# Chapter 2. Innovation in practices to develop technical skills in mathematics

*This chapter presents the change in maths education teaching and learning practices aimed at developing student content and procedural knowledge. The change within countries is presented as an increase or decrease in the share of students exposed to the practice. The percentage point change is also expressed as a standardised effect size in the final table.*

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

## 1. Memorising rules, procedures and facts as a pedagogical technique in mathematics

**Why it matters**

Memorising facts, rules and procedures is part of all learning strategies. Often associated to "traditional" and relatively "teacher-centred" approaches to teaching and learning, memorisation should be seen as part of the mix of pedagogical practices that teachers should use. Good teachers will find the right dosage with other, more active learning practices. An increase of these practices is often related to the existence of high-stakes exams or assessments in education systems.

### Primary education

**Change at the OECD level: large**

In primary education, this practice has mainly expanded in the OECD area. On average it has increased by 21 percentage points, with 43% of mathematics students being asked to memorise facts and procedures in at least half of their lessons in 2015 against 22% in 2007. The absolute change of also 21 percentage points, including both positive and negative changes, corresponds to a large effect size of 0.5. There are large disparities in the shares of students regularly asked to memorise for learning: from 22% in Germany in 2015, to almost 80% in Slovenia.

**Countries where there has been the most change**

Turkey is by far the country that has experienced the largest decrease in this pedagogical practice, with a decrease of over 33.5 percentage points between 2007 and 2015. In Slovenia the share of students concerned has increased by more than 50 percentage points. Lithuania, the Netherlands, England (United Kingdom) and Quebec (Canada) have also highly innovated in the use of this practice with increases by more than 30 percentage points.

### Secondary education

**Change at the OECD level: large**

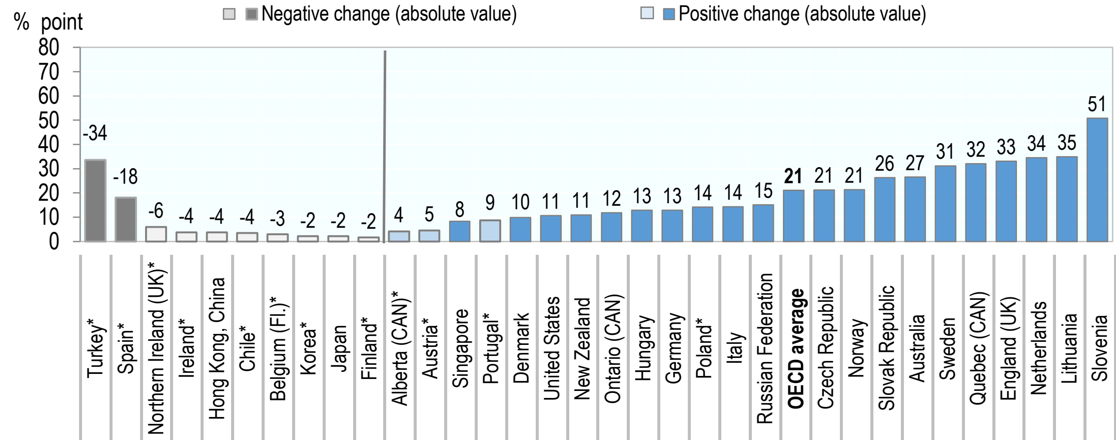
In secondary education, most OECD countries have experienced an expansion of this practice resulting in an average increase of 14 percentage points. The change, be it positive or negative, has amounted to 19 percentage points on average, corresponding to a large effect size of 0.4. In 8th grade mathematics, this practice is common across countries in spite of large variations. For instance, 32% of 8th grade students were asked to memorise rules, procedures and facts in at least half of their mathematics lessons in Ontario (Canada) in 2015, compared to 80% in Slovenia.

**Countries where there has been the most change**

Secondary education presents similar patterns as primary education. Turkey shows the largest decrease in this pedagogical practice with a contraction of over 29 percentage points between 2007 and 2015. Italy and Slovenia registered the largest increases, over 40 percentage points. The spread of this practice in Sweden, England, Australia and Indonesia was also remarkable.

