



Russian Academy of
Education

THE MINISTRY OF EDUCATION AND SCIENCE OF THE RUSSIAN FEDERATION
FEDERAL SERVICE FOR SUPERVISION IN THE SPHERE OF EDUCATION AND SCIENCE
RUSSIAN ACADEMY OF EDUCATION
INSTITUTE OF CONTENT AND METHODS OF EDUCATION
Centre for Evaluating the Quality of Education



International Association for
the Evaluation of
Education Achievement

TIMSS-2011 RESULTS

In 2011 Russia demonstrated a notable rise in mathematics and science achievement of 8th grade students.

The Russian students have demonstrated high results in mathematics and science within international TIMSS benchmarks since 1995.

International comparative monitoring study of science and mathematics education TIMSS (Trends in Mathematics and Science Study) is the first monitoring study in the field of general education that enables to observe trends in development of mathematics and science general education since 1995 (the study is conducted every 4 years). The study assesses educational achievements of 4th grade and 8th grade students. Special features of mathematics and science education in participating countries are additionally studied: content of mathematics and science education, teaching process, characteristics of educational institutions, teachers, students and their families. The study is conducted by International Association for the Evaluation of Educational Achievement (IEA).

More than 600 000 primary and secondary students from 63 countries took part in TIMSS-2011. 412 Russian education institutions from 50 regions participated in the study. Testing of the 4th grade students (primary school graduates, 4467 students) took place in 202 educational institutions, testing of the 8th grade students took place in 210 schools (4893 students).

In Russia the study was carried out by the Centre for Evaluating the Quality of Education of the Russian Academy of Education with active participation of the Ministry of Education and Science, Federal Service for Supervision in the Sphere of Science and Education, and local education authorities. The study was conducted within the framework of the Federal target program for the development of education.

The study provides answers on the following key questions:

1. What is the state of national mathematics and science education in relation to international education benchmarks?
2. What changes in the achievement results of the Russian students have occurred over the last ten years?
3. How do the achievement results of the Russian students change when they finish primary school and enter secondary school?
4. What factors affect the highest achievement results of the Russian students in mathematics and science?
5. What are the ways of improving education in Russia?

MATHEMATICS. Key findings

The mathematics achievement results of the 4th grade students¹

Country	Average Scale Score	
Singapore	606 (3,2)	⬤
Korea, Rep. of	605 (1,9)	⬤
Hong Kong SAR	602 (3,4)	⬤
Chinese Taipei	591 (2,0)	⬤
Japan	585 (1,7)	⬤
Northern Ireland	562 (2,9)	⬤
Belgium (Flemish)	549 (1,9)	=
Finland	545 (2,3)	=
England	542 (3,5)	=
Russian Federation	542 (3,7)	=
United States	541 (1,8)	=
Netherlands	540 (1,7)	=
Denmark	537 (2,6)	=
Lithuania	534 (2,4)	=
Portugal	532 (3,4)	=
Germany	528 (2,2)	▼
Ireland	527 (2,6)	▼
Serbia	516 (3,0)	▼
Australia	516 (2,9)	▼
Hungary	515 (3,4)	▼
Slovenia	513 (2,2)	▼
Czech Republic	511 (2,4)	▼
Austria	508 (2,6)	▼
Italy	508 (2,6)	▼
Slovak Republic	507 (3,8)	▼
Sweden	504 (2,0)	▼
Kazakhstan	501 (4,5)	▼
TIMSS Scale Centerpoint	500	
Malta	496 (1,3)	▼
Norway	495 (2,8)	▼
Croatia	490 (1,9)	▼
New Zealand	486 (2,6)	▼
Spain	482 (2,9)	▼
Romania	482 (5,8)	▼
Poland	481 (2,2)	▼
Turkey	469 (4,7)	▼
Azerbaijan	463 (5,8)	▼
Chile	462 (2,3)	▼
Thailand	458 (4,8)	▼
Armenia	452 (3,5)	▼
Georgia	450 (3,7)	▼
Bahrain	436 (3,3)	▼
United Arab Emirates	434 (2,0)	▼
Iran, Islamic Rep. of	431 (3,5)	▼
Qatar	413 (3,5)	▼
Saudi Arabia	410 (5,3)	▼
Oman	385 (2,9)	▼
Tunisia	359 (3,9)	▼
Kuwait	342 (3,4)	▼
Morocco	335 (4,0)	▼
Yemen	248 (6,0)	▼

⬤ An average country score is statistically significantly higher than the average score of Russia

= No statistically significant difference between an average score of a country and the average score of Russia

▼ An average country score is statistically significantly lower than the average score of Russia

In TIMSS-2011 the Russian 4th and 8th grade students' achievement results are much higher than international average.

4th grade

The average score of the Russian students is **542**.

8th grade

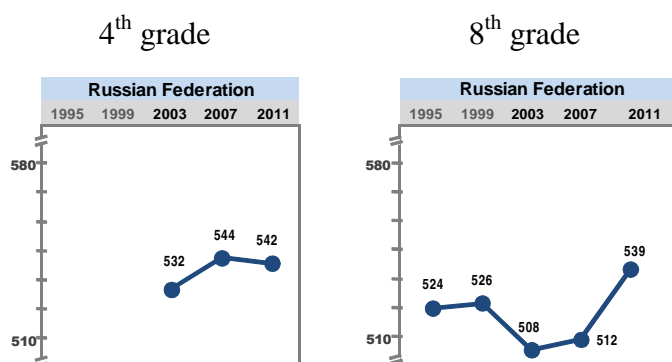
The average score of the Russian students equals to **539**.

The top-performing countries in mathematics achievements of 4th and 8th grade students are East Asian countries: Singapore, Republic of Korea, Hong Kong, Chinese Taipei and Japan. These countries demonstrated similar results in 2003 and 2007 years.

The Russian 4th grade students are in the second group of 9 countries that have shown similar results, and took the place from 7 to 15. The achievement results of other 35 countries participated in the study (including Germany, Australia, Czech Republic, Hungary, Austria etc.) are much lower than the results of the Russian students.

The achievement results of the Russian 8th grade students are much lower than the results of the top-performing countries and higher than the results of 36 countries (including such countries as Finland, United States, England, Australia, Hungary).

The Russian 4th grade students demonstrate stably high mathematics achievement results in accordance with international TIMSS benchmarks. This situation has not changed over the last years (2003–2011)².



In 2011 the Russian 8th grade students significantly raised their levels of mathematics achievement compared to 2007: the results were increased by 27 points. This is one of the highest rise in achievement results among all other countries.

¹ The results are presented according to the international 1000-point scale. Standard errors appear in parentheses.

² Russia has been participating in international testing of 4th grade students since 2003, 8th grade students – since 1995.

In accordance with TIMSS international benchmarks 13% of the Russian 4th grade students reached advanced mathematics achievement results, 34% – high mathematics achievement results. This means that almost half of the Russian 4th grade students can solve relatively difficult mathematical problems and explain their reasoning.

35% of the students achieved intermediate benchmark. They can apply basic knowledge in straightforward situations. 15% of the students achieved low benchmark. Low benchmarks reached 15%, they have only some basic knowledge. 3% of the 4th grade students have some fragmentary knowledge that does not correspond to the low international benchmark.

Compared to other TIMSS studies, the distribution of the 4th grade students across benchmarks was similar.

