a significant improvement has been noted in Poland (28 points), Italy (18 points), Korea (16 points), Japan (15 points) and also Latvia (13 points). A decline of performance is observed in European countries with a relatively high level of education – in Finland (-18 points), Hungary (-10 points), Sweden (-19 points), Slovakia (-17 points) and Iceland (-13 points). In 2006, the performance of Latvian students in science was lower than that of Swedish students, in 2009 – the same, but in 2012 – statistically significantly higher.

While looking at the average performance of students from European Union in science in 2006, 2009 and 2012, invariably the highest performance is shown by the students from Finland and Estonia, the lowest – by Greek, Bulgarian and Romanian students. The performance of Latvian students is on the increase, in 2012 it is already slightly (statistically insignificantly) above the EU average. Latvia has stepped up in ranking lists by three places and now outperforms France, Denmark, Hungary and Sweden, but not Austria.

In PISA 2012, the highest reading literacy performance is demonstrated by the students of East Asian countries – Shanghai (China) (570 points), Hong Kong (China) (545 points), Singapore (542 points), Japan (538 points), Korea (536 points) and Taiwan (China) (523 points). The highest performance in the European countries was shown by the students of Finland (524 points), Ireland (523 points), Poland (518 points) and Estonia (516 points). The average performance of Latvian students in reading (489 points) is slightly below the OECD average (496 points), however, this difference is statistically significant. The performance of our students does not statistically significantly differ from those of the Czech Republic (493 points), Italy (490 points), Austria (490 points), Hungary (488 points), Spain (488 points), Luxembourg (488 points), Portugal (488 points), Israel (486 points), Croatia (485 points) and Sweden (483 points). The performance of our students is higher than that of our neighbours – Lithuania (477 points) and Russia (475 points). The lowest performance in Europe was shown by the students of Bulgaria, Romania and Montenegro.

Similarly to mathematics and science, in 2012 the number of Latvian students at the highest – sixth level of reading proficiency was very low (0.3%). By comparison, one can look at the following example: if in a big school there are 1000 students, only three of them will demonstrate the performance of the highest level. If one class group (for example, all the 9th grades) in Latvia comprises 20 000 students, only 60 of them will have the performance of the highest level. This is much too little to provide the country with advanced doctors, scientists, politicians and entrepreneurs. However, it should be noted that the fifth level of proficiency also corresponds to the top level performers' group of OECD PISA, which in Latvia within PISA 2012 has been reached by 3.9% of the students in reading. Thus, there are altogether 4.2% of the students representing the 5th and 6th proficiency levels in Latvia.

The greatest increase in reading performance since 2000, excepting the countries with very low performance, was in Poland (39 points), Israel (34 points), Liechtenstein (33 points) and Latvia (31 points). In case of Israel and Latvia, the relatively low performance in 2000 should be noted. The greatest decline can be observed in the countries of Northern Europe – Sweden (-33 points), Iceland (-24 points) and the European leader in education – Finland (-22 points). Since 2009, the biggest performance increase was noted in Taiwan (China), Ireland, Macao (China), Thailand, Japan and Poland. The most significant performance decrease was in Iceland, Slovakia, Sweden and Finland. The international community comparatively early noted a decrease in Swedish students' average performance revealed by international comparative studies (not only PISA), however, insufficiently adequate attention yet has been paid to the fall in Finland's performance.

Overall, from 2006 to 2012 the average performance of the European Union students in reading has increased. The average performance of Latvian students has also been constantly increasing, yet in 2009 and 2012 only by two points (statistically insignificantly), falling behind the average performance of EU students (486 and 491 points, respectively). Over the past three years, Latvia has moved up one place in the ranking, surpassing Hungary, Portugal and Sweden, where the student performance has decreased. By contrast, Czech and Austrian student performance in 2009 was lower than that of Latvian students, but in 2012 – higher.

Latvian student performance in relation to different contextual factors

In long-term perspective – throughout the whole period since regaining of independence in 1991 – Latvian educational system has ensured a gradual increase in the quality of education, furthermore, the average quality increase is among the highest in comparison to other countries of the world. The level of education quality attained by our students places Latvia among 15–25% of the countries of the world with the highest quality of education.

The above conclusions are justified by the fact that we can assess the average education quality level in Latvia and its changes in international comparison over quite a long period of time, because Latvia was actively involving in international comparative education studies immediately after regaining its independence. International analysis shows that, as per Latvian results, not only in the OECD PISA since its first cycle – PISA 2000, but also in the cycles of TIMSS and PIRLS of IEA that were started earlier, the annual average increase of Latvian education quality in mathematics, science and reading is the greatest among 49 countries in the period from 1995 to 2009. We are followed by countries like Germany, Poland, Lithuania, Finland, Denmark, Hungary, USA, Russia, Austria, etc., while the most notable decrease in the level of quality is found in Sweden, followed by the Czech Republic, Norway, etc.