**Figure 2.1. 4th grade students memorising rules, procedures and facts in maths**

Change in and share of students whose teachers ask them to memorize rules, procedures and facts in at least half the lessons, 2007-2015, teachers report




| % of students | Turkey* | Spain* | Northern Ireland (UK)* | Ireland* | Hong Kong, China | Chile* | Belgium (Fl.)* | Korea* | Japan | Finland* | Alberta (CAN)* | Austria* | Singapore | Portugal* | Denmark | United States | New Zealand |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2015 | 49 | 48 | 58 | 68 | 22 | 63 | 25 | 67 | 71 | 43 | m | m | 41 | 74 | 22 | 46 | 24 |
| 2011 | 82 | 66 | 64 | 72 | 17 | 67 | 28 | 69 | 77 | 45 | 22 | 14 | 45 | 66 | 29 | 62 | 35 |
| 2007 | m | m | m | m | 26 | m | m | m | 73 | m | 18 | 10 | 33 | m | 12 | 35 | 13 |

| % of students | Ontario (CAN) | Hungary | Germany | Poland* | Italy | Russian Federation | **OECD average** | Czech Republic | Norway | Slovak Republic | Australia | Sweden | Quebec (CAN) | England (UK) | Netherlands | Lithuania | Slovenia |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2015 | 30 | 31 | 22 | 71 | 68 | 61 | **43** | 29 | 30 | 37 | 43 | 37 | 54 | 55 | 62 | 79 | 79 |
| 2011 | 33 | 29 | 22 | 57 | 64 | 64 | **42** | 22 | 34 | 35 | 45 | 30 | 66 | 55 | 46 | 78 | 27 |
| 2007 | 18 | 18 | 9 | m | 54 | 46 | **22** | 8 | 9 | 10 | 16 | 6 | 22 | 22 | 28 | 45 | 28 |

*Note*: Darker tones correspond to statistically significant values.
* refers to calculations based on other years, based on data availability.
The OECD average is based on OECD countries with available data in 2007, 2011 and 2015.
*Source*: Authors' calculations based on TIMSS Databases.

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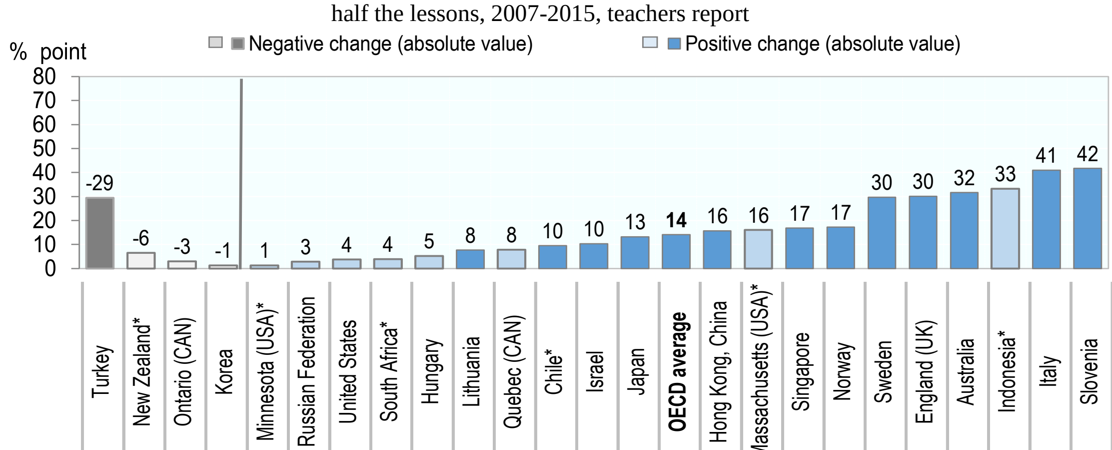
**Figure 2.2. 8th grade students memorising rules, procedures and facts in maths**

