How did Estonia achieve first place in PISA and why has Finland fallen behind?

- Eight key questions that require urgent answers

Edited by: *Juuso Luomala*
2022

Published by: *Finnish Energy (ET); Chemical Industry Federation of Finland; Union of Professional Engineers; Union of Professionals in Natural, Environmental and Forestry Sciences (Loimu); and Academic Engineers and Architects in Finland (TEK)*
2022

Graphic design: *Julkaisumonistamo Eteläranta Oy*

Contents

1 Foreword

Finland has always been among the leading countries in skills and competence, and Finland's Programme for International Student Assessment (PISA) scores have been a cause of pride. However, the decrease in Finnish students' PISA scores has raised concerns in recent years. The skills and competence of Finnish students aged 15 have decreased since 2006. Science skills and competence have especially been in a steady statistically significant decline from one assessment year to the next. Furthermore, one in every ten young people who have completed basic education cannot do mathematics, read or write at a sufficient level. In learning results, Finland has dropped from the top, and its decline is expected to continue.

While Finland's PISA scores are falling, Estonia has steadily climbed to first place in Europe and also to the top positions globally. In the previous PISA survey conducted in 2018, Estonian students already outperformed Finnish students in all areas.

The goal set in the Prime Minister Sanna Marin's Government Programme is to make Finland climate neutral by 2035 and the first fossil-free welfare state (Finnish Government 2019). Several industrial sectors, towns and cities, as well as organisations, have joined Finland's climate neutrality goal. For example, the Chemical Industry Federation of Finland has announced that its goal is to have a climate neutral chemical industry in Finland by 2045 (Chemical Industry Federation of Finland 2019). The energy sector also supports the Government's goal to become climate neutral as early as in the 2030s. The development path of the energy sector's roadmap, updated in 2021, shows that emissions are decreasing more steeply than expected and the achievement of the climate neutrality goal is closer than before (Finnish Energy (ET) 2020). As a result of the current energy crisis, Finland has only aimed to accelerate the green transition.

On a global scale, Finland has the opportunity to be a pioneer larger than its actual size in terms of climate neutrality goals, but this is estimated to require top skills and competence in science, mathematics and technology. Finland's competitiveness in skills and competence must also be guaranteed in the future when the competition

over skilled professionals becomes fiercer in Europe as a whole. It is simply necessary to increase Finnish people's skills and competence carbonin science and mathematics.

Even though Estonia's success in the PISA survey has also attracted interest in Finland in recent years, its underlying reasons have not been so far studied or investigated extensively. This is a societally important theme in various ways, and it is even more topical because the Ministry of Education and Culture is currently preparing an action plan for Finland's mathematics, science and technology strategy, extending to 2030.

The aim of this report is to summarise the opinions of various specialists, already expressed before, that may be linked to Estonia's success story, especially to the development of knowledge and skills in science and mathematics and also to the downward trend in Finnish students' knowledge and skills. Unfortunately, this report cannot offer any ready-made answers, but it sheds light on the background of the development of PISA scores in Finland and Estonia, describes the potential consequences of the decrease in knowledge and skills in Finland, and asks eight key questions for which answers should especially be sought in the future. This report sums up perspectives from various sources, in addition to which three Estonian specialists were interviewed in person or in writing: Gunda Tire, PISA National Project Manager, Estonian Education and Youth Board; Liisa Ojaveer, Adviser for EU and international cooperation, Estonian Ministry of Education and Research; and Hallar Meybaum, Executive Director, Estonian Chemical Industry Association.

This report was commissioned by Finnish Energy (ET), the Union of Professional Engineers, the Chemical Industry Federation of Finland, the Union of Professionals in Natural, Environmental and Forestry Sciences (Loimu), and Academic Engineers and Architects in Finland (TEK). This report was funded through aid granted by the foundation of the Confederation of Finnish Industry and Employers (TT).

2 PISA scores of Finland and Estonia

2.1 PISA

The Programme for International Student Assessment (PISA) is a joint research programme of the member countries of the Organisation for Economic Co-operation and Development (OECD). It produces information not only about the state and results of education for comparison in an international frame of reference, but also about factors affecting learning outside the education system. PISA assesses key skills for the future in students aged 15, the factors that affect these skills, and any changes in knowledge and skills. PISA focuses on reading, mathematics and science. PISA assesses the knowledge and skills of students aged 15 by randomly selecting the research subjects (University of Jyväskylä 2021).

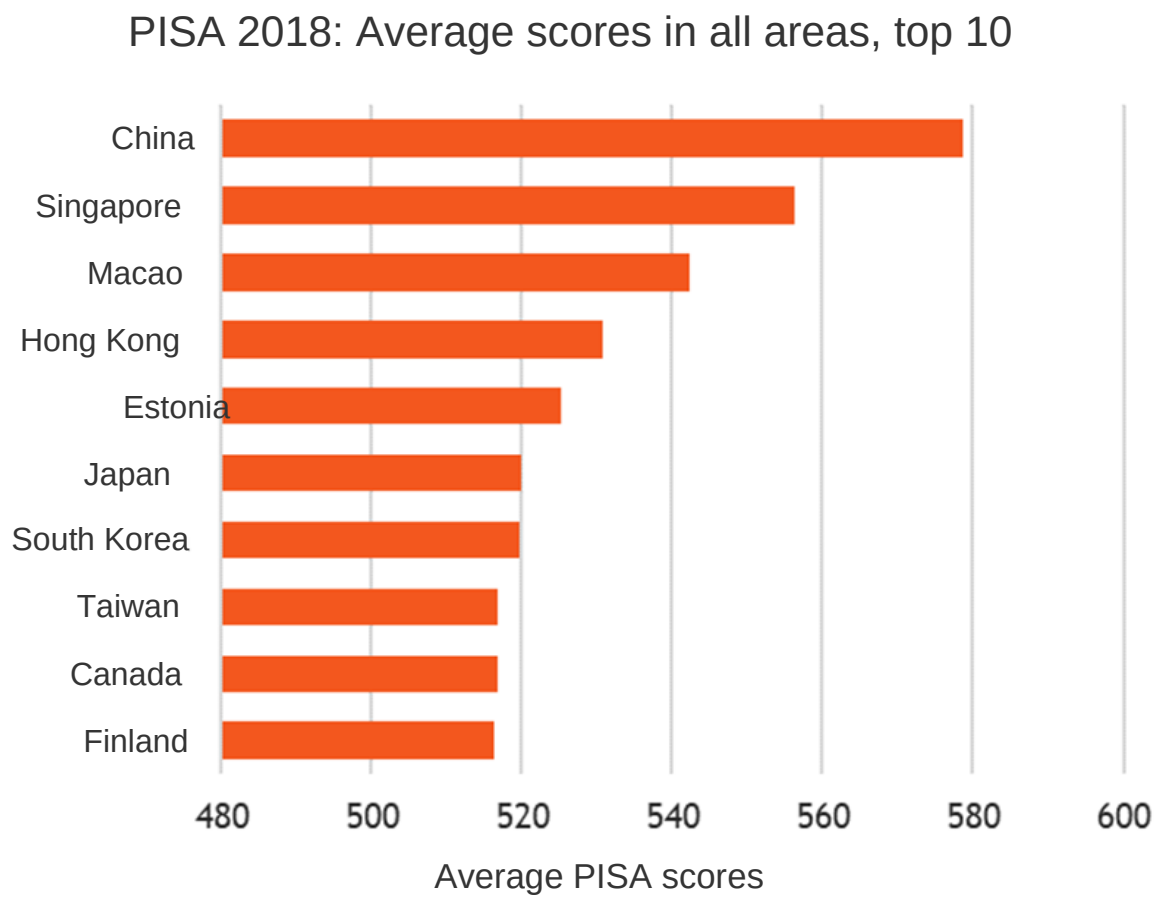
The highly representative sample size and a broad international comparison, currently consisting of more than 80 countries, are regarded as the strengths of the PISA survey. PISA is considered a reliable indicator of knowledge and skills, which is also able to provide information about development trends. The PISA survey has developed constantly, but sufficiently slowly, so that any changes can be identified when comparing results from different years. However, PISA is not free of criticism: in the end, it assesses a fairly narrow part of knowledge and skills. The PISA methodology sets restrictions on how knowledge and skills are measured. In addition, PISA only focuses on students of 15 years of age (Himberg 2022).