14% of the 8th grade students demonstrated advanced mathematics results, 33% – high achievement and 31% – intermediate. 17% showed low achievement results. 5% of the students have some fragmentary knowledge that does not correspond to the low international benchmark.

Compared to other TIMSS studies, the distribution of the 8th grade students across international benchmarks have improved: the number of the students with high and advanced achievement results increased (from 30% to 47%) and the number of the students with low achievement results decreased (from 36% to 23%).

For comparison, in top-performing countries 60-80% of the 4th and 8th grade students demonstrated advanced and high achievement results.

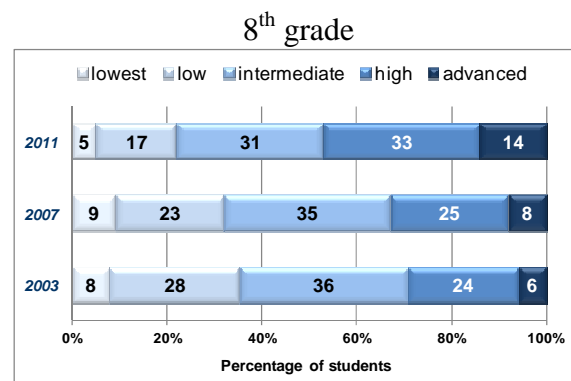
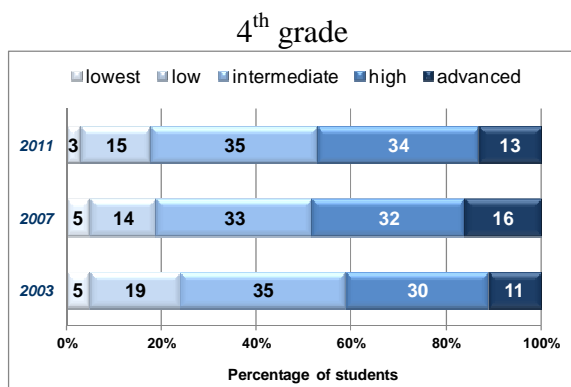
The mathematics achievement results of 8th grade students

Country	Average score	
Korea, Rep. of	613	(2,9) ⬆
Singapore	611	(3,8) ⬆
Chinese Taipei	609	(3,2) ⬆
Hong Kong SAR	586	(3,8) ⬆
Japan	570	(2,6) ⬆
Russian Federation	539	(3,6) =
Israel	516	(4,1) ⬇
Finland	514	(2,5) ⬇
United States	509	(2,6) ⬇
England	507	(5,5) ⬇
Hungary	505	(3,5) ⬇
Australia	505	(5,1) ⬇
Slovenia	505	(2,2) ⬇
Lithuania	502	(2,5) ⬇
TIMSS Scale Centerpoint	500	
Italy	498	(2,4) ⬇
New Zealand	488	(5,5) ⬇
Kazakhstan	487	(4,0) ⬇
Sweden	484	(1,9) ⬇
Ukraine	479	(3,9) ⬇
Norway	475	(2,4) ⬇
Armenia	467	(2,7) ⬇
Romania	458	(4,0) ⬇
United Arab Emirates	456	(2,1) ⬇
Turkey	452	(3,9) ⬇
Lebanon	449	(3,7) ⬇
Malaysia	440	(5,4) ⬇
Georgia	431	(3,8) ⬇
Thailand	427	(4,3) ⬇
Macedonia, Rep. of	426	(5,2) ⬇
Tunisia	425	(2,8) ⬇
Chile	416	(2,6) ⬇
Iran, Islamic Rep. of	415	(4,3) ⬇
Qatar	410	(3,1) ⬇
Bahrain	409	(2,0) ⬇
Jordan	406	(3,7) ⬇
Palestinian Nat'l Auth.	404	(3,5) ⬇
Saudi Arabia	394	(4,6) ⬇
Indonesia	386	(4,3) ⬇
Syrian Arab Republic	380	(4,5) ⬇
Morocco	371	(2,0) ⬇
Oman	366	(2,8) ⬇
Ghana	331	(4,3) ⬇

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The examples below illustrate what knowledge and skills students with advanced and low benchmarks can demonstrate

MATHEMATICS. Examples of test items

4th grade

Item 1

Content domain: Numbers

Cognitive domain: «Reasoning»

Benchmark: Advanced

Russia's result: 46%³

Countries' average: 25%

Maximum result: 59%

Minimum result: 0,2%

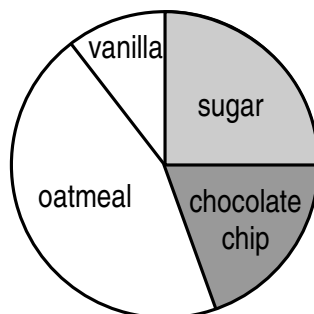
Three thousand tickets for a basketball game are numbered 1 to 3000. People with ticket numbers ending with 112 receive a prize. Write down all the prize-winning numbers.

Prize-winning numbers: _____

Expert's comment. Knowledge on whole numbers and numbers recording is tested. The task is challenging for the Russian students as they have to apply knowledge in a new situation. They have to draw conclusions based on numbers recording and take into account the problem conditions. The task is difficult because the students have to select numbers with two stated properties. Almost half of the Russian students solved the problem and gave the correct answer. This is high result and it is higher than average. However this result is lower than the maximum result of the top-performing country (Republic of Korea).

This chart shows the types of cookies sold by the local bakery.

Cookies Sold



Which type of cookie did the bakery sell most?

- (A) oatmeal
- (B) vanilla
- (C) chocolate chip
- (D) sugar

Item 2

Content domain: Data analysis

Cognitive domain: Applying knowledge in straightforward situations («Knowing»)

Benchmark: Low

Russia's result: 92%

Average: 76%

Maximum result: 98%

Minimum result: 28%

Expert's comment. Reading skills and interpretation of data represented in a pie-chart are tested. This content is not taught in Russian primary schools. The students have to understand what is "sell most" and realize that they need to compare squares of the pie-chart sectors to solve the problem. This task is difficult for the Russian students as they have to deal with a new situation. These types of tasks are not presented in the Russian textbooks. However, all Russian students tried to solve this problem and 92% gave the correct answer. High achievement result demonstrates that the Russian 4th grade students are well-informed and are active even in unknown situations.

8th grade

³ Percentage of students who solved the problem successfully.

Item 3

Content domain: Geometry

Cognitive domain: «Reasoning»

Benchmark: Advanced

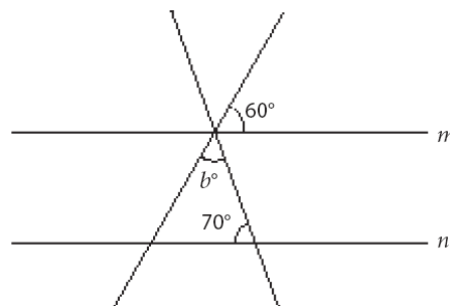
Russia's result: 48%

Countries' average: 31%

Maximum result: 86%

Minimum result: 13%

Expert's comment. This problem is referred as advanced in TIMSS. This task is challenging for the Russian 8th grade students because they have to apply knowledge at least of two facts. The solution is based on factual knowledge of angles' properties that were formed by parallel lines and a cut line. For example, the students can reason as following: an angle located between angles 60° and b° equals to 70°, because they are crosswise lying angles. The angle b° is adjacent to the angle which value equals to the sum of 60° and 70°. The answer is: $b^\circ = 180^\circ - (60^\circ + 70^\circ) = 50^\circ$.