According to PISA 2012 and TIMSS 2011 data, the education quality level attained in Latvia corresponds to the 24th position among 76 countries. According to the OECD PISA cycle results, the education quality level in Latvia corresponds or is close to the average performance of OECD and EU countries (except the considerably lower results obtained in PISA 2000). Nevertheless, the results of Latvia according to IEA TIMSS and PIRLS data until 2007 (since subsequently Latvia temporarily ceased to participate in IEA studies, remaining only in OECD PISA) were significantly above the average level of the participating countries of the studies and with a growing trend.

The relative position of Latvia in countries' ranking in each of the OECD PISA cycle, taking into account the total number of participating countries, also has an overall tendency to rise. More and more new participating countries become involved in the research, but their education systems usually show the level of education quality that is lower than the OECD average, and thus also lower than the already achieved level of Latvia. Envisaging the continuation of this process and notionally composing a ranking chart containing the results demonstrated by students representing almost all the countries of the world, and the expected results in international comparative studies, we obtain the assessment that Latvia falls within the 15–25% of countries with the highest performance. Of course, all the countries of the world do not participate in international comparative assessment of education quality, therefore, we can have only an approximate idea of their possible quality of education.

Educational reforms have also been summarised and analysed internationally – implementation of student and school assessment and evaluation (centralized examinations, international comparative studies, accreditation, licensing, etc.), arrangement of the fundamental organizational and financial issues related to education system (development of school management and financing mechanisms, and to a certain extent – their decentralization, etc.), systematising the pedagogical foundations of the education system (curriculum reforms, education standards and study programmes, textbooks, etc.), that have formed the basis of increasing the quality of education in Latvia and other countries (for example, in Poland, Lithuania, Hong Kong (China) and Singapore), in certain periods of national education system development in these countries generally achieving a good level of education quality according to internationally established criteria.

According to PISA 2012, Latvia has one of the smallest student performance variation in mathematics in comparison to the OECD countries, practically, it is the same only in Estonia and even smaller in Mexico, even Finland shows a greater performance variation than Latvia. Latvia has demonstrated a relatively small student performance variation also in other PISA cycles and other content areas. Furthermore, there has been an increase in performance, and simultaneously a reduction of its performance variation, indicating that the quality of education in Latvia has increased while the disparity in equity of education quality has decreased. One component of performance variation – the between-school variance – in Latvia is two times smaller than the average in OECD.

Overall, it certainly positively characterizes the education system of Latvia, since it indicates that the high proficiency level of our students does not have as great a difference from the low proficiency level in comparison with the average difference in OECD countries – consequently, the education system provides a relatively greater equity of education quality throughout the education system of the country. This also means that the relative number of students in Latvia in the lowest and highest proficiency levels, which are defined according to OECD countries' average distribution, will be below the average in OECD, as the average student performance in Latvia is close to the average score of OECD, but performance variation is smaller.

Although the performance variation in Latvia is relatively smaller than in many OECD countries, it certainly exists, and depends upon a number of factors – regional, school, family, and individual student's level. Analysis of PISA 2012 results shows that the degree, to which the performance of Latvian fifteen-year old students in tests depend on the material welfare of the family, educational and cultural resources available at home, parental education and occupation (i.e., student SES), generally is consistent with the average level in OECD countries. However, in the last years the dependence of student performance on student SES in Latvia has slightly increased, as previously it was lower than the average in OECD countries. Consequently, the situation in the field of education equity in Latvia has somewhat deteriorated.

The average level of school's SES significantly influences student performance, when comparing various schools in Latvia and on the average in OECD countries. A more detailed analysis of school SES and average school performance shows that 21.3% of Latvian students attain a high level of performance studying in schools with a high level of SES. These are joined by additional 3.8% of the students who attend schools with a high performance but average level of SES. On the other hand, 9% of Latvian students study in schools with a low school SES and a low performance level. Increasing the student performance in these schools is certainly not just a matter of education system, but mainly a topic of regional development, if these schools are located in the area where SES generally is low, and perhaps it is partly a matter of student selection in these schools. 11.5% of students attend schools with a low performance level, but an average level of SES. In such schools, improvement of education should be the key factor in increasing the learning outcomes.

The international comparison of schools in respect to school performance levels and school SES is favourable to Latvia – in OECD countries, on the average, 18% of students learn in schools with a low SES and low performance level, and 20% attend schools with a high SES and high performance levels. In Latvia, the relative number of such students is 9.0% and 21.3%, respectively. Thus, the number of students from schools with a low performance level and a low SES in Latvia is relatively small in comparison to the OECD average. The smallest number of students from schools with a low SES and a low level of performance is in Finland – only 4%. Finland is followed by Norway (4.1%), Iceland (7.1%), Estonia (7.8%), Sweden (8.1%), Latvia (9.0%), Canada (9.5%) and Denmark (10.1%).

The average performance of fifteen-year olds in mathematics, science and reading in rural schools of Latvia still lags behind the performance level of the students of similar age group in the schools of Riga and other Latvian cities and towns. Difference in performance levels depending on urbanization does not significantly change over the period of time, it has been present in all studies, in all content areas and levels of education. The analysis shows that the difference in performance is not determined solely by objectively lower student SES in rural areas, but also by other factors.