2.2 Development of PISA scores in Finland and Estonia

Knowledge and skills of Finnish students aged 15 have decreased since 2006. Science knowledge and skills have especially been in a steady statistically significant decline from one assessment year to the next. Mathematical knowledge and skills have decreased relatively the most in Finland. In learning results, Finland has dropped from the top, and its decline is expected to continue (Pehkonen 2022a).

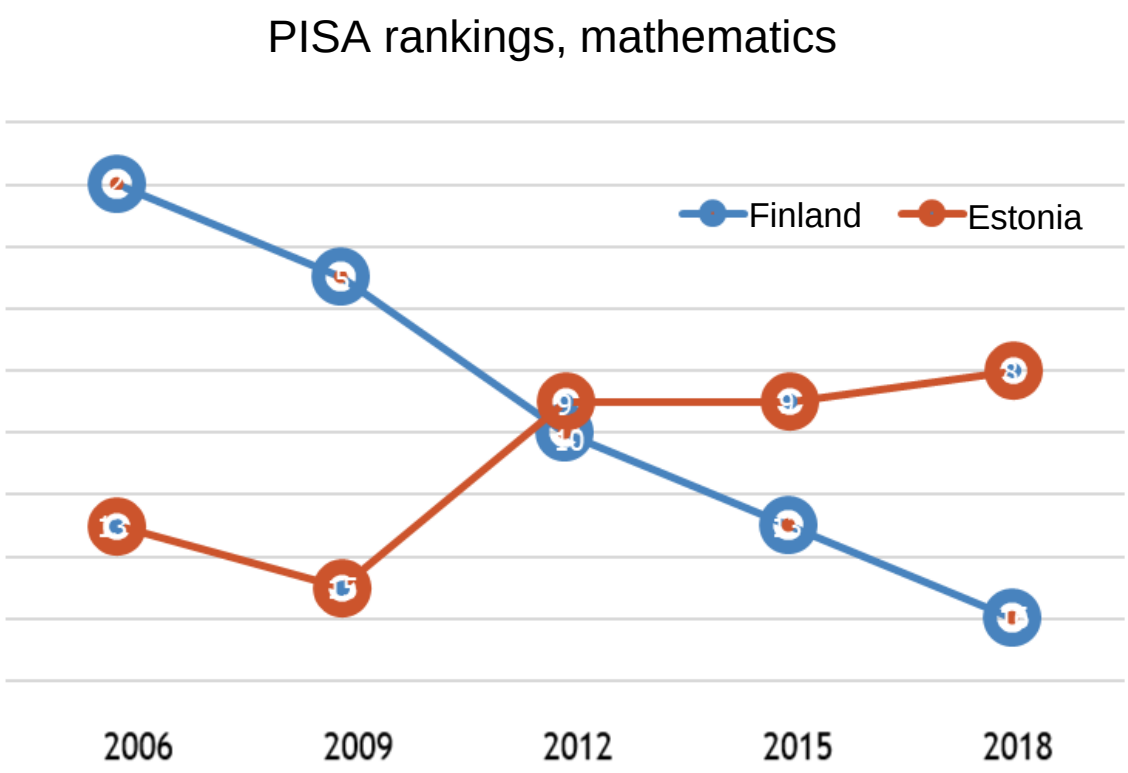
While Finland’s PISA scores are still good, they are no longer excellent. In the 2018 PISA survey, Finland ranked in tenth place when comparing the average scores of

each area. The trend of Finland's learning scores can be examined by comparing Finland's positions in 2003 and 2018: 1st in reading in 2003 and 7th in 2018; 1st in science in 2003 and 6th in 2018; and 2nd in mathematics in 2003 and 16th in 2018. It is worth noting that Finland's declining trend is the steepest in mathematics and science, and only Cyprus has shown a more significant decrease in reading (Pehkonen 2022a).



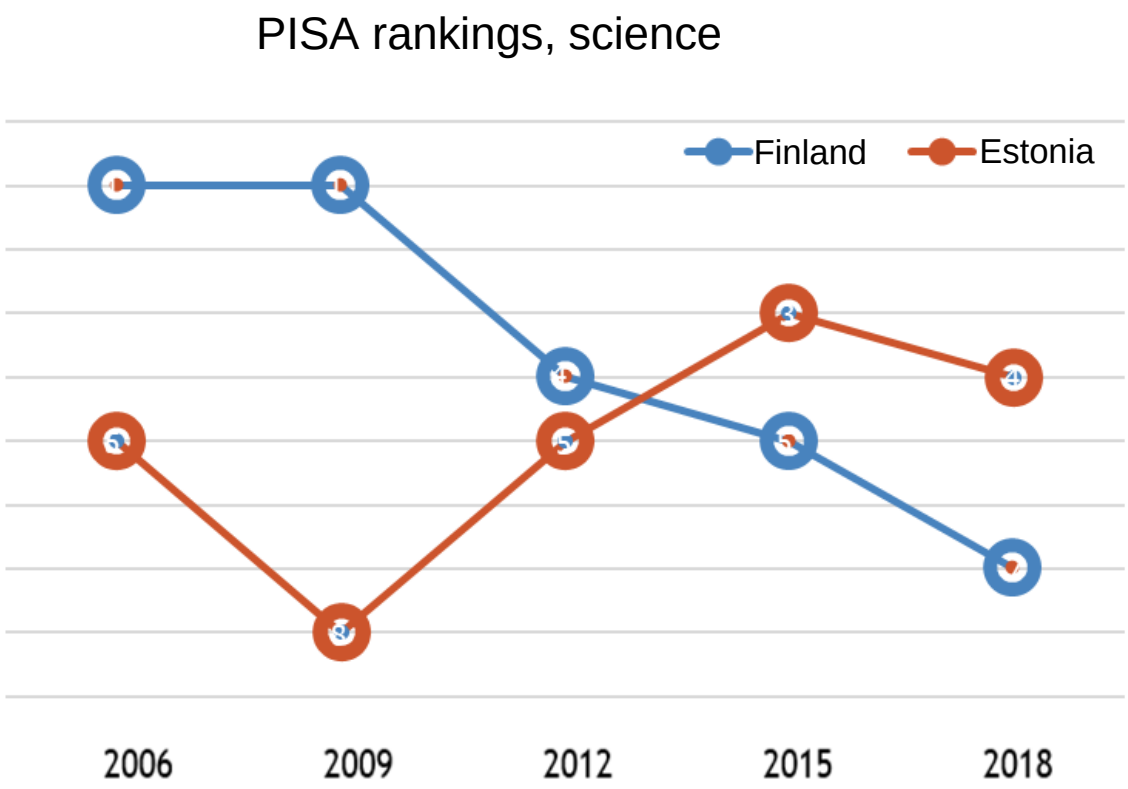
Source: OECD (2020a) (*Note: China's PISA scores only cover Beijing, Shanghai, Jiangsu and Zhejiang.)*

Finland's decline is particularly steep in mathematics. Instead, the results are rising in our neighbouring Estonia.