Lines m and n are parallel.

What is the value of b ?

Answer: _____

Item 4

Content domain: Algebra

Cognitive domain: Applying knowledge in straightforward situations «Knowledge»

Benchmark: Low

Russia's average: 91%

Average: 69%

Maximum result: 92%

Minimum: 48%

Expert's comment. This is a standard task with a simple algebraic expression. The students have to put variables into this expression and calculate the value. The Russian students successfully solve this problem.

$$y = \frac{a+b}{c}$$

$$a = 8, b = 6, c = 2$$

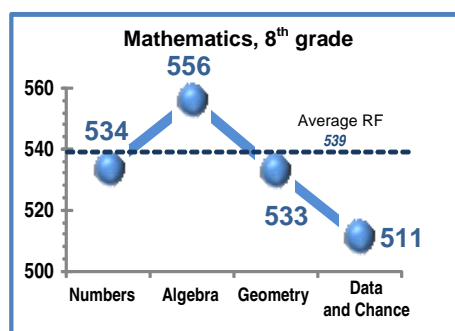
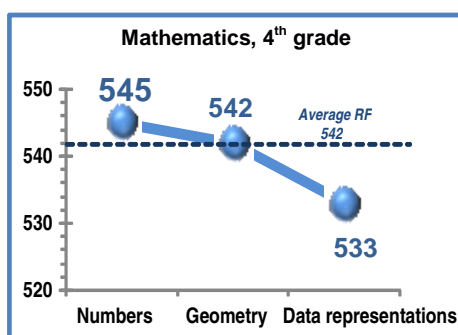
What is the value of y ?

- (A) 7
- (B) 10
- (C) 11
- (D) 14

Key features of TIMSS tests

TIMSS test booklet includes 4 blocks of items (two blocks on mathematics and two blocks on science). Each version of test booklet consists of 44-50 items for the 4th grade students and 55-60 items for the 8th grade students.

The testing time was 72 minutes with a break for the 4th grade students and 90 minutes with a break for the 8th grade students.



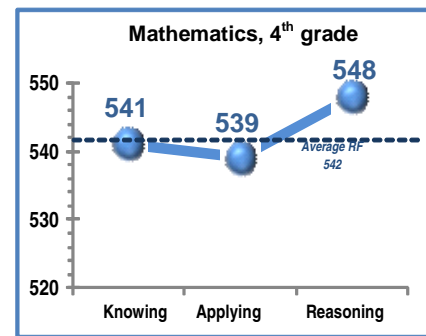
In 2011 the Russian 4th grade students demonstrated high achievement results in such content domains as “Numbers” and “Geometry”. Achievement results in “Data representation” were lower, but not significantly.

The Russian 8th grade students demonstrated the highest achievement results in “Algebra” content domain (556), which is higher than their average mathematics achievement results (539). The results in content domains “Numbers” and “Geometry” are comparable to average. The achievement results in “Data and Chance” content domain are significantly lower than average. The mathematics education of the Russian 8th grade students focused on “Algebra” content domain and such content domains as “Statistics. Probability” are not adequately taught.

The achievement results in content domains of the Russian 4th grade students did not change compared to the 2007 year achievement results. The results of the Russian 8th grade students significantly increased in each content domain: “Numbers” by 25 points, “Algebra” by 31 points, “Geometry” by 23 points and “Data and Chance” by 28 points. Most of all the achievement results increased in “Algebra” content domain.

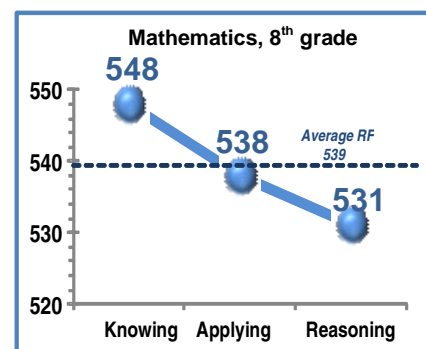
TIMSS. Mathematics			
4 th grade		8 th grade	
Content domains			
50%	Numbers	30%	Numbers
35%	Geometry	30%	Algebra
15%	Data representation	20%	Geometry
		20%	Data and Chance
Cognitive domains			
40%	Knowing	35%	Knowing
40%	Applying	40%	Applying
20%	Reasoning	25%	Reasoning

The Russian fourth graders equally successfully mastered cognitive skills “Knowing”, “Applying” and “Reasoning”. Average in “Knowing” is 541, in “Applying” – 539 and in “Reasoning” – 548. Cognitive activity of primary school students is balanced according to TIMSS benchmarks. There are no significant changes compared to the year 2007 results.



Cognitive activity of the 8th grade students is focused on applying knowledge in straightforward (standard) situations (average – 548). The achievement results in applying knowledge in relatively complex situations are lower (average – 538), the lowest results are in applying knowledge in unknown, new situations, complex and multi-step tasks, justification the solutions (average – 531).

The achievement results of the 8th grade students in acquiring all three types of cognitive skills increased (by 28–31 points). However, cognitive activity focused on applying knowledge in standard situations is dominated.



Why did the achievement results of the 8th grade students increase?

Expert’s answer. *The increasing of the Russian eighth graders achievement can be explained by various reasons. The main reason is that an independent state attestation of school graduates was introduced. The 9th and 11th grade students take compulsory mathematics examinations (State Final Examination-9 and Unified State Examination). There used to be a compulsory algebra examination until 2010. Thus, high achievement results in algebra can be explained by this.*

High achievement results in algebra compared to other content domains could be also explained by special features of mathematical education: more than half of study time in 7th-9th grades is given to algebra (3 academic hours per week, from 5 academic hours per week). The increase in achievement results in the content domain “Probability, Statistics” can be explained by introducing this subject area in Russian secondary schools in 2004.

An overall rise in mathematics achievement results can be explained by the rise in reading literacy of the Russian primary school graduates in 2006-2007 (they took the first place in PIRLS-2006). These well-prepared students moved up in secondary school and participated in TIMSS-2011.

SCIENCE. Key testing results.

The science achievement results of the 4th grade students

Country	Average	
Korea, Rep. of	587 (2,0)	⬆
Singapore	583 (3,4)	⬆
Finland	570 (2,6)	⬆
Japan	559 (1,9)	=
Russian Federation	552 (3,5)	=
Chinese Taipei	552 (2,2)	=
United States	544 (2,1)	⬇
Czech Republic	536 (2,5)	⬇
Hong Kong SAR	535 (3,8)	⬇
Hungary	534 (3,7)	⬇
Sweden	533 (2,7)	⬇
Slovak Republic	532 (3,8)	⬇
Austria	532 (2,8)	⬇
Netherlands	531 (2,2)	⬇
England	529 (2,9)	⬇
Denmark	528 (2,8)	⬇
Germany	528 (2,9)	⬇
Italy	524 (2,7)	⬇
Portugal	522 (3,9)	⬇
Slovenia	520 (2,7)	⬇
Northern Ireland	517 (2,6)	⬇
Ireland	516 (3,4)	⬇
Croatia	516 (2,1)	⬇
Australia	516 (2,8)	⬇
Serbia	516 (3,1)	⬇
Lithuania	515 (2,4)	⬇
Belgium (Flemish)	509 (2,0)	⬇
Romania	505 (5,9)	⬇
Spain	505 (3,0)	⬇
Poland	505 (2,6)	⬇
TIMSS Scale Centerpoint	500	
New Zealand	497 (2,3)	⬇
Kazakhstan	495 (5,1)	⬇
Norway	494 (2,3)	⬇
Chile	480 (2,4)	⬇
Thailand	472 (5,6)	⬇
Turkey	463 (4,5)	⬇
Georgia	455 (3,8)	⬇
Iran, Islamic Rep. of	453 (3,7)	⬇
Bahrain	449 (3,5)	⬇
Malta	446 (1,9)	⬇
Azerbaijan	438 (5,6)	⬇
Saudi Arabia	429 (5,4)	⬇
United Arab Emirates	428 (2,5)	⬇
Armenia	416 (3,8)	⬇
Qatar	394 (4,3)	⬇
Oman	377 (4,3)	⬇
Kuwait	347 (4,7)	⬇
Tunisia	346 (5,3)	⬇
Morocco	264 (4,5)	⬇
Yemen	209 (7,3)	⬇