Student SES in rural schools of Latvia is significantly lower than in Riga, the relative differences being much more pronounced than on the average in OECD countries, and these are considerably increasing. The relative number of rural students in Latvia is twice as large as on the average in OECD countries. Therefore, the role of regional development policy in providing support to rural development is very significant. Without development of the rural regions, the education system alone will not have a capacity to ensure equally qualitative education opportunities in the entire territory of the country.

At the same time, as the difference of performance levels in Riga and rural schools remains the same in a situation, when the relative differences of family SES between Riga and rural areas are visibly increasing, it is not a bad indicator regarding the rural schools. Besides, the achieved science literacy level in Latvian rural schools within PISA 2012 is close to the average level of students in Sweden and Russia (the entire countries), in reading – approaching Cyprus' level, and in mathematics – close to the level of Israel and Greece.

PISA 2012 in Latvia shows that the performance level of girls is higher than the performance level of boys in all content areas. In reading and science, this difference is statistically significant, but in mathematics it is statistically insignificant. In reading, the superiority of girls in Latvia in all PISA cycles since 2000 has been invariably high (it has been so also on the primary school education level, as shown by IEA PIRLS results in grade 4). The girls show a higher performance in science in all cycles, as well, although the performance difference in scores varies, and within the last cycles it has a tendency to increase. Until today, the performance difference in mathematics between our boys and girls has been statistically insignificant.

The average performance of Latvian students in all content areas and all PISA cycles does not significantly differ in schools that teach in Latvian language and schools where minority education programmes are implemented in Russian language.

The average performance of Latvian students differ in case of students who study in different types of education establishments. Gymnasium students have the highest performance, followed by secondary school students and then – by basic school students. An identical dependence of Latvian student performance on the type of education establishment is observed in all PISA cycles since 2000 and in other international studies.

For example, PISA 2012 results show that the performance of students from Riga gymnasiums in mathematics almost reaches 570 points, just behind the average achievements of Shanghai (China) and Singapore, thus relatively ranking the 3rd in international performance. The average performance in mathematics of students from all the other PISA 2012 participating countries is lower. However, it should be understood that we are comparing only the single best, but relatively small education segment of Latvia to the average indicators of other countries (although it should be noted that Shanghai also is only one of China's cities).

We know that there is a student selection, often using entrance examinations, in gymnasiums, students do prepare beforehand (with private tutors and through enhanced lessons in extracurricular groups, etc.) in order to study in gymnasiums. The gymnasiums have a quite high student SES, the atmosphere strongly promotes focussing on excellent study performance, etc. At the same time, it clearly demonstrates that very high results like these are quite achievable in Latvia. However, in Latvian basic schools the student performance level is much lower, for example, in mathematics PISA 2012 reveal that they score between 480 and 455 points (depending on the location of the school), which is below the OECD average. Then again, it is the same range of average performance level in mathematics as achieved by the students of USA, Lithuania, Sweden, Hungary and Greece.

To contribute to the equity of education quality, one should pay attention also to the lower performance levels of Latvian students in basic schools in comparison to secondary schools, besides, this phenomenon is most pronounced in Riga, slightly less in other cities and rural areas of the country, but it is almost absent in the towns. Possibly, it is influenced by a certain selection of students, which, in turn, is related, among other factors, also to SES.

Comparing the performance levels in different types of schools, the data characterising student SES in different types of schools in Latvia should definitely be taken into account. Gymnasiums, particularly the state gymnasiums, have a very high level of SES. They are followed by secondary schools and basic schools, where this index is the lowest. Consequently, the variations in performance levels in different types of schools to a certain extent can be explained also by the different SES, which, in turn, depends on the location of the school, the student selection process, as well as other factors.

The questionnaire of school principals in Latvia reflects that their resource management activities (responsibility of planning and spending the school budget, selection and recruitment of teachers, setting the initial salaries and bonuses for teachers) is significantly more autonomous as in OECD countries on the average. On the other hand, regarding curriculum and assessment management (choice of textbooks, study subjects and their content, choice of student assessment methods) the level of autonomy in Latvia is lower than on the average in OECD countries. The relative level of school autonomy in Latvia has a tendency to grow.

The principals of Riga schools see less autonomy in their activities with regard to resource, curriculum and assessment management in comparison to their colleagues in other Latvian schools. On the other hand, student – teacher relationship, discipline, provision with study materials and teachers, extracurricular activities are evaluated by school principals as equally good both in the city schools and rural schools of Latvia. Rural schools on average are smaller, they have less students per teacher and there are less students in the classrooms.

Competitiveness among schools with regard to attracting students from the same area is higher in Latvia than on the average in OECD countries, and it has definitely increased due to the reduced number of students. 74% of school principals think that the school is competing with two or more schools in attracting the students, 19.5% – with one school and only 6.5% state that they do not have a competition with other schools. Besides, only 20.5% of school principals think that living in the school area "always" equals to admission of the student, 79.5% of the school principals have replied "sometimes" or "never". The comparatively free choice of schools in Latvia foster the impact of family SES on the choice of school, the relative number of schools that are chosen by most socio-economically favourable families is rapidly decreasing (since 2006, the relative number of schools in Latvia that are being chosen by families with a very high SES has decreased from 75–77 % to 55%).