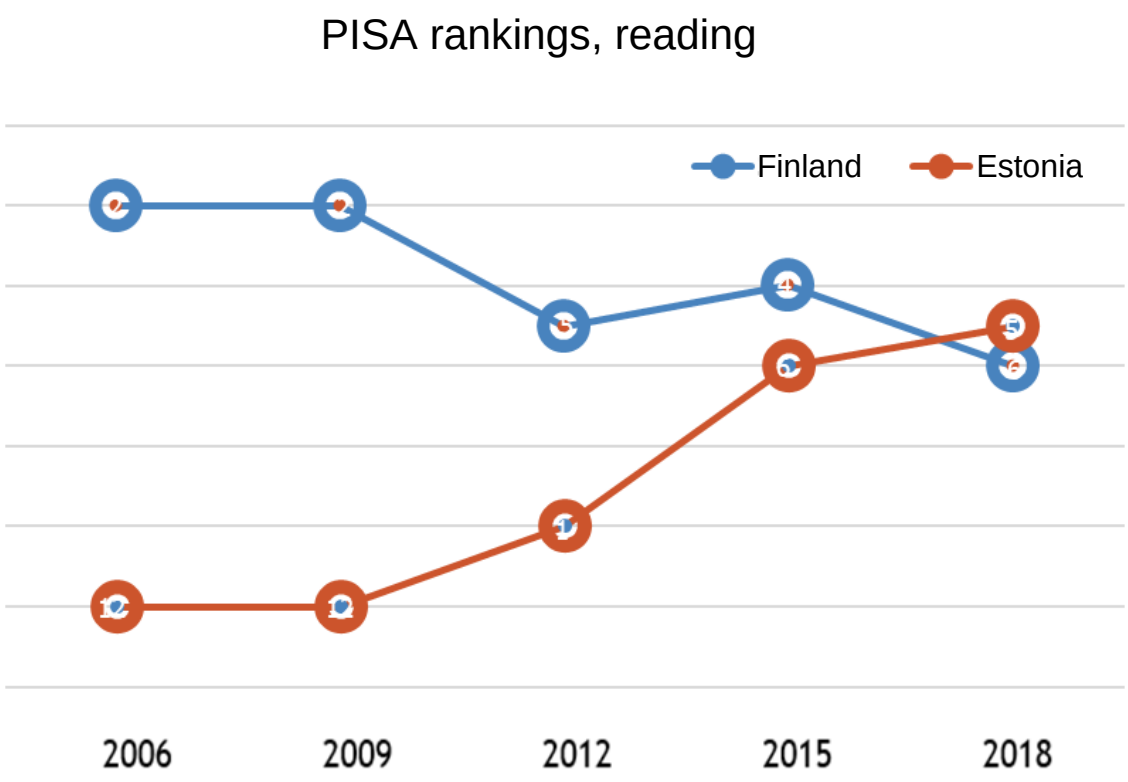
Source: OECD (2020)

Estonia clearly outperformed Finland in science already in 2015.



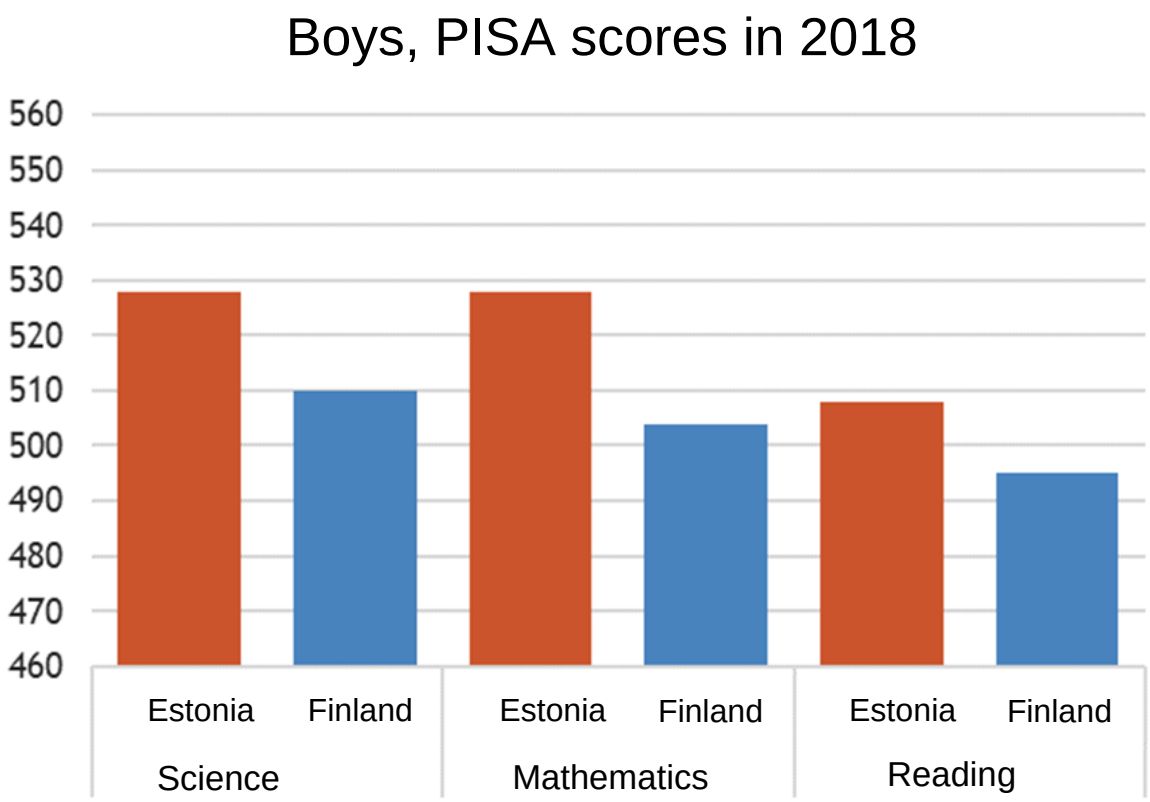
Source: OECD (2020a)

Finland's PISA ranking in reading is showing a clear downward trend, while Estonia's reading scores are improving.