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⬇ An average country score is statistically significantly lower than the average score of Russia

The Russian 4th and 8th grade students' science achievement results are much higher than achievement results of the students from most other countries participated in TIMSS-2011.

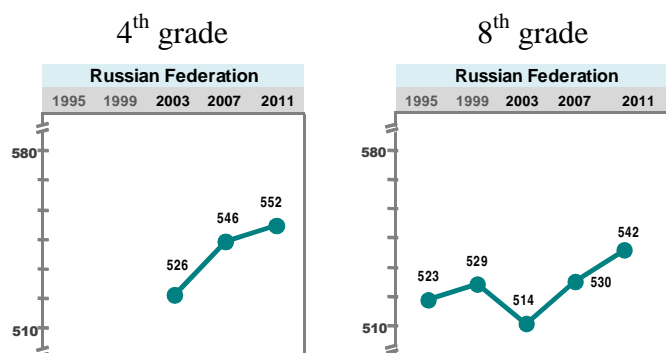
The achievement results of the 4th grade students equals to **552 points**, the 8th students reached **542 points**.

Only few countries outperformed Russia in this study:

4th grade: three countries from 50 (Republic of Korea, Singapore and Finland) outperformed Russia. There is no significant difference in achievement results of the Russian, Japanese and Chinese Taipei students.

8th grade: five countries from 42 (Singapore, Chinese Taipei, Republic of Korea, Japan and Finland) outperformed Russia. There is no significant difference in the achievement results of Russia, Slovenia, Hong Kong and England.

Compared to 2003, there is a positive trend in achievement results of the 4th and 8th grade students. The achievement results of the 4th grade students increased by 26 points, and 8th grade students – by 28 points.



In TIMSS four benchmarks were identified: low, intermediate, high and advanced.

16% of the Russian 4th grade students reached advanced benchmark, 36% – high, 34% – intermediate, and 12% – low benchmark. 2% of the Russian 4th grade students did not demonstrate even elementary science knowledge.

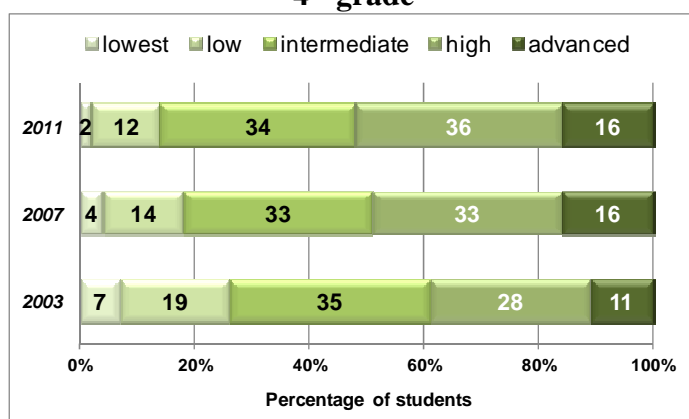
14% of the 8th grade students reached advanced benchmark, 34% – high, 33% – intermediate, and 15% – low benchmark. 4% of the 8th grade students did not reach even low benchmark.

In top-performing countries 65-70% of the 4th and 8th grade students reached advanced and high benchmarks. In Russia there are only about 50% of such students.

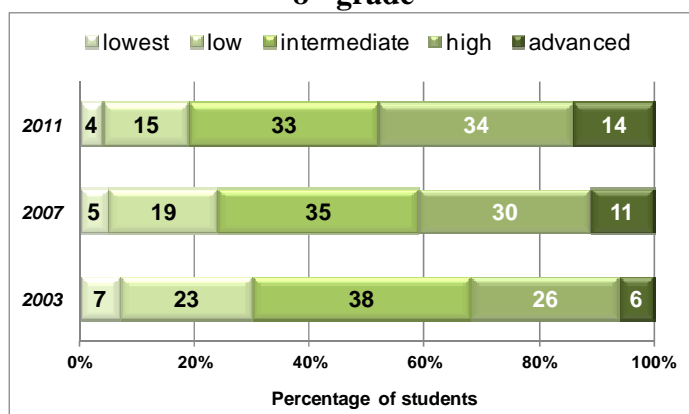
Compared with previous TIMSS studies, the number of the 4th grade students achieved advanced and high results increased, and the number of the students with low and lowest results decreased.

Compared to 2003 and 2007 studies, the number of eighth graders achieved intermediate, high and advanced results increased.

4th grade



8th grade



The science achievement results of the 8th grade students

Country	Average	
Singapore	590 (4,3)	▲
Chinese Taipei	564 (2,3)	▲
Korea, Rep. of	560 (2,0)	▲
Japan	558 (2,4)	▲
Finland	552 (2,5)	▲
Slovenia	543 (2,7)	=
Russian Federation	542 (3,2)	=
Hong Kong	535 (3,4)	=
England	533 (4,9)	=
United States	525 (2,6)	▼
Hungary	522 (3,1)	▼
Australia	519 (4,8)	▼
Israel	516 (4,0)	▼
Lithuania	514 (2,6)	▼
New Zealand	512 (4,6)	▼
Sweden	509 (2,5)	▼
Italy	501 (2,5)	▼
Ukraine	501 (3,4)	▼
TIMSS Scale Centerpoint	500	
Norway	494 (2,6)	▼
Kazakhstan	490 (4,3)	▼
Turkey	483 (3,4)	▼
Iran, Islamic Rep.of	474 (4,0)	▼
Romania	465 (3,5)	▼
United Arab Emirates	465 (2,4)	▼
Chile	461 (2,5)	▼
Bahrain	452 (2,0)	▼
Thailand	451 (3,9)	▼
Jordan	449 (4,0)	▼
Tunisia	439 (2,5)	▼
Armenia	437 (3,1)	▼
Saudi Arabia	436 (3,9)	▼
Malaysia	426 (6,3)	▼
Syrian Arab Republic	426 (3,9)	▼
Palestine Nat'l Auth.	420 (3,2)	▼
Georgia	420 (3,0)	▼
Oman	420 (3,2)	▼
Qatar	419 (3,4)	▼
Macedonia, Rep. of	407 (5,4)	▼
Lebanon	406 (4,9)	▼
Indonesia	406 (4,5)	▼
Morocco	376 (2,2)	▼
Ghana	306 (5,2)	▼

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The examples below illustrate what knowledge and skills the high and low performed students can demonstrate.