There is a pronounced correlation in Latvia that higher performance in international studies is demonstrated by schools and classes with a bigger number of students. However, it should be noted that correlation between two variables does not signify a direct causal link. The situation is considerably influenced by other factors, for example, student SES, location of the school, student selection procedures (if such exist), striving for improved learning performance in school and in classroom, etc. As a result, the possible pedagogical advantages in small schools and classes in Latvia to be gained because of small number of students still cannot compensate for other negative factors, and student performance there, on the average, is lower (also after accounting for student SES).

The dramatic decrease of student numbers in Latvia calls for an optimization of school network. The number of 15-year old students in Latvia's education establishments in the period from 2003 to 2012 has decreased by 50.5%. This is the greatest decline among PISA participating countries. The number of students from general education day schools in Latvia has decreased by 42% since 1998, and the number of teachers and schools – by 25%. The relation between the numbers of students and teachers within this period has decreased from 11.7 to 8.9. The authors do not consider that the reduction in numbers of schools and teachers has to be relatively as big as the decrease in student number, however, a large disproportion instigates problems.

The greater school management autonomy in smaller municipalities could be a hindering factor for school optimization there. School principals and individual teachers quite often also are elected officials in these municipalities and they can possibly have a crucial vote in municipal decisions with regard to the field of education in the interests of their schools. As a result, school principals fight for retaining their own schools at any cost, and the local municipalities support them.

Undoubtedly, the issue of school network reform is closely linked to the state administrative and territorial division, possible changes thereof (continuation of the reform) and the regional development policy of the state in general. It is very complicated to ensure efficient education in regions that are not being developed. Likewise, regions cannot properly develop without schools. Thus, this is a matter of intersectoral policy and it can be solved more efficiently, if municipalities choose to cooperate.

If there is a clarity on state administrative territorial division and regional development, then it is possible to systematically implement the goal set in the current government's declaration of 2014: "We shall establish a strategic development model of school network, which will ensure a quality education for students of the first six grades as close as possible to students' homes, while preserving the rural schools of Latvia as important local community centres. Secondary education will be concentrated in schools with a well-developed pedagogical resources, as well as material and technical facilities." The declaration exactly corresponds to the recommendations the researchers have been publishing since 2000, based on the data of international comparative education studies implemented in Latvia in 1990s and later. Thus, essentially, one of the proposals arising from the results of all the current international comparative studies is the necessity to optimize school network in Latvia and to ensure the equity of education quality throughout the state.

Student performance is improved both by their positive interaction with the teacher (student feels the teacher's interest in each student's performance, the teacher provides additional assistance when necessary, and explains the topic until the students have understood it, teacher gives students an opportunity to express their opinion) and the discipline in the classroom (lack of noise and disorder, students listen to the teacher, they are not late arriving to school or do not skip the entire school days), as well as student interest in the respective study subject (i.e., mathematics). This was confirmed by performance analysis of students with a high SES in relation with various contextual factors in nine Baltic Sea Region states, using PISA 2012 data.

Overall, the analysis of truancy and disciplinary problems in classroom, using PISA 2012 student questionnaire data, showed that our students have a relatively quite high truancy level. Skipped days in schools of Latvia are related to essential weakening of performance level, a less pronounced correlation was established between the decrease in performance and arriving late for school. However, skipped classes in case of Latvian students in comparison to the OECD average, as well as Baltic Sea Region states, was related to a small decrease in performance level, thus raising considerations about significance of that particular lesson and its added value.

The truancy trends of Latvian students were not statistically significantly different in schools with different study languages, urban and rural schools, basic schools, secondary schools and gymnasiums. Both girls and boys have similar truancy habits. The schools with a better disciplinary climate index have a lower intensity of truancy. Latvian students from the families with a higher SES, on the whole, are less prone to truancy than the students from families with a low SES.

Undoubtedly, the role of ICT is very important in all the areas of the contemporary life. However, the obtained results here in a way counter our expectations and hopes. OECD PISA participant performance analysis demonstrated that the highest average performance in all content areas was shown by the group of students, who indicated that in the respective study subject the computers were not used at all during the lessons within a week at school. On the other hand, with increasing of computer use time, the average performance of students in all content areas deteriorated. Not to deny the growing role of ICT in study process, the obtained research results signal that meaningful ICT use in Latvian general education schools should be viewed as insufficient, as it is still impossible to identify the added value obtained through the use of ICT in the study process.

Students with a higher performance more often use Internet to search for the information about further career options, secondary school, college and university study programmes, as well as try to establish their interests and skills. Unfortunately, among these there are rather few rural basic school students (14%). Students' interest in future career can serve as a motivating factor for higher study performance, therefore career education has a particular role at schools. PISA data analysis demonstrates that students from families with a lower SES have mastered the skills related to future careers more at school than outside it. Consequently, schools have the possibilities as well as obligation to motivate students from less well-off families to choose to continue their education and think purposefully about their future career.