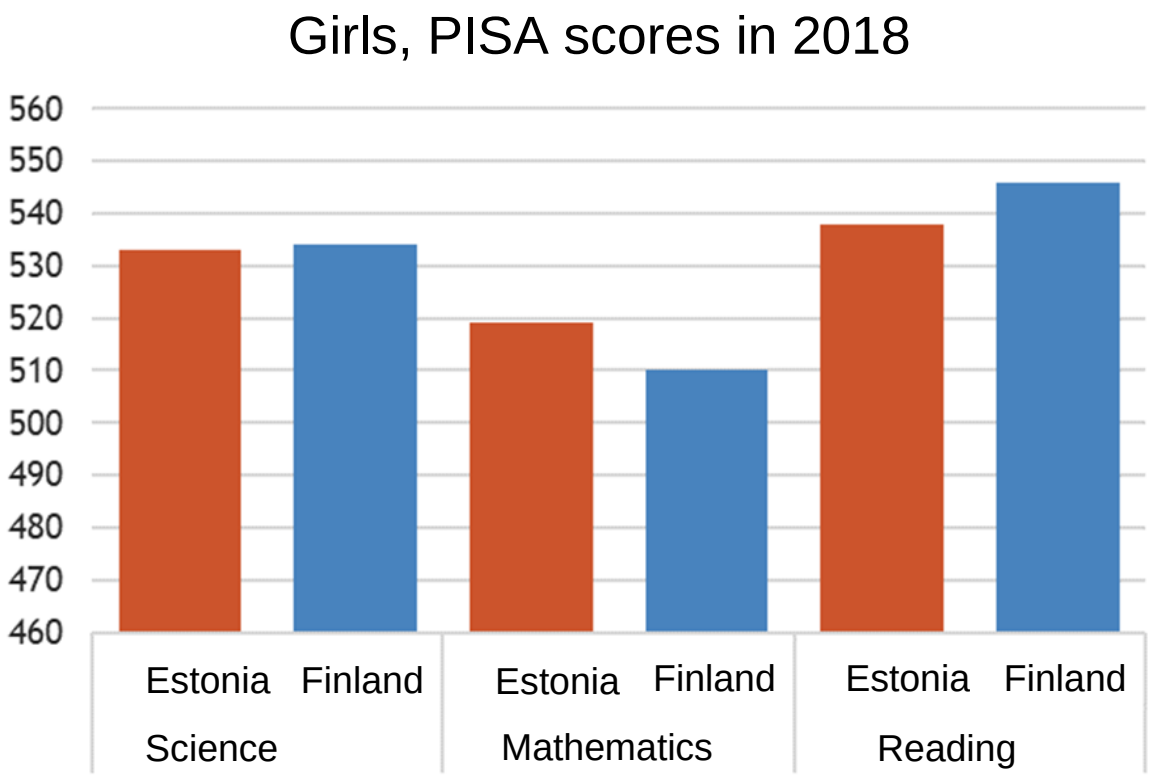


Source: OECD (2020)

Finnish girls are on par with Estonian girls in the light of PISA scores. However, Estonian boys are clearly ahead of Finnish boys.

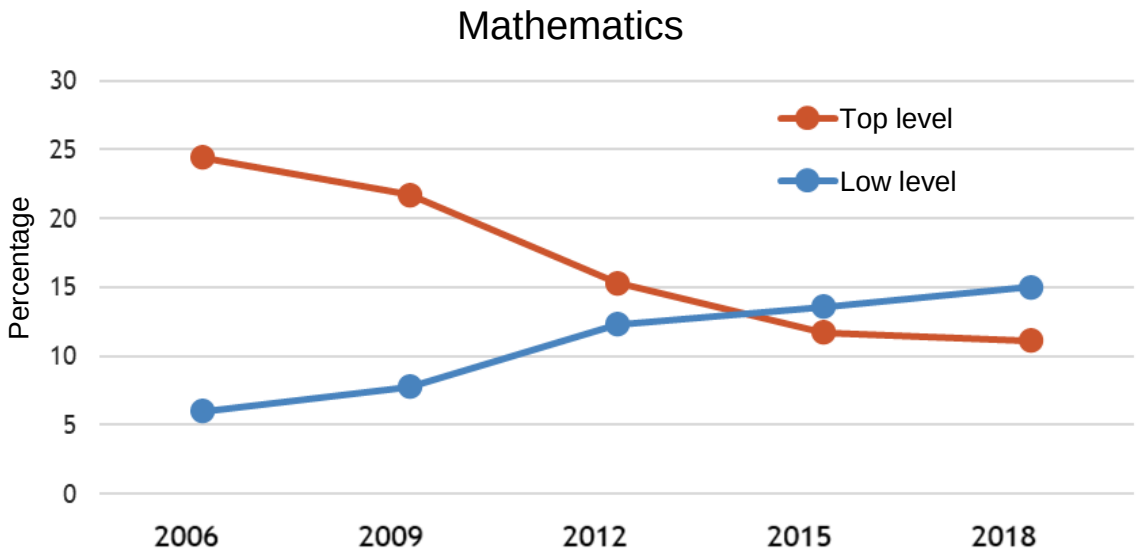


Source: OECD (2020a)

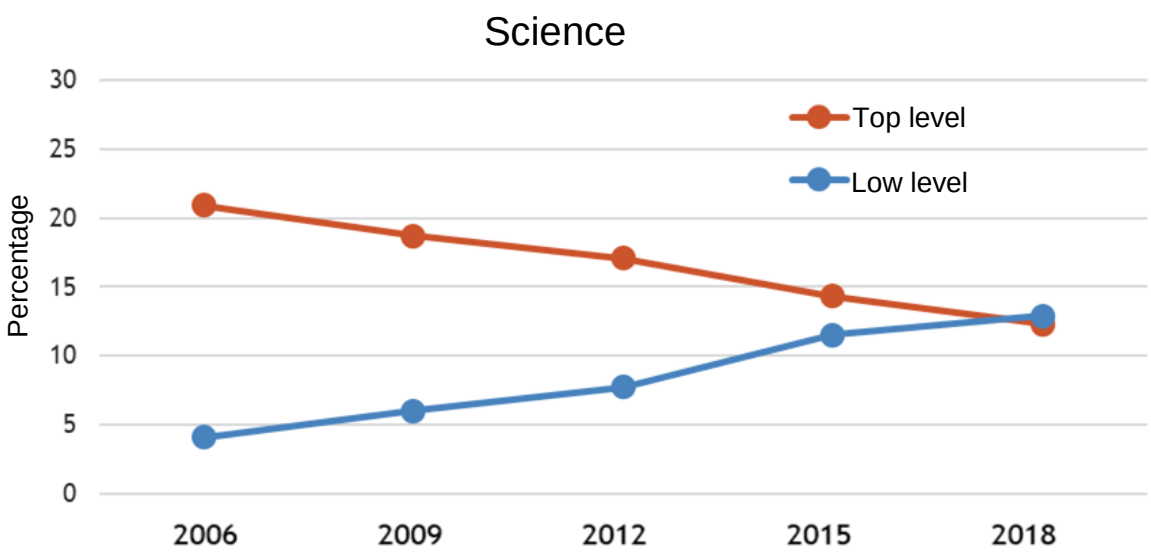


Source: OECD (2020)

Regarding mathematics and science, it is important to note that the number of low-level students is increasing, while that of top-level students is decreasing in Finland.



Source: OECD (2020a)



Source: OECD (2020)

3. Impact of Finland's declining PISA scores

The decline in Finland's PISA scores can be considered to have at least three key effects:

1) Poor learning results reduce future learning.
2) Finnish working life and industries do not have access to the skills and professionals they need.
3) The quality of knowledge and skills has a significant long-term impact on Finland's national economy.

3.1 Poor learning results reduce future learning

Learning is seen as a constructive process, in which the student actively builds their own knowledge using new information and previously acquired knowledge and experiences as building blocks (University of Vaasa, n.d.).

Insufficient knowledge and skills are reflected in challenges in further studies when new skills should be built on previous knowledge. For example, engineering students quit their studies more frequently than other students at universities of applied sciences. A survey conducted by E2 Research regarding this theme showed that mathematical skills have a significant impact on how difficult engineering studies are experienced to be: the students who considered their skills to be poor or adequate experienced their studies to be more challenging than on average. The interviews of staff members at universities of applied sciences included in the survey showed that teachers believe that students' basic knowledge of mathematical subjects has decreased. For example, an interviewed teacher said that it would be impossible to have students complete similar tests as 15–20 years ago, because 60% of current students would receive zero points (Pitkänen 2021).