Change in and share of students whose teachers ask them to memorize rules, procedures and facts in at least half the lessons, 2007-2015, teachers report




| % of students | Turkey | New Zealand* | Ontario (CAN) | Korea | Minnesota (USA)* | Russian Federation | United States | South Africa* | Hungary | Lithuania | Quebec (CAN) | Chile* | Israel |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2015 | 35 | 39 | 32 | 60 | m | 75 | 41 | 69 | 46 | 84 | 47 | 64 | 54 |
| 2011 | 90 | 45 | 35 | 80 | 37 | 78 | 57 | 65 | 49 | 84 | 65 | 55 | 64 |
| 2007 | 65 | m | 35 | 61 | 35 | 72 | 37 | m | 40 | 76 | 39 | m | 43 |

| % of students | Japan | **OECD average** | Hong Kong, China | Massachusetts (USA)* | Singapore | Norway | Sweden | England (UK) | Australia | Indonesia* | Italy | Slovenia |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2015 | 71 | **52** | 40 | m | 44 | 32 | 40 | 52 | 63 | m | 74 | 80 |
| 2011 | 83 | **60** | 39 | 44 | 55 | 41 | 50 | 47 | 65 | 85 | 85 | 35 |
| 2007 | 57 | **38** | 24 | 28 | 27 | 15 | 10 | 22 | 31 | 51 | 33 | 39 |

*Note*: Darker tones correspond to statistically significant values.
* refers to calculations based on other years, based on data availability.
The OECD average is based on OECD countries with available data in 2007, 2011 and 2015.
*Source*: Authors' calculations based on TIMSS Databases.

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## 2. Practising skills and procedures in computers in mathematics

**Why it matters**

Practice makes perfect. Part of the mastery of mathematics relies on implementing and practising the procedural knowledge one has acquired. While computers can now make complex calculations with perfect accuracy, part of this procedural knowledge allows students to understand how mathematicians think and assess how to deal with mathematical problems. This pedagogical practice needs to be supplemented by other pedagogical practices requiring more thinking from the student, but computers are a good medium for this kind of learning.

### Primary education

**Change at the OECD level: large**

Across the OECD area, the share of students using computers regularly for practising skills and procedures during 4th grade mathematics lessons increased by 42 percentage points on average between 2007 and 2015. The average absolute change during this time period is also at 42 percentage points, corresponding to a very large effect size of 1. The extent to which students are exposed to this practice varies significantly across countries, from 5% in Japan to over 77% in the Netherlands in 2015.

**Countries where there has been the most change**

This practice has been a significant pedagogical innovation in New Zealand, where it expanded the most between 2007 and 2015 (74 percentage points), followed by Australia and the United States (over 60 percentage points). Korea, Chile, Belgium (Fl.) and Portugal have experienced declines above 12 percentage points in this practice, although these more modest negative changes were only measured between 2011 and 2015.

### Secondary education

**Change at the OECD level: large**

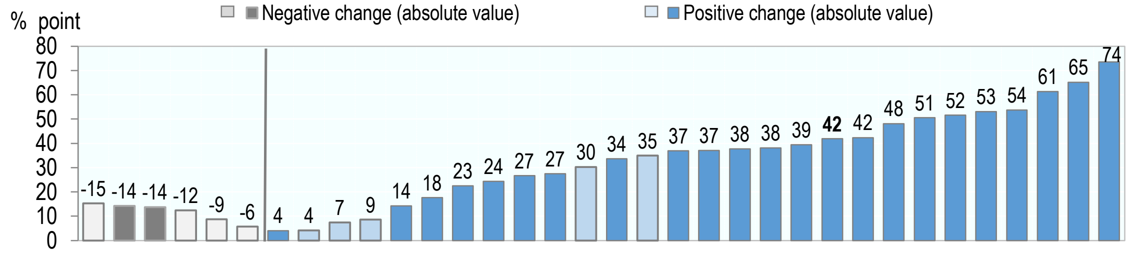
The share of students frequently using computers for practising skills and procedures during 8th grade mathematics lessons has expanded by 23 percentage points on average. Only Chilean students experienced a contraction in this domain (between 2011 and 2015). The average change between 2007 and 2015 has been positive for all OECD countries, around 23 percentage points, corresponding to a very large effect size of 0.6. At the OECD level, the share of 8th grade students regularly using this learning strategy ranged from nearly 8% in Slovenia to over 57% in the United States in 2015.