The above-mentioned results of analysis have contributed to the following recommendations:

- to continue increasing the overall quality of education in Latvia (student proficiency in mathematics, science and reading), enhancing the work with gifted students and simultaneously focusing on the less advanced ones. It will result in raising the average performance level, the relative number of top performing students will increase and the number of students showing a low performance will decrease;
- to define the situation and look for ways to help students from families with a lower SES to achieve a higher performance, and particularly to assist schools with a relatively great number of these students. In this respect, a particular attention should be paid to the group of schools with low overall SES and

low performance (approximately one tenth of 15-year old students study in this group of schools), although this is the matter of regional development as much as that of education;

- to optimize school network in Latvia and develop state regions, ensuring the high equity of education quality throughout the country (in cities and rural areas, basic schools and secondary schools). In this process, the students from the first six grades must be ensured with education of a good quality as close as possible to their homes, concentrating the secondary education in schools with teachers of a high professional level and well-developed infrastructure by improving the school network, schools should be merged or closed, secondary schools should be transformed into basic schools, basic schools – into primary schools, etc. The education quality factor should definitely be taken into account during optimization, not basing the decisions only, for example, on infrastructure costs. As the resource economy through optimization of infrastructure appears, the funds must be directed towards improvement of education process and professional growth of teachers. Appropriate methods must be chosen for comparing the education quality levels of individual schools – centralized exams, international comparative studies of education, specialised quality monitoring activities – in order to determine both the level of student performance and, as much as possible, its growth, while taking into account SES of student families and overall SES of the school;
- to change the attitude toward truancy, which in Latvia is not usually considered as something out of the ordinary. On the state and municipal levels to meticulously comply with all the requirements established by the legislation with regard to absence recording, monitoring and reporting, to revise the registration system of truancy cases, to set a procedure of cooperation between schools and parents with regard to absences, to improve the definition of actions to be implemented in case of truancy, depending on its type and scale;
- to carry out extensive scientific and methodological work to study the opportunities for ICT use during lessons at school to achieve a positive impact of ICT integration on student performance. It is required that ICT industry supports this work;
- to focus the work of teachers on creating a positive cooperation with students, a good disciplinary climate, to provide strong support for students during their learning. All stakeholders – parents, teachers, intellectuals, mass media – should try to increase the students' motivation to learn;
- to reduce disparity between genders in reading literacy:
  - to use as many diverse study methodologies during study process as possible to ensure that different student groups would benefit as much as

possible during the study process and to meet the interests and needs of different students;

- to provide speech therapist free of charge to all the students at pre-school and basic school levels;
- to create a school environment where students would not abuse each other neither verbally, nor physically;
- to preserve the mandatory pre-school education and to ensure the required number of places in pre-schools for all age groups.

Latvian students with a high level of performance

The proportion of top-performing students in mathematics, science and reading in Latvia in all PISA cycles is lower than on the average in OECD countries. PISA 2012 results show a very small tendency to increase in comparison with PISA 2009, however, the relative number of such students in Latvia has not statistically significantly changed in any cycle and content area. In comparison to the neighbouring countries, we are behind Estonia, in Lithuania and Russia the proportion of such students is similar to our country. The number of girls in the top-performing group in Latvia is higher particularly in reading, in the last PISA cycles this difference is increasing. In mathematics, in the last cycles the number of boys in the top-performing group is slightly greater than that of girls. On the other hand, in the area of science the number of boys and girls in the top-performing group is nearly the same. A particular attention should be devoted to rural schools, especially basic schools, since they show the poorest results with regard to achieving top-performance.

The strategic state development and education policy documents of Latvia envisages an increase in the number of students achieving high performance and that undoubtedly is crucial for successful development of our country, therefore, the secondary analysis using the data of PISA cycles aims to define the factors that could contribute to increasing the number of such students in Latvia. It resulted in identification of general factors, like higher parental education level, which is positively related to a higher student performance in all the content areas, as well as a number of factors specific to each content area.

Accordingly, by constantly increasing the level of education among the public and particularly young families in Latvia, we can expect a rise in student performance. In this respect, our country has good prospects, as the relative number of inhabitants who have obtained higher education in Latvia is rapidly increasing, for example, our country belongs to those EU countries that have already exceeded the EU indicator for 2020 – 40% of young people in the age group from 30 to 34 have obtained a higher education. The forecast provided in OECD Education at a Glance (2014) testifies that almost 85% of young people in Latvia will start studies in tertiary education during their lifetime, and this is the second greatest indicator value after Australia (the average indicator of OECD countries is close to 60%).

A positive impact on high student performance in mathematics is achieved, if the students experience adequate anxiety when responsibly solving mathematical tasks, at the same time overcoming the excessive anxiety and insecurity in this subject. Additionally, the performance is positively influenced also if the students often solve the so-called formal mathematics tasks. Thereby, they learn how to act upon instructions and develop algorithmic thinking, which, in turn, also helps to achieve a higher performance in other areas, for example, reading. The frequent use of computers does not improve students' results in mathematics, while a positive student opinion regarding the use of computer and Internet information for the purposes of learning and solving school exercises is related to a higher performance in mathematics.