3.2 Finnish working life and industries do not have access to the skills and professionals they need

The shortage of skilled employees and the declining quality of knowledge and skills are directly reflected in companies' growth and competitiveness. For example, the member companies of the Chemical Industry Federation of Finland are worried about the decrease in top expertise in future technological innovation. The sufficiency of skilled employees, the quality of skills and competence (especially in science and mathematics), and the future of top expertise are the most significant causes of concern. Companies even feel that the sector's climate neutrality goal is at

risk if the correct skills and competence cannot be found (Aalto 2022). The responses given to the competence requirement survey conducted for the member companies of Finnish Energy in 2022 also indicates that recruitment difficulties have increased in recent years, and up to 90% of companies faced difficulties in recruitment processes in 2021 (Yli-Koivisto 2022).

Furthermore, the Education Policy Report of the Finnish Government recognises the shortage of talent. According to the Education Policy Report, the low availability of workforce in recent years has been one of the key factors in Finland that has prevented companies from recruiting new employees. Companies seeking significant growth especially are having difficulties in finding workforce. The Education Policy Report states that, from the perspective of the availability of a skilled workforce, the educational range must follow each sector's development and any changes in it. Without a determined approach, the shortage of workforce will already be significant in the near future, affecting Finland's ability to modernise its national economy and Finland's position in international markets (Finnish Government 2021).

3.3 The quality of skills and competence has a significant long-term impact on Finland's national economy

Increasing the level of skills and competence offers a potential measured in the billions. If Finland returned to the 2006 level in learning results, this would, according to the calculations of the Chemical Industry Federation of Finland, increase Finland's gross domestic product by roughly EUR 1.5 billion a year from 2035 and by another EUR 10 billion from 2075 (Pehkonen 2022b). Significantly larger potential long-term productivity benefits can be achieved by improving the quality of education than by increasing its quantity: A permanent improvement in learning results (an increase of 5.1% in PISA scores) will increase total productivity by 3.4–4.1%. Correspondingly, an increase of 1.2 years in average years of education will increase total productivity by 1.8–2.2% (Égert, Maisonneuve & Turner 2022). Achieving Finland's 2006 PISA level would produce the same increase in total productivity as increasing the average years of education by roughly two years (Pehkonen 2022b).

4. Key questions behind Estonia's success story and the decrease in Finland's learning results

The paths of Finland and Estonia leading to the level of skills and competence and PISA scores resemble each other in many respects which is also highlighted by various specialists. For example, Arto K. Ahonen, National Project Manager of Finland for PISA, has stated that Estonia is now leading the way in education, as Finland did before. According to Ahonen, it seems that the Estonian education system is now in the situation where the Finnish system was 15 years ago (Chemical Industry Federation of Finland 2022). It should also be noted that Estonia has adopted many examples from Finland when developing its education and teaching (Tire, interview, 17 November 2022).

Despite the similar paths of Finland and Estonia, eight questions are presented below, on which various specialists have previously voiced such opinions that their further examination can be considered justified to identify the reasons for Estonia's current PISA success and Finland's declining trend.

4.1 Are there already different levels of educational beliefs in Estonian and Finnish societies?

The term "educational belief" means an understanding according to which education benefits individuals and society alike: generally speaking, education pays off (Silvennoinen et al. 2018).

Arto K. Ahonen, National Project Manager of Finland for PISA, has said that, in Estonia, education is regarded as a valuable asset, and students and their families are willing to invest in education (Chemical Industry Federation of Finland 2022). In addition, Mari-Pauliina Vainikainen, professor of education, has stated that Estonian children and their parents are highly motivated to move ahead through education, whereas a similar educational belief has weakened in Finland (Puttonen 2022).

Even though empirical research results that represent beliefs and opinions do not always hint at a general deterioration in educational beliefs, young people's

educational beliefs especially have become differentiated based on the cultural and financial capital at home (Silvennoinen et al. 2018).

The Education Policy Report of the Finnish Government also recognises significant challenges in the current state of Finland's education and research system: *"However, the [education and research] system does not work as expected by society and learners in all respects or produce the desired results. Children's participation rate in early childhood education and care is lower in Finland than in other Nordic countries. Learning outcomes in basic education have deteriorated. Approx. 15% of the cohort does not complete an upper secondary qualification, and the proportion of those completing a higher education degree has not risen at the same rate as in reference countries. No progress has been made regarding equality in education. School fatigue and other threats to pupils' and students' well-being have become more widespread. There is a shortfall in RDI investments, and Finland is lagging behind the reference countries in the volume and impact of RDI activities."* (Finnish Government 2021).

The rapid expansion of higher education continues internationally, but Finland is falling behind. During the first two decades of this century, the percentage of people aged 25–34 completing a higher education degree increased from 27% to 48% in the OECD. In Finland, the corresponding percentage has, however, remained relatively stable, increasing from 39% to 40%. This means that, back in 2000, the percentage of young people completing a higher education degree in Finland was among the best OECD countries (on par with the United States and South Korea), while in 2021 Finland is clearly below the average (at the level of Chile and Turkey) (Ministry of Education and Culture 2022).

4.2 Does the more active participation of Estonians in early childhood education have an impact on the level of skills and competence

There is a link between participation in early childhood education and later skills and competence, especially among children with loading factors in their growth environment (Karvi 2020a).

In Finland, participation in early childhood education has, however, been below the OECD countries' average and significantly lower than in the other Nordic countries (Karvi 2020b). When the situation is compared with Estonia, the participation of Estonian children in early childhood education in 2013 was significantly more extensive than in Finland (Karila 2016).

The goal of education policy has for years been in Finland to increase participation in early childhood education, and there has been positive progress: In the OECD countries, the participation rate among children aged 3–5 increased by one percentage point from 2015 to 2020, while the corresponding figure in Finland was 14 percentage points, marking the highest increase among the OECD countries (Ministry of Education and Culture 2022).

In Estonia, early childhood education can be seen to focus on developing school readiness. For example, Marja-Kristiina Lerkkanen, professor of education, has stated that, in Estonia, children must learn how to read at the age of 6, whereas in Finland some children only learn how to read at the beginning of basic education (Ferrante 2021).

4.3 Does Estonia's highly teacher-driven form of teaching produce better learning results than in Finland?

Gunda Tire, PISA National Project Manager in Estonia, has said that Estonia's reliance on more conventional teacher-driven form of teaching, in which teachers are responsible for children's learning, can be a decisive factor in Estonia's PISA scores (Puttonen 2022).

The current Finnish form of teaching has also received criticism in Finland. For example, according to Liisa Keltikangas-Järvinen, professor emerita of psychology, today's schoolchildren are required to possess such self-guidance, independence and responsibility, for which not nearly all basic education pupils are ready in terms of their age (Malmberg 2018). Keltikangas-Järvinen has said: *"In place of self-guidance, there is, however, only a new division. There are the children who have already been equipped with a sufficient amount of self-guidance at home. There are not many such pupils, and they are girls at this age. Then there are the children*

whose learning is monitored, guided and helped by their parents. They are often small boys who do not want to set goals for themselves, but who give up and go to a corner to play when facing a difficult task. Then there is a third group. They are normal children at the development level required by their age, but whose development level is insufficient for the independence requirements set at school, and who have no parents to attend school with them" (Keltikangas-Järvinen 2018).