Science: examples of test items
4th grade

Item 5

Content domain: Physical science

Cognitive domain: «Reasoning»

Benchmark: Advanced

Russia's result: 27%

Countries' average: 26%

Maximum result: 66%

Minimum: 1%

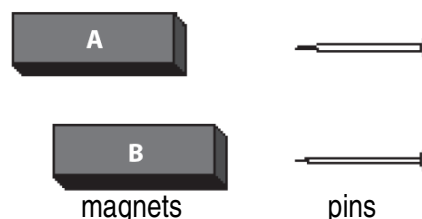
Expert's comment. *Ability to analyze experiment's outcomes, find a mistake in an experiment-based conclusion, justify your answer is tested. To solve the problem the students have to understand that "a magnet power" is measured through a distance from which the magnet starts attracting the pin.*

The Russia's result is almost equal to average international. This can be explained by the fact that national courses of science in primary schools do not pay enough attention to conducting experiments and making observations.

Lisa has two magnets (A and B) and two metal pins that are the same.

She moved the magnet A along a table, so that the nail was attracted by the magnet.

She moved the magnet B along the table, so that the second nail was attracted by the magnet.



Lisa finds that Magnet A attracts the pin from 15cm and Magnet B attracts the pin from 10cm.

Sergei says that both magnets are equally strong.

Do you agree with Sergei?

Check one box.

☐ Yes

☐ No

Explain your answer.

Item 6

What do birds, bats and butterflies have in common?

- (A) feathers
- (B) hair
- (C) internal skeleton
- (D) wings

Content domain: Biology

Cognitive Activity: «Applying»

Benchmark: Low

Russia's results: 92%

Countries' average: 83%

Maximum result: 99%

Minimum result: 31%

Expert's comment. *Factual knowledge of mammals', birds and insects characteristics is tested. Ability to identify a common characteristic for these animals is also tested. The Russian students demonstrate high achievement results, although such tasks are not typical for national textbooks.*

8th grade

Item 7

Content domain: Geography

Cognitive domain: «Reasoning»

Benchmark: Advanced

Russia's result: 31%

Countries' average: 18%

Maximum result: 48%

Minimum result: 2%

Two continents are separated by water.

Geologists are looking for evidence that the two continents were once joined.

What fossil evidence would support this idea?

Expert's comment. *The task tests ability to analyze research stages and prove the hypothesis. The answer should include the statement that similarity of the fossils can be used to prove the hypothesis that the continents were used to be a single unit.*

The achievement results in completing this task are higher than international average. However, Russia lags behind top-performing countries and this is typical for tasks where a detailed answer and explanation and reasoning are required. In the national practice of teaching science it is necessary to use tasks that require detailed answers to develop logical skills and coherent written skills.

What is the chemical formula for carbon dioxide?

- (A) CO
- (B) CO₂
- (C) C
- (D) O₂

Item 8

Content domain: Chemistry

Cognitive domain: «Knowledge»

Benchmark: Low

Russia's average: 92%

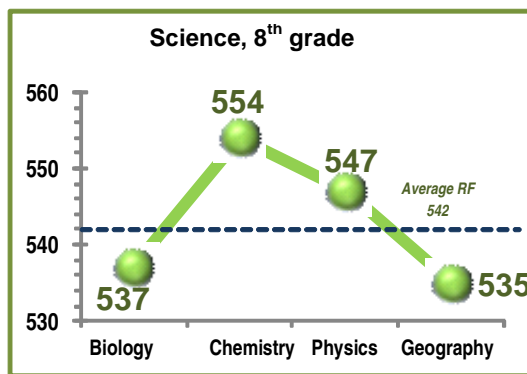
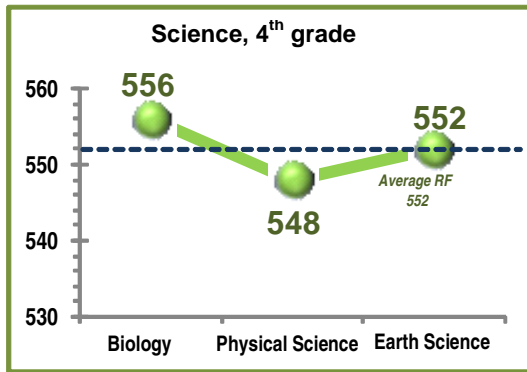
Countries' average: 85%

Maximum result: 99%

Minimum result: 59%

Expert's comment. *Knowledge of carbon dioxide formula is tested.*

The Russian students successfully completed this task because signs of chemical elements chemical symbols and formula of carbon dioxide are introduced to them during their first year of studying chemistry.



There is no significant difference in average results in different content domains of the 4th grade students.

The 8th grade students demonstrate highest achievement results in chemistry and physics.

Compared to the previous study (2007) there is no significant changes in the achievement results of the fourth graders in different content domains.

The achievement results of the eighth graders in all content domains (except geography) increased. The highest increase is in physics content domain (by 26 points).

Science part. TIMSS			
4 th grade		8 th grade	
Content domains			
45%	Biology	35%	Biology
35%	Physical sciences	20%	Chemistry
20%	Earth Science	25%	Physics
		20%	Earth Science
Cognitive domains			
40%	Knowledge	35%	Knowledge
40%	Applying	35%	Applying
20%	Reasoning	30%	Reasoning

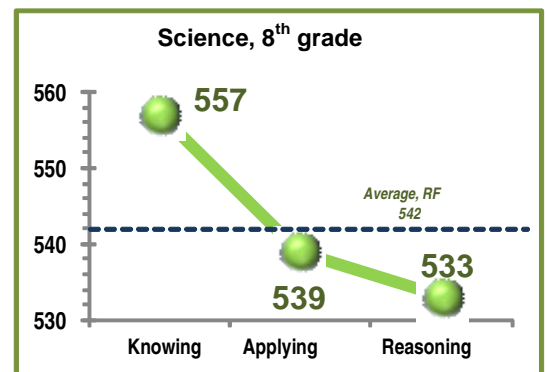
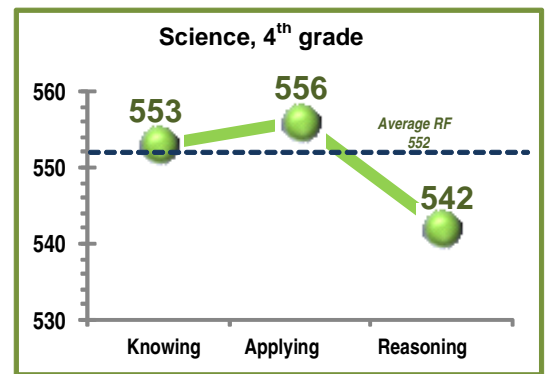
The results in different cognitive domains differ considerably for the fourth graders. The students achieved 553 points in tasks that assess knowledge of scientific facts (“Knowing”), applying of knowledge – 556 points. The lowest result (542 points) is showed in tasks with “Reasoning” where the students have to explain natural phenomena or observations and experiments.

Compared to 2007 there are no considerable changes in achievement results in cognitive domains for the 4th grade students

Top-performing countries demonstrate a different another pattern: the highest results were achieved in tasks with reasoning and problem solving. The achievement results of the leading top-performing countries considerably increased in this cognitive domain compared to 2007 year results.

The Russian 8th grade students have the advanced results in cognitive domain “Knowing” where factual knowledge and its application in typical situations is tested (557 points). The lowest results (533 points) are in domain “Reasoning”, where explanations, justification and problem solving skills are tested.