To improve student reading literacy, a positive attitude towards reading must be promoted, students should be encouraged to read for their own pleasure, not only the mandatory literature at school, including electronic texts. Particular attention should be devoted to literature intended to boys in all age groups. A more correct learning strategy should be shaped for the students in order to understand and remember texts or write text summary.

High achievements in science are promoted by a number of specific factors, such as students being well-informed about environmental issues, confidence and satisfaction with their performance in science, positive attitude towards the role of science in people's lives and in development of society, and the possibility of building their careers in the field of science.

PISA data analysis and study of foreign experience allows to offer a number of recommendations to education policy makers, school principals, teachers, parents and students.

Recommendations to education policy makers:

- create exact and detailed education policy with respect to gifted students;
- devote more attention to education of teachers, their qualification and work quality;
- improve public opinion regarding education by creating respectable, intelligent and positive image of the teacher. If the teachers will be the best of the best and if they will respect their own work, then the others will also respect them;
- ensure a higher state financial support to implementation of education process both in general education and higher education, as well as further education – teacher salaries, state-funded study places, grants and scholarships;

- devote more attention to higher education and lifelong learning, since the learning process should not stop, it must continue throughout lifetime;
- create a student assessment procedure, which, in parallel to assessment with a mark, would provide a descriptive evaluation of student's progress as well as assessment of behaviour.

Recommendations to school principals:
- recruit only the best candidates as teachers;
- give teachers the maximum allowed autonomy in developing the study programme;
- ensure student-friendly environment at school;
- organize student-development related interviews with participation of student's parents. The aim of the interviews: to promote student's development instead of reprimand;
- organize various events related to environmental issues and involve the school thereof;
- build a closer cooperation with libraries, participate in their events, as well as proactively organise different activities related to reading, paying a special attention to youth attendees.

Recommendations to teachers:
- develop your own study programmes according to education standard and based on the needs and skills of the particular class and students;
- encourage student motivation to learn, read and educate themselves;
- regularly involve students in self-evaluation;
- raise your qualifications, attend courses, seminars or increase the level of education by enrolling into higher study levels at the university.

Recommendations to parents:
- choose a school that is close to home and adapted to child's physical, intellectual and emotional needs;
- set an example that education matters, that education does not end with obtaining a diploma and continues throughout one's lifetime, and that the main benefit from the education is knowledge and competencies;
- never speak disparagingly about a teacher in the presence of a child, even when parents disagree with teacher's opinion. It will help to maintain the status of the teacher and child's respect to him or her. Never let students speak bad about the teacher, instead teach them how to defend their opinion by maintaining a calm and respectful attitude;

- become actively involved in events organized by the school, thus demonstrating to children that school and the things happening in it do matter to parents. Support teachers to help your child to achieve a better performance, show the interest about events at the school – not only in problem situations but also in everyday life;
- devote a particular attention to reading in family by reading yourself and encouraging children to read, by choosing relevant and interesting literature together with children. Concentrate particularly on the boys' reading habits;
- do not punish children for failure, rather support and help to overcome errors;
- control the time the children spend with computer, tablet or smart phone, using Internet for leisure, playing games or watching films. Make sure that children go to bed early and have done their homework;
- together as a family participate in different events related to environment protection – sorting waste, taking care of environment, reducing water and electricity consumption by participating in "Earth Hour", etc.

Recommendations to students:

- as much as possible participate in the events organised by the school. Try to do your best, giving the maximum of your capacity to complete the task as well as possible;
- in case of failure do not give up, rather study more efficiently, ask help from teachers, parents and fellow students who are more advanced in the subject;
- try to understand your own interests and choose appropriate literature by visiting school and municipal libraries. Each day read at least a page of a book which is not a textbook;
- limit the use of computer for leisure, first of all complete your homework and then think about the entertainment, not forgetting the sleep;
- together with family and school actively participate in environment protection events;
- try to understand the real meaning of education, – the main benefit is knowledge and competencies, and not the assessment or mark. Knowledge and competencies is the only thing that nobody can take away and which we can supplement throughout our lifetime both in formal and informal ways.

Analyses of Latvia's mathematics curriculum and student assessment in comparison with PISA results

The researchers in Latvia have carried out a specialised analysis to determine the correspondence of mathematics curriculum and PISA items, and furthermore, this compatibility is always established in the structure of the study itself – commencing another PISA cycle, all participating countries evaluate suitability of the new items to the students of respective country, taking into account the content and context of each item. In Latvia, the skills and knowledge required for solving PISA mathematics items generally correspond to Regulations on the State Standard in Basic Education and on Basic Education Study Subjects' Standards.