Aino Saarinen, doctor of psychology, has studied the reasons behind Finland's declining PISA scores. In her study, she states that the use of independent teaching practices or digital study materials was linked to poorer learning results in several knowledge areas. Instead, teacher-driven practices were linked to better learning results (Saarinen 2020).

This gives reason to ask do Finland's broadly used student-driven forms of teaching achieve sufficiently good learning results? Teachers are not to blame, however. It should also be remembered that children's school hours in basic education are significantly lower in Finland than in other countries (Trade Union of Education (OAJ) 2022). Teachers are also highly experienced in Estonia: currently, 54% of teachers are more than 50 years of age, and teachers have good digital skills (OECD 2020b).

As a result of Estonia's more teacher-driven form of teaching, children can work in more peace and quiet. Various media services, in particular, have highlighted differences in peace and quiet in Finnish and Estonian classrooms (e.g. Puttonen 2022). These concerns may not be wholly unfounded as, according to the PISA survey, there seems to be a link between peace and quiet and learning results. Surveys regarding peace and quiet have confirmed the finding according to which there are significant differences in this area between Finnish schools and especially within them (Holopainen et al. 2009).

.

4.4 How has Estonia been able to build a higher motivation among children and young people towards science and mathematics than Finland?

Arto K. Ahonen, National Project Manager of Finland for PISA, has said that internal motivation is particularly strongly linked to learning. In Finland, both external motivation and student's performance motivation towards science studies have decreased since 2006, so much so that it was significantly lower in 2015 than the average of the OECD countries. Correspondingly, Estonian students' motivation towards science studies has increased (Chemical Industry Federation of Finland 2022). However, Ahonen has also said that, while PISA surveys have assessed students' motivation, it appears that there are no major differences between Finnish boys and girls. Therefore, it seems that girls study and learn better than boys, even without any motivation (Pehkonen 2022a).

There are significant differences in the motivation of Finnish and Estonian students towards science and mathematics. Estonia's PISA results for 2015 stated that 30% of Estonian students watch science programmes often or very often (12% in Finland), 25% of Estonian students search for information about mathematics, science and technology on the internet often or very often (7% in Finland), and 24% read science magazines or articles often or very often (10% in Finland). Correspondingly, 71.3% of Estonian students agree or strongly agree with the claim that "studying mathematics, science and technology is mostly fun" (64.3% in Finland), and 77.4% agree or strongly agree with the claim that "I think it's fun to learn something new when studying mathematics, science and technology" (49.8% in Finland). It is worth noting that Estonia has been able to significantly increase students' motivation towards mathematics, science and technology, while the corresponding change in Finland has been negative: students' interest and motivation towards these subjects has decreased (Tire 2016).

Annely Tank, Advisor at the Economic Development Department of Estonia, has estimated that Estonian students' high motivation towards science can at least partly be explained by mathematics, science and technology clubs intended for young people that have been included in the national curriculum in Estonia, but that are

also actively provided as extracurricular activities. According to Tank, robotics, mathematics and physics clubs are highly popular among students, constituting a rising trend in Estonia. Tank also finds it important that after-school activities provided in the private sector and similar mathematics, science and technology activities have been supported in Estonia (Chemical Industry Federation of Finland 2022).

Gunda Tire (2022) has also mentioned the broad range of after-school activities provided at Estonian schools (choirs, dancing, technology, sports and arts) as a possible reason for Estonia's success.

As many as 25% of Estonian students aged 15 want to work in science-related jobs at the age of 30. The percentage of students who are willing to choose a science-related profession in the future has increased by 7.8% in nine years. The level of skills and competence also has a significant impact on interest towards science: 38.4% of Estonian top students prefer a career in science, while the corresponding figure among low-performing students is 13.7% (Tire 2016).

The goal of the Finnish model for leisure activities is to enable every child and young person to have a leisure activity in connection with the school day (Finnish National Agency for Education, n.d.). Currently, it would be important to consider whether various mathematics, science and technology clubs can also have a place in the Finnish model.

4.5 How can the Estonian school system balance differences in skills and competence derived from family backgrounds more effectively than the Finnish system?

Arto K. Ahonen, National Project Manager of Finland for PISA, has said that, in Estonia, the student's family background has less impact on their skills and competence than on average in the OECD countries, while Finland is at the average level. The Estonian education system can balance any differences in skills and competence derived from family backgrounds better than on average in the OECD countries, whereas Finland was at the average level in 2015 (Chemical Industry Federation of Finland 2022).

Estonia is also monitoring this situation. Estonia's PISA results for 2015 point out that the impact of the social background on students' performance has remained low. There are many high-performing students among children with a lower social background. The situation is better in Estonia than in most OECD countries. Estonia has been able to guarantee fairly equal learning conditions for all students. Even though there are statistically significant differences between school reference groups measured by certain indicators, high-risk schools (lower socioeconomic backgrounds, any exclusion due to language barriers, distant location) have often guaranteed better learning and teaching conditions (Tire 2016).

In an international comparison, equal education systems usually also produce good learning results. In Finland, the alarming trend has also been addressed in the Education Policy Report of the Finnish Government, which states that, in recent years, the impact of the socioeconomic background on students' learning results has increased. Parents' level of education and students' school have also been found to be linked to students' skills and competence (Finnish Government 2021).

Educational inheritance has become higher and higher in Finland in recent years. A link has been found between the level of education of parents and children: the level of education of parents is linked to their children's performance in upper secondary education, applications for higher education and their final level of education (Eskelinen et al. 2020.)

4.6 How has Estonia been able to maintain high levels of skills and competence among boys?

Arto K. Ahonen has emphasised that the decrease in skills and competence especially concerns boys more than girls. In Finland, the differences in skills and competence come from the lower performance of boys, whereas Finnish girls are still roughly at the same level as Estonian girls. Ahonen points out that finding the underlying reasons for boys' steeper decline compared with girls is one of the key questions (Chemical Industry Federation of Finland 2022). Gunda Tire, PISA National Project Manager in Estonia, has also mentioned that Finland's key question is how to solve Finnish boys' declining level of skills and competence (Tire, interview, 17 November 2022).

An examination of the differences between the two genders in science performance shows that the average score of boys in science is an average of four points higher in the OECD countries than that of girls, which is statistically significant. Boys' results are noticeably higher in 24 countries, and the largest differences between boys and girls, in boys' favour, are in Austria, Costa Rica and Italy. The difference was statistically significant in girls' favour in 22 countries, including Finland (19 points), Latvia (11 points) and Lithuania (7 points). Instead, there were no statistically significant differences between boys and girls in Estonia in the 2015 PISA survey or the PISA surveys before that (2006, 2009, 2012). In Finland, the gap between boys and girls (16 and 19 points) has increased over the years (2012–2015) (Tire 2016).

The differences in skills and competence between boys and girls are minor in grade one in Finland, with girls' knowledge and skills being only a little higher (Karvi 2020a). It is also worth noting that the differences between the two genders develop during basic education (Finnish Government 2021).

Education is differentiated by gender in Finland. Choices regarding upper secondary education are also gender-biased: in 2018, 65% of girls applied primarily for general upper secondary education, while 54% of boys applied primarily for vocational education. The significant gender segregation in education can also be seen in higher education in Finland. Of the working age population, women participate in education much more than men (Finnish Government 2021).