The achievement results of the Russian 8th graders in all cognitive domains have been increased over the last years. The highest increase is showed in tasks that assess knowledge of various scientific facts and procedures.



The reasons for increasing achievement results of the 8th grade students in TIMSS

Expert’s answer. One of the reasons for increasing achievement results is introduction of an independent state attestation (State Final Examination) of school graduates from 2008. Developing assessment tools on science subjects helped teachers to understand requirements to final learning outcomes. Introducing of new tasks focused on assessing new content domains and cognitive activities and contributed to reorientation of teaching process on the formation of new learning outcomes, for example, developing skills of conducting experiments. Moreover, teachers received quality tools for classroom assessment.

What changes occur in the educational achievements of students when they move from primary to secondary school?

TIMSS is carried out every 4 years. Educational achievements of primary school students (4th grade) and secondary school students (8th grade) are assessed. It enables researches to:

- conduct **comparative study** on educational achievements of primary and secondary school students from different countries;
- identify **trends** in quality development of mathematics and science education in primary and secondary school;
- identify **changes** in mathematics and science education that occur when students move from primary to secondary school (the **same sample** of students is examined: as the 4th grade students become 8th grade students in 4 years).

The following table demonstrates mathematics and science average scores of the Russian 4th and 8th grade students in 2003, 2007 and 2011 years.

Mathematics Average scores			
Russia	2003 year	2007 year	2011 year
4 th grade	532	544	542
8 th grade	508	512	539

Science Average			
Russia	2003 year	2007 year	2011 year
4 th grade	526	546	552
8 th grade	514	530	542

Data analysis demonstrates that education achievements of primary school students changed when they go to secondary school. The sample of 4th graders participated in the study in 2003 and 8th grade students participated in 2007 demonstrated higher than average (500 points) results in mathematics (by 32 points) and in science (by 26 points). The fourth graders who became eighth graders in 2007 demonstrated higher than average results in mathematics (by 12 points) and in science (by 30 points). In this way, However, in 2007, after moving to secondary school the mathematics results of the same sample of students dropped by 20 points (Grade 4 – 532, Grade 8 – 512) within their transition from primary to secondary school, and their results in science slightly increased by 4 points (Grade 4 – 526, Grade 8 – 530).

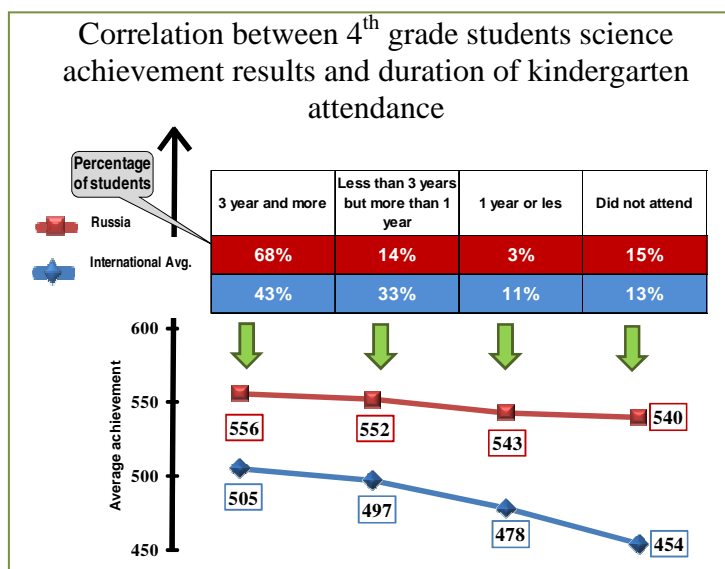
The mathematics and science results of the 4th grade students (2007 year) within their transition from primary to secondary school slightly decreased (by 4-5 points)/

In 2011, after transition from primary to secondary school the mathematics results (Grade 4 – 544, Grade 8 – 539) and science results (Grade 4 – 546, Grade 8 – 542) of the same sample of students decreased by 4-5 points.

Therefore, the mathematics achievement results of the Russian 8th grade students in 2007 were much lower than the achievement results of the 4th grade students in 2003. In 2011 the mathematics and science achievement results of the 8th grade students were equal to mathematics and science achievement results of the 4th grade students in 2007.

Factors contributing to the highest achievement results in mathematics and science

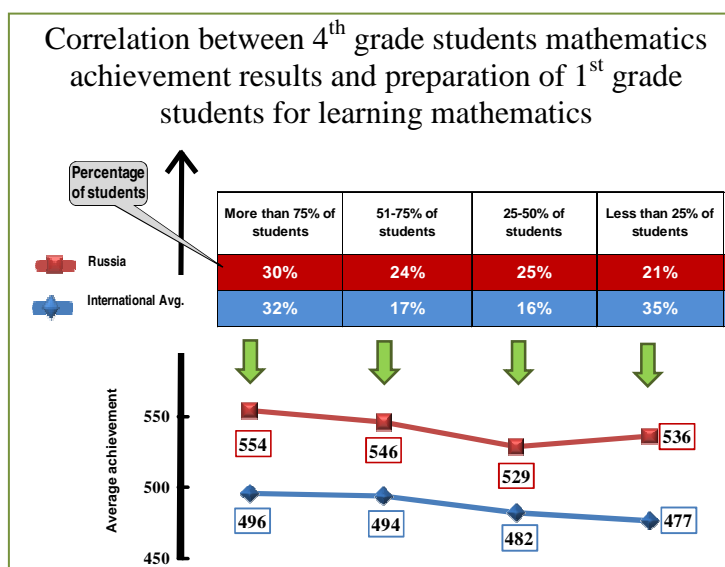
Quality pre-school education contributes to successful learning of mathematics and science in primary school



TIMSS results demonstrate positive correlation between duration of pre-school education institutions attendance and 4th grade students' mathematics and science achievement results. The 4th grade students who attended kindergartens for 2 or 3 years have the highest mathematics and science achievement results. There are 68% of such students in Russia.

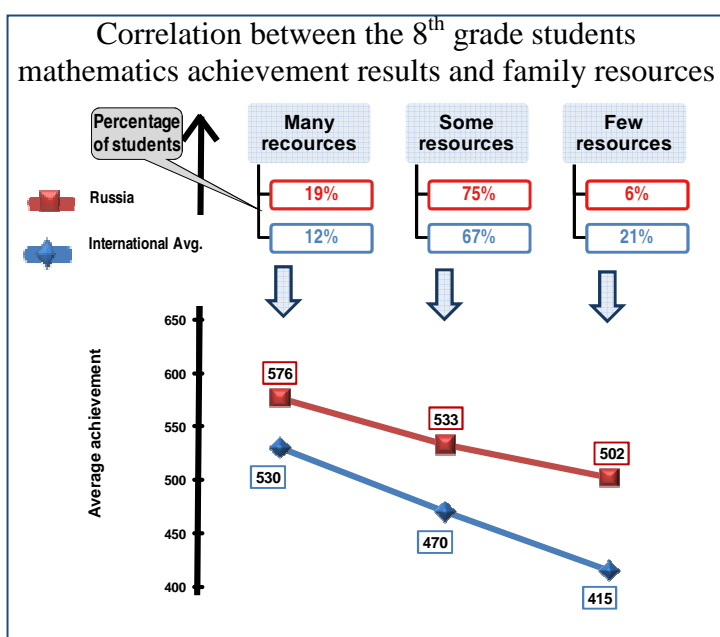
The received data indirectly confirms the effectiveness of pre-school preparation. According to school principals 30% of the Russian students study at schools where the majority of the 1st grade students have a high level of readiness for learning mathematics.