Comparing student performance in mathematic link items in both PISA study cycles with mathematics as the main content area – PISA 2003 and PISA 2012, it was established that the results differ only in some items. In 2012, Latvian students were better at solving the items involving numbers and measurements, but less successful concerning the items involving shapes and spatial reasoning. The items concerning space and shape (geometry) have traditionally been the field in which Latvian students have shown the highest performance, however, decreasing performance in mathematic link items may indicate negative trends in teaching geometry at school.

In comparison to the OECD countries' average results, Latvian students have been statistically significantly better at solving 12, but less successful – at solving 27 out of 109 mathematics items included in PISA 2012. In the remaining 70 items the results of Latvian students correspond to the average level achieved by the students of OECD countries. Students in Latvia have a greater difficulty with open-constructed response items requiring logical justification of the judgments and making conclusions, to transform formulas or use the respective formulas in a specific situation. Among the best-solved items there are less open-constructed response items, and these items do not require transformation of formulas. According to the mathematics content area, in comparison with the students from OECD countries, Latvian students faced the greatest difficulties with the items involving probability and statistics. These items also involve the interpretation of data in tables and content of diagrams, which still proves to be complicated for our students, even though these themes are included in the State Standard in Basic Education. Latvian students also faced problems with items involving numbers and measurements. Although students can use calculators in solving PISA items, numerical calculations, proportions and percentages present difficulties to our students.

The basic education study results in Latvia are evaluated both according to student's final assessment (the average mark calculated from the results throughout the final year) upon graduating from the 9th grade and the examination results graduating the 9th grade. The examination in mathematics at the end of the 9th grade mainly tests students' knowledge and skills, and their application in standard tasks of mathematics. Tasks, where mathematical knowledge and skills should be applied to real-life situations make up 20–29% of the total number of examination tasks. By contrast, in OECD PISA a much greater part of items is dedicated to the use of mathematics in real-life situations. Between the mathematics examination results achieved by the 9th grade students and PISA 2012 score there is a statistically significant correlation (correlation coefficient is 0.656). However, the distribution of students' performance according to yearly mark in mathematics at the end of the 9th school year, the examination at the conclusion of the 9th school year, and PISA 2012 differs – only PISA 2012 performance distribution is close to normal. The most commonly received evaluation at the end of the 9th grade is 4 (the lowest passing mark), in the examination – 5 and 6.

Comparing the performance distribution according to school types, it can be concluded that PISA 2012 performance distribution is close to normal in basic and secondary schools, gymnasiums and state gymnasiums. Thus, it can be affirmed that the items of PISA mathematics test were appropriate for Latvian students, regardless of the school in which they were studying. The 9th grade examination assessment distribution is close to normal in case of secondary school and gymnasium students. Examination tasks were easy for state gymnasium students, but more difficult for basic school students. Distribution of performance in examination and at the end of the school year casts doubts on the objectivity of assessment.

Upon comparing PISA 2012 and the examination performance distribution (in marks according to ten-point scale), it is evident that among the students who have received a relatively low mark in the examination (4, 5 and 6), there are the students who have reached both high and low results in PISA. By contrast, virtually in all PISA mathematics proficiency levels there are students who have received the highest mark in the examination. A high mark in examination in combination with a low evaluation in PISA test could be attained by the students who to a certain extent have mastered the school curriculum well, but are unable to apply this knowledge in real-life everyday situations.

OECD PISA student knowledge and skills are considered to be sufficient for successful continuation of education, if a student's performance corresponds to at least the second proficiency level. Only 17% of the students whose performance in PISA 2012 is lower than the proficiency level 2, have obtained unsatisfactory mark (lower than 4) in examination, all the other students who have showed a low performance in PISA test, received passing marks in the examination – most often they received 4 (almost satisfactory), 5 (satisfactory) and 6 (almost good).

Students with a higher SES show better results in examination and PISA. In comparison, SES influence on examination results is less pronounced. Student performance in examination and in PISA 2012 is most closely related to occupation of student's parents. The more prestigious is the profession of student's parents, the higher achievement is shown by the student both in examination and PISA 2012. A higher performance in PISA 2012 is demonstrated by those students, who have more household items as well as education and culture-related items at home. Examination score is less influenced by these factors.

In order to analyse the further achievement of PISA participants, upon graduating from the secondary school, researchers selected the students, who participated in PISA 2009, and took the centralized examination in mathematics in 2012, upon finishing the 12th grade – a total of 1,410 students or 31% of PISA 2009 participants. Between the performance of these students in mathematics in PISA 2009 and in the centralized examination in 2012 there is a statistically significant positive correlation (correlation coefficient 0.561). Both students with a high performance in PISA 2009 and those with a very low performance – from 240 to 725 points continued their studies in the secondary school. Students who had reached the highest proficiency levels (5 and 6) in mathematics in PISA 2009, obtained a high assessment also in the centralized examination at the end of 12th grade (90% of these students achieved A, B and C level).

The correlation between performance of all PISA 2009 participants in mathematics and their SES is 0.355. In case of those PISA 2009 participants who in 2012 took the centralized examination in mathematics, this correlation is weaker – the correlation coefficient is 0.109, although it is statistically significant. SES impact on the level of secondary education is weaker because secondary school and gymnasium students have a higher SES and it is less diverse. Those PISA 2009 basic school students, who continued to study in secondary school, have the average SES of 0.014, while all PISA 2009 participants who attended basic school, have the average SES of -0.429. Consequently, the education in secondary schools or gymnasiums is continued by those students of basic schools (and basic schools mainly are rural schools), whose socio-economic status is higher.