4.7 Are talented students addressed better in Estonia than in Finland?

When comparing top performers in the OECD countries on average, their percentage only increased in Estonia, Macao (China) and Norway from 2006. In Finland, the percentage of top performers has decreased. However, Finland was still ahead of Estonia in top performers in science (Level 5 or 6 in PISA scores), while Estonia has the fewest students at a low level in science (Tire 2016).

The increase in top performers and the unchanged percentage of lowest-achieving students have been mentioned as a key factor behind Estonia's success. The percentage of students who are top performers in all three areas of the PISA survey

(reading, mathematics and science) has also increased in Estonia since 2006 (Tire 2016).

In Estonia, it is considered to be significant in principle that the educational reforms made so far in Estonia and the current curricula follow international trends and respond to international conceptions related to the learning and teaching of science. Even though it has simultaneously been proposed that Estonia's curricula and students are overloaded, the PISA scores show that Estonian students represent the top of the western countries, Estonia has fewer lowest-achieving students than other countries, and its results are the best considering statistical significance (Tire 2016).

In her master's thesis, Kati Hirvonen-Blomqvist (2020) studied the level of teaching provided for gifted students in Finnish basic education. She states that, even though the level of teaching provided for gifted students is debated publicly from time to time, there have not been any significant changes during the last decades. In conclusion, she states that the level of teaching provided for gifted students is advanced by close cooperation between the school and home, individual forms of teaching, the teacher's professional skills, and attitudes towards gifted students. Instead, the level of teaching provided for gifted students is reduced by such factors as lack of cooperation between the school and home, large teaching groups, heterogeneous skill levels in student groups, and teachers' increased workloads outside education. Both parents and teachers felt that large teaching groups present a challenge in students' learning, regardless of each student's skill levels. Teaching gifted students was found particularly challenging in this situation, as it was seen as the first area that can be ignored due to the lack of resources.

The percentage of top performers is significant considering interest in science. As already stated in this report, a clear link between the level of skills and competence and interest towards a career in science has been found in Estonia: top-performing students are much more interested in a career in science (Tire 2016).

Estonia has worked hard to address gifted students. Gunda Tire, PISA National Project Manager in Estonia, has previously said that, after Estonia's first PISA results, it was discussed how gifted students can be addressed in Estonia. It was

noticed that more work needs to be done with gifted students so that their knowledge and skills can also be developed. As an example, Tire mentions that some schools started to provide more challenging after-school activities for gifted students (Puttonen 2022).

Liisa Ojaveer, Adviser for EU and international cooperation, Estonian Ministry of Education and Research, points out that, during the last ten years, the aim has been to provide thorough feedback when evaluating learning results which has also enabled and ensured top skills and competence (Ojaveer, interview, 22 November 2022). External evaluations that concern the development and implementation of a quality system for educational institutions are conducted in Estonia. They include supervision and monitoring, as well as the analysis of their results (Estonian Ministry of Education and Research 2022).

Ojaveer also points out that measures have been carried out in Estonia to engage young people in innovation activities. For example, support has been granted for holding such student events that raise young people's interest in science and robotics, and that also enable a competitive approach to the development of talent. In addition, Estonia hosts science studios in which students of different ages can experiment and innovate in practical conditions. What is more, the Estonian television has broadcast a programme in which young people compete in tasks requiring mathematical and science skills, for example, by demonstrating how they can apply their knowledge to disasters by building earthquake-resistant buildings (Ojaveer, interview, 22 November 2022).

4.8 Has Estonia realised that a good solution cannot always be found from additional resources?

Estonia is one of the countries in which annual education expenses per student are more than USD 50,000. In most developed countries, education expenses per student are significantly higher than in Estonia. It is worth noting that Estonia has succeeded in distributing and spending its limited funds allocated to education so that all schools can offer equally good conditions for learning and teaching (Tire 2016).

Researcher Mart Saarma and Indrek Tammeaid, who has worked as an innovation policy adviser for the Estonian Ministry of Finance, have stated about Estonia's innovation policy that Estonia can be regarded as an example to show that a good solution cannot always be found from additional resources: often, Estonia's innovative successes have been based on a lack of resources or the impossibility to solve problems in the same way as in long-established industrial countries (Saarna & Tammeiad 2021). Even though this statement is expressly related to the innovation policy, similar agility can also be seen in Estonia's education policy.
Tommi Himberg, counsellor for education and science at the Permanent Delegation of Finland to the OECD, has said that, based on PISA scores, it seems that financial investments in education in wealthy countries, such as Finland, do not produce similarly positive impacts on learning results as in poorer countries (Himberg 2022). It is safe to say that direct financial investments or a potential lack thereof cannot explicitly explain Finland's trend in PISA scores. Himberg has encouraged Finland to rely on its traditional strengths in education: skilled teachers who have the autonomy and opportunity to focus on teaching; equality and the local school principle; advanced curricula; maintaining educational beliefs and education in society; and ensuring the interest and appreciation related to skills and competence (Himberg 2022).

Sources

Printed and online sources

Hirvonen-Blomqvist K. 2020. Mistä on lahjakkaiden opetus tehty? Eriyttämisestä, rikastuttamisesta, nopeuttamisesta vai jostain muusta? (What is teaching provided for gifted students made of? Differentiation, enrichment, acceleration or something else?) Master's thesis in education. University of Jyväskylä. https://jyx.jyu.fi/bitstream/handle/123456789/69343/1/URN%3ANBN%3Afi%3Ajyu-202006013600.pdf

Égert B; Maisonneuve de la C & Turner D 2022. A New Macroeconomic Measure of Human Capital: Exploiting PISA and PIAAC: Linking Education Policies to Productivity.

https://www.oecd.org/fr/publications/a-new-macroeconomic-measure-of-human-capital-exploiting-pisa-and-piaac-linking-education-policies-to-productivity-a1046e2e-en.htm

Finnish Energy 2020. Low-carbon roadmap for the energy sector. https://energia.fi/energiapolitiikka/vahahiilisyyden_tiekartta

Eskelinen N, Erola J, Karhula, A, Ruggera, L & Sirniö O. 2020. Eriarvoisuuden periytyminen (Inherited inequality). In Mattila, M. (ed.), Eriarvoisuuden tila Suomessa 2020 (State of inequality in Finland 2020). Kalevi Sorsa Foundation. https://www.julkari.fi/handle/10024/144447?show=full

Ferrante A 2021. Lukutaito 4-vuotiaana? – varhaisia oppijoita yhdistää yksi selkeä tekijä, toisaalta syytä lukutaidon kiirehtimiselle ei ole (Literacy at the age of four? – one factor connects young learners, no need to hurry literacy). Kaksplus 8 December 2021. https://kaksplus.fi/taapero/kehitys/lukutaito-4-vuotiaana-varhaisia-oppijoita-yhdistaa-yksi-selkea-tekija-toisaalta-syyta-lukutaidon-kiirehtimiselle-ei-ole/

Estonian Ministry of Education and Research 2022. External evaluation. https://www.hm.ee/ministeerium-uudised-ja-kontakt/ministeerium/valishindamine?view_instance=0&current_page=1#valishindamise-uleva

Holopainen P.; Järvinen R.; Kuusela J. & Packalen P 2009. Työrauha tavaksi. Kohtaaminen, toimintakulttuuri ja pedagogiikka koulun arjessa (Peace and quiet as a norm. Daily encounters, operating culture and pedagogy at schools). Finnish National Agency for Education. https://www.oph.fi/sites/default/files/documents/holopainen-p.-et-al.-tyorauha-tavaksi-kohtaaminen-toimintakulttuuri-ja-pedagogiikka-koulun-arjessa.-2009.pdf