About 20% of the students study at schools with poor pre-school preparation. These students show lower achievement results.



The level of pre-school preparation for learning mathematics was identified through school administration surveys. They had to assess the number of the 1st grade students who can count up to 100, who can recognize, name and write down numbers from 1 to 10.

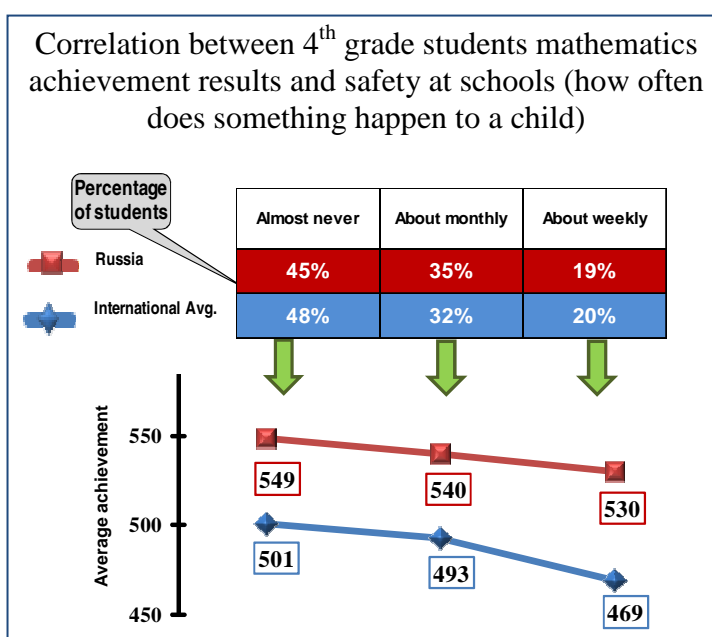
Family as a resource for learning



According to TIMSS-2011 findings, the highest mathematics and science achievement results are demonstrated by the 4th and 8th grade students whose families have enough resources to support learning. The international indicator “home resources for learning” includes: 1) educational background of parents, 2) parents’ occupation (only for 4th grade students), 3) the total number of books at home, 4) the number of books for children (only for 4th grade students), 5) Internet access and availability of a personal room.

Only 16% of the 4th grade Russian students and 19% of the 8th grade students participated in the study belong to a well-resourced families. There are more than 30% such students in Norway, Australia, Sweden, Finland, Republic of Korea.

Most successful educational institutions

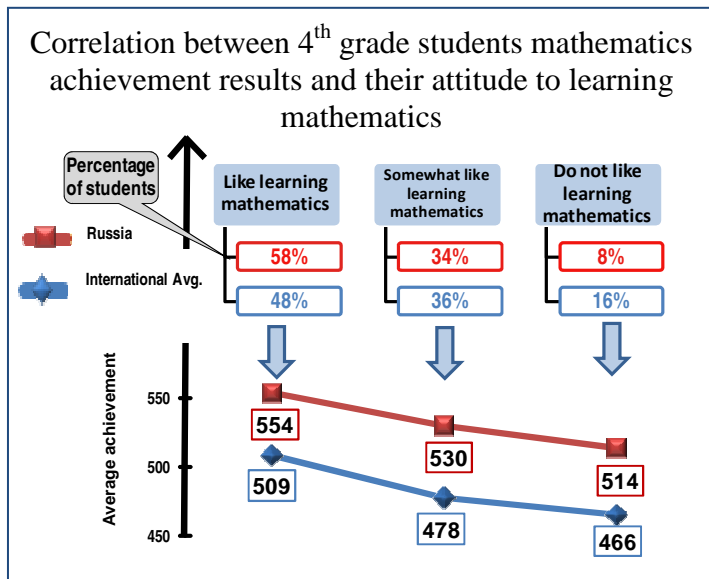


Similarly to previous studies, TIMSS-2011 findings demonstrate that the best achievement results are showed by the 4th and 8th grade students who study at educational institutions with the following characteristics:

- they have enough resources for education;
- they have more children from socially well-off families;
- they put emphasis on academic success;
- children feel safe at these schools.

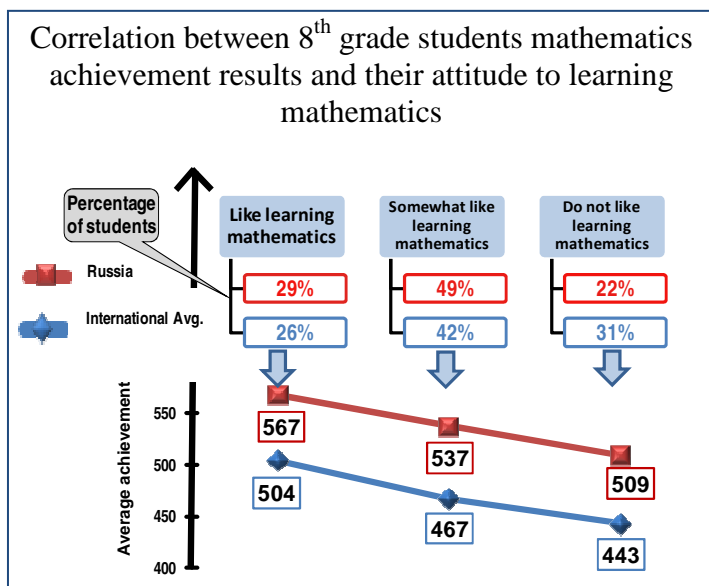
In Russia the factor related to schools’ safety is one of the most important in defining efficiency of educational institutions. Those students who always feel safe at school have better results in mathematics and science. This is true both for 4th and 8th grade students.

Best students have positive attitudes to learning mathematics and science

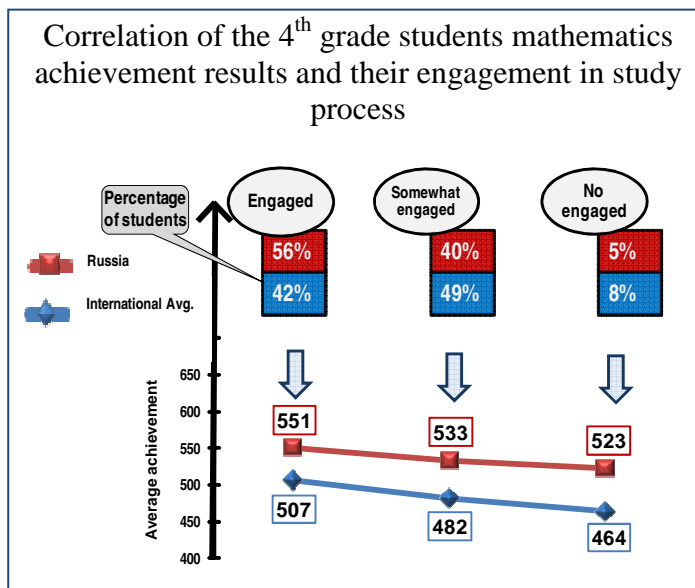


The Russian students' positive attitude to learning is related to their achievement results in TIMSS. The students who performed well have positive attitudes to learning mathematics and science. However, interest in learning mathematics and science decreases when the students finish primary school and start secondary school – fewer eighth graders indicate an interest in the study of both mathematics and science subjects. 58% of the 4th grade students like learning mathematics and only 29% of the 8th grade students are interested in learning mathematics.