**Countries where there has been the most change**

The share of students using this practice has increased by 44 percentage points in Australia and the United States between 2007 and 2015. Chile is the only country where it has contracted, by 15 percentage points between 2011 and 2015.

**Figure 2.3. 4th grade students using computers to practice skills and procedures in maths**

Change in and share of students who frequently practise skills and procedures on computers during mathematics lessons, 2007-2015, teachers report




| % of students | Korea* | Chile* | Belgium (Fl.)* | Portugal* | Spain* | Northern Ireland (UK)* | Japan | Ireland* | Turkey* | Poland* | Finland* | Germany | Slovenia | Hong Kong, China | Singapore | Czech Republic | Austria* | England (UK) | Alberta (CAN)* | Sweden | Hungary | Italy | Denmark | Lithuania | **OECD average** | Russian Federation | Slovak Republic | Quebec (CAN) | Norway | Netherlands | Ontario (CAN) | United States | Australia | New Zealand |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2015 | 13 | 25 | 29 | 31 | 39 | 52 | 5 | 50 | 83 | 29 | 29 | 24 | 28 | 30 | 43 | 39 | m | 47 | m | 43 | 40 | 39 | 47 | 42 | **51** | 56 | 57 | 53 | 56 | 89 | 59 | 79 | 75 | 87 |
| 2011 | 28 | 40 | 43 | 43 | 48 | 58 | 2 | 46 | 76 | 20 | 15 | 31 | 29 | 40 | 39 | 37 | 35 | 31 | 40 | 44 | 31 | 42 | 22 | 31 | **41** | 41 | 31 | 31 | 51 | 84 | 25 | 61 | 59 | 81 |
| 2007 | m | m | m | m | m | m | 1 | m | m | m | m | 7 | 5 | 6 | 16 | 11 | 5 | 13 | 5 | 6 | 3 | 1 | 8 | 2 | **9** | 14 | 9 | 3 | 5 | 36 | 5 | 18 | 10 | 13 |

*Note*: Darker tones correspond to statistically significant values.
* refers to calculations based on other years, based on data availability.
The OECD average is based on OECD countries with available data in 2007, 2011 and 2015.
*Source*: Authors' calculations based on TIMSS Databases.

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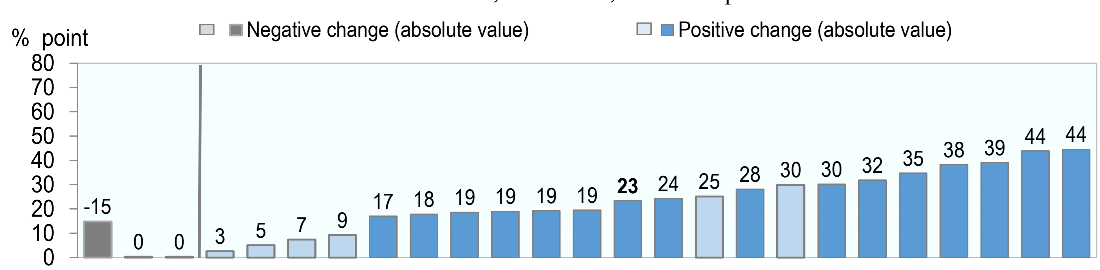
**Figure 2.4. 8th grade students using computers to practice skills and procedures in maths**

Change in and share of students who frequently practise skills and procedures on computers during mathematics lessons, 2007-2015, teachers report




| % of students | Chile* | Lithuania | Japan | Hong Kong, China | Slovenia | Turkey | Indonesia* | Singapore | Korea | Israel | Sweden | Norway | Italy | **OECD average** | England (UK) | Massachusetts (USA)* | New Zealand* | Minnesota (USA)* | South Africa* | Ontario (CAN) | Russian Federation | Hungary | Quebec (CAN) | United States | Australia |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2015 | 11 | 4 | 1 | 22 | 8 | 32 | m | 29 | 26 | 41 | 21 | 26 | 25 | **31** | 31 | m | 47 | m | 55 | 32 | 42 | 42 | 44 | 57 | 48 |
| 2011 | 26 | 14 | m | 12 | 5 | 42 | 13 | 9 | 25 | 39 | 11 | 2 | 15 | **20** | 18 | 27 | 19 | 35 