University of Jyväskylä 2021. PISA. https://ktl.jyu.fi/fi/pisa/en

Karila K 2016. Vaikuttava varhaiskasvatus (Effective early childhood education). Reports and surveys 2016:6. Finnish National Agency for Education. https://www.oph.fi/sites/default/files/documents/vaikuttava_varhaiskasvatus.pdf

Karvi 2020a. Alkumittaus - koulutulokkaiden matematiikan ja äidinkielen ja kirjallisuuden taidot ja osaamisen taustatekijät (First evaluation – underlying factors for new pupils' knowledge and skills in mathematics, Finnish and literature). Finnish Education Evaluation Centre. Abstracts 13:2020. https://karvi.fi/publication/alkumittaus-koulutulokkaiden-matematiikan-ja-aidinkielen-ja-kirjallisuuden-taidot-ja-osaamisen-taustatekijat-tiivistelma/

Karvi 2020b. An experiment on free of charge early childhood education and care for five-year-olds: The second phase of evaluation. Participation in early childhood education, its costs and organisation. Finnish Education Evaluation Centre. Publications 14:2020.
https://karvi.fi/publication/viisivuotiaiden-maksuttoman-varhaiskasvatuskokeilun-arvioinnin-toinen-vaihe-varhaiskasvatukseen-osallistuminen-kokeilun-kustannukset-ja-jarjestaminen/

Keltikangas-Järvinen L 2018. Suomalainen peruskoulu on tasa-arvoinen - vai onko? (Finnish basic education is equal – or is it?) Suomen lääkärilehti 22/2018, Volume 73.
http://www.laakarilehti.fi/pdf/2018/SLL222018-1456.pdf

Chemical Industry Federation of Finland 2019. Climate neutral chemistry 2045 – The chemical industry in Finland set an ambitious goal. Bulletin 25 January 2019.
https://www.kemianteollisuus.fi/fi/uutishuone/tiedotteet/hiilineutraali-kemia-2045-suomen-kemianteollisuus-asetti-itselleen-kovan-tavoitteen/

Chemical Industry Federation of Finland 2022. What is Estonia doing right and Finland wrong, as their learning results are moving in opposite directions? The Chemical Industry Federation of Finland's five ways for Finland to get back to the top. Bulletin 14 June 2022.
https://www.kemianteollisuus.fi/fi/uutishuone/tiedotteet/mita-viro-tekee-oikein-ja-suomi-vaarin-kun-oppimistulokset-menevat-eri-suuntiin-kemianteollisuus-esittaa-5-keinoa-joilla-suomi-voi-nousta-takaisin-huipulle/

Malmberg K 2018. Tutkimus paljastaa: Koulujen uudet menetelmät heikentävät oppimista merkittävästi (Study: new methods used at schools significantly reduce learning). Helsingin Sanomat 18 November 2018. https://www.hs.fi/elama/art-2000005903400.html

OECD 2020a. PISA 2018 Database.
https://www.oecd.org/pisa/data/2018database/

OECD 2020b. 2018 TALIS Results: Teachers and School Leaders as Lifelong Learners and Valued Professionals
https://www.oecd.org/education/talis/

Trade Union of Education 2022. OAJ's goals for parliamentary elections and the next government term 2023–2027.
https://www.oaj.fi/politiikassa/vaalit2023/vaalitavoitteet/#4-taitavaa-tyovoimaa-ja-korkeaa-osaamista

Finnish National Agency for Education n.d. The Finnish model for leisure activities. https://harrastamisensuomenmalli.fi/en

Ministry of Education and Culture 2022. OECD comparison: educational attainment of Finnish young people fallen below average. Bulletin 3 October 2022 https://valtioneuvosto.fi/-/1410845/oecd-vertailu-suomalaisten-nuorten-koulutustaso-laskenut-keskitason-alapuolelle?languageId=en_US

Puttonen M 2022. Koulutuksen uusi mallimaa (The new paragon of education). Helsingin Sanomat 28 September 2022. https://www.hs.fi/tiede/art-2000008902553.html

Pitkänen V 2021. Miksi opinnot viivästyvät ja keskeytyvät? Selvitys AMK-insinööriopiskelijoiden opintojen viivästymisen ja keskeyttämisen syistä (Why do students quit or postpone their graduation? A study of underlying reasons among engineering students). E2 Research. https://www.ilry.fi/wp-content/uploads/2021/11/Miksi-opinnot_viivastyvat-ja-keskeytyvat-selvitys.pdf .

Saarinen A 2020. Equality in cognitive learning outcomes: the roles of educational practices. Doctoral dissertation. University of Helsinki. https://helda.helsinki.fi/handle/10138/320436

Saarma M & Tammeaid I 2021. Innovaatiopolitiikka Virossa – mitä hyvää, mitä kehitettävää? (Innovation policy in Estonia – what is good, what should be developed?) Article series for long-term R&D funding. Prime Minister's Office. https://vnk.fi/-/mart-saarma-ja-indrek-tammeaid-innovaatiopolitiikka-virossa-mita-hyvaa-mita-kehitettavaa-

Silvennoinen H; Kalalahti M. & Varjo J. 2018. Koulutususko yhteiskunnallisena ilmiönä (Educational belief as a societal phenomenon). In Koulutuksen lupaukset ja koulutususko (Educational promises and beliefs). Finnish Educational Research Association. Helsinki.

Tire G 2016 (ed.). Suurim rahvusvaheline õpilaste õpitulemuslikkuse uuring PISA 2015. Haridus- ja Noorteamet. https://harno.ee/sites/default/files/documents/2021-02/PISA-2015_EESTI_ARUANNE_FINAL.pdf

University of Vaasa n.d. Learning. https://www.uwasa.fi/en/students/developing-your-study-skills/learning

Finnish Government 2019. Programme of Prime Minister Sanna Marin's Government 10 December 2019. https://julkaisut.valtioneuvosto.fi/handle/10024/161931

Finnish Government 2021. Education Policy Report of the Finnish Government. https://julkaisut.valtioneuvosto.fi/handle/10024/162995

Seminar presentations

Mika Aalto 2022. Director General, Chemical Industry Federation of Finland. Chemical industry review. Seminar presentation, 15 June 2022.

Tommi Himberg 2022. Counsellor, Permanent Delegation of Finland to the OECD. Finland in an international comparison of skills and competence. Seminar presentation, 11 October 2022.

Sampo Pehkonen 2022a. Chief Advisor, Chemical Industry Federation of Finland. We need mathematics science and technology. Seminar presentation, 15 June 2022.

Sampo Pehkonen 2022b. Chief Advisor, Chemical Industry Federation of Finland. Link between PISA scores and financial growth and competitiveness. Seminar presentation, 11 October 2022.

Tire Gunda 2022. Head of International Assessments, Estonian Education and Youth Board. What is behind Estonian education success? Seminar presentation, 11 October 2022.

Interviews and other unpublished sources

Hallar Meybaum. Executive Director. Estonian Chemical Industry Association. Interview, 21 November 2022.

Liisa Ojaveer. Adviser (EU and International Cooperation), Estonian Ministry of Education and Research. Interview, 22 November 2022.

Tire Gunda. Head of International Assessments, Estonian Education and Youth Board. Interview, 17 November 2022.

Timo Yli-Koivisto. Director, Labour Market. Finnish Energy. Email, 29 November 2022.