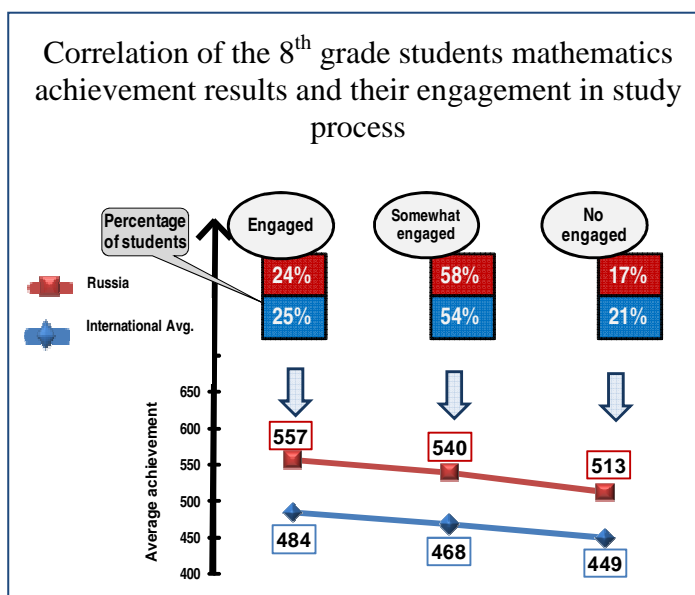
Increasing motivation for learning is the key factor in education quality enhancement!



High cognitive activity of students – a key to success!



Highly successful performed students according to TIMSS results are those who are actively engaged in studying process: they understand teacher's requirements, they listen attentively to teacher's explanations, and not distracted from a lesson. Thus, the difference in mathematics achievement results for the students actively engaged in study process and for students who not engaged equals to 28 points for the 4th grade students and 44 points for the 8th grade students. It should be noted that the number of students actively engaged in lessons decreased after transition from primary to secondary school. There are 56% of the 4th grade students actively engaged in study process and only 24% of the 8th grade students who actively engaged in lessons.



The received data demonstrated that the Russian schools differ significantly from schools in other countries. In particular, in Russian schools the large amount of study time is given to testing (in 2011 the study revealed that this time was even increasing in mathematics lessons for 8th grade students). In Russia 97% of 8th grade students have tests in mathematics every 2 weeks.

Only in Taiwan students have tests so frequently. In Finland, only 1% of eighth graders are tested often. Data varies in top-performing countries: 15% in Japan and 46% in Republic of Korea.

Experts' opinions

How can school mathematics and science education be improved on the basis of TIMSS findings

Mathematics expert

It is important to ensure every student success in learning in accordance with his/her educational needs and interests. In 2011 the significant number of students (23%) demonstrated low mathematics achievement results. The study revealed decreasing interest in learning mathematics and low levels of students' cognitive independence. To solve these and other problems, it is necessary to revise the content of mathematics education: keep its fundamentality but exclude some unnecessary theoretical material. The released school hours should be used to increase students' interest in mathematics, to motivate students, to teach them how to apply mathematical knowledge in various educational and real-life situations, to develop their ability to independent continuous self-education.

Expert in Science.

The frame of TIMSS study is the result of agreed consensus of experts from 50 countries participated in the study. Thus, TIMSS frame includes content which is considered important for learning and is taught in the majority of countries. Comparison of TIMSS framework with the Russian school exemplary programs that meet the new standards in 2009 enables us to make the following conclusions:

- 1. "Science" taught at primary school includes less study material than international content (TIMSS). In the Russian primary school the amount of content in the part "Science" in the course "The world around us" is less than in international TIMSS framework. For example, physical phenomena are not taught at the Russian primary school. The 21st century children get acquainted with electrical phenomena in 8th grade only. Obviously, the time has come to review the content of the historically established science course in the primary school, intensifying attention to the study of the elements of physical, chemical and geographical knowledge.*
- 2. For the basic school the national courses of biology, physics, chemistry and geography include more factual materials than in TIMSS. High achievement results of the Russian students are based on their factual knowledge and ability to apply them in straightforward situations. However the students do not have enough time to think over the received knowledge and learn how to apply it in non-standard situations. The content of science education should contain less factual knowledge; and teaching materials should include tasks based on real-life situations that require complex cognitive skills such as project and research skills.*

The results of TIMSS-2011 are presented on the websites:

Center for Evaluating the Quality of Education – <http://www.centeroko.ru>

International Study Centre– <http://timssandpirls.bc.edu/>

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The list of Russian regions participated in TIMSS-2011

- | | |
|---|---|
| 1. Republic of Bashkortostan (4, 8 grades) | 26. Kostroma region (4, 8 grades) |
| 2. Republic of Dagestan (4, 8 grades) | 27. Kursk region (4, 8 grades) |
| 3. Republic of Sakha (Yakutia) (4, 8 grades) | 28. Lipetsk region (4 grade) |
| 4. Republic of North Ossetia – Alania (4, 8 grades) | 29. Moscow region (4, 8 grades) |
| 5. Republic of Tatarstan (4, 8 grades) | 30. Murmansk region (4 grade) |
| 6. Chuvashi Republic (4, 8 grades) | 31. Nizhni Novgorod region (4, 8 grades) |
| 7. Altai territory (4, 8 grades) | 32. Novgorod region (8 grades) |
| 8. Krasnoyarsk territory (4, 8 grades) | 33. Novosibirsk region (4, 8 grades) |
| 9. Krasnodar territory (4, 8 grades) | 34. Orenburg region (4, 8 grades) |
| 10. Primorsky territory (4 grade) | 35. Perm territory (4, 8 grades) |
| 11. Stavropol territory (4, 8 grades) | 36. Rostov region (4, 8 grades) |
| 12. Amur region (8 grade) | 37. Ryazan region (8 grade) |
| 13. Arkhangelsk region (4 grade) | 38. Samara region (4, 8 grades) |
| 14. Astrakhan region (4, 8 grades) | 39. Saratov region (4, 8 grades) |
| 15. Belgorod region (4 grade) | 40. Sverdlovsk region (4, 8 grades) |
| 16. Bryansk region (8 grade) | 41. Tver region (4 grade) |
| 17. Volgograd region (4, 8 grades) | 42. Tomsk region (4, 8 grades) |
| 18. Vologda region (8 grade) | 43. Tula region (8 grade) |
| 19. Voronezh region (4, 8 grades) | 44. Ulyanovsk region (4, 8 grades) |
| 20. Ivanovo region (4 grade) | 45. Chelyabinsk region (4, 8 grades) |
| 21. Irkutsk region (4, 8 grades) | 46. Zabaikalsk territory (4, 8 grades) |
| 22. Kaliningrad region (8 grade) | 47. The City of Moscow (4, 8 grades) |
| 23. Kaluga region (8 grade) | 48. The City of Sankt-Petersburg (4, 8 grades) |
| 24. Kamchatka territory (4 grade) | 49. Khanty-Mansijsk autonomous district (4, 8 grades) |
| 25. Kemerovo region (4, 8 grades) | 50. Yamalo-Nenets autonomous district (4, 8 grades) |