Student performance in both PISA 2009 and centralized mathematics examination in 2012 is closely related to students' further education plans after graduating from basic school. Students who responded in PISA 2009 that they are planning to obtain a higher professional education or a bachelor's or master's degree, showed a higher performance.

On the level of school, one can also observe a statistically significant correlation between the student performance in mathematics in PISA 2009 and in centralized examination in 2012 (correlation coefficient 0.502), as well as between the student performance in mathematics in PISA 2012 and the centralized examination in 2015 (correlation coefficient 0.528). Thus, in secondary schools and gymnasiums, where students show high performance in PISA tests, good results can also be expected in centralized examinations at the graduation from the 12th grade.

The following recommendations have been developed as a result of the analysis.

Education policy-makers should transform the 9th grade mathematics examination into a centralised examination, where examination papers are also marked in centralised manner on the level of state, as this would ensure a more objective comparison of education quality provided by different schools. It is necessary to prepare an adequate analysis and reviews to be submitted to the local municipality leaders of the 12th grade compulsory centralized examination results, that would provide municipalities with a better understanding of the education quality achieved by schools (comparable indicators, relative quality level of each secondary school in relation to other schools and its changes over the years, the number of students, etc.).

Mathematics teachers should concentrate a particular attention to the tasks representing probability, statistics and geometry spheres, interpretation of data tables and content of diagrams, formula transformations, proportion and percentage calculations.

Organizers of teachers' further education and methodological associations of mathematics teachers should include in their operational programmes the topics referred to in the recommendations above.

Student performance in financial literacy

The fifteen-year old Latvian students' financial literacy in OECD PISA 2012 (50 score points) fully corresponds to the average level of students from OECD countries. The performance of Latvian students does not statistically significantly differ from Polish (510 points) and USA student performance (492 points). Estonian student performance (529 points) is higher than the average score of OECD countries, Russia's (486 points) – lower. The relationship of Latvian student performance and SES index, as it changes by a unit, is lower than the OECD average, and performance standard deviation in case of Latvia is the smallest of all 18 countries participating in PISA financial literacy module. The smallest performance variation in Latvia suggests more equity in education quality in our country, and, at the same time, it influences the relative number of students with low and high performance. In comparison to the average values of OECD countries, Latvia has relatively less students with a low performance and, unfortunately, that is also the case with the high achievements.

Of course, significant specifics of financial sector also emerge in the analysis of various contextual factors. The volume and place of financial education in basic school curriculum in Latvia is not sufficiently expressed and defined, an important role in performance of students in the field of finance is played by knowledge and skills obtained informally, for example, using the bank account and debit card, conversations with parents about money issues, family budget, joint planning of family recreational travel expenses, saving and spending habits of their own.

The structure and respective items included in OECD PISA 2012 financial literacy module are also incorporated in the curriculum of other countries participating in the research, although in a less regular and consistent manner than, for example, in mathematics. This is demonstrated by the surveys of school principals, as well as students. To the question regarding availability of financial education in basic schools a negative response was given even by 84% of school principals in Spain, the least often the answer "financial education is not available" was provided in Slovakia (16%). Even in the countries with a high student performance there is a great relative number of school principals who believe that the financial education in basic schools is not available – Estonia 78%, Shanghai (China) 51%, in Latvia it is an opinion expressed by 28% of school principals.

Not more than 40–50% of the students confirm that they have learned how to manage money at school, or in various events and projects outside the school. There are even fewer affirmative answers to the question, whether students have learned it in a special school subject or classes dedicated to management of one's own finances. 19% of Latvian students claim that they have not learned how to manage money in any of the ways listed above. It is surprising that these are exactly the students who show a high performance in the financial test (573 points), second only to the average performance of students from Shanghai (China). However, it should be noted that these students have a good performance in mathematics (518 points), reading (513 points), and they have a relatively high SES.

Consequently, we can conclude that the overall student performance in the finance test has no relation to the amount of financial education at school. In our opinion, these facts testify that the nature of the financial field in the school curriculum is integrated, i.e., cross-subject. In the financial sphere, the knowledge and skills obtained informally are also of a great importance. Perhaps these results reflect the change in the teaching and learning in the modern world – in many cases, specific knowledge and skills can be acquired outside the school, through information and communication technologies, informally, however, that requires a high level of key competencies, for example, in mathematics, reading comprehension, critical thinking, etc.

Therefore, we recommend to develop the key competencies of students, to analyse and improve curriculum as well as teaching and learning methods, integrate financial themes in different school subjects (social studies, mathematics, home economics, etc.), to develop appropriate training materials, to organize teachers' methodological seminars, to a greater extent to include the respective topics in teacher training and professional development, to involve experts from financial institutions and non-governmental organisations in educational process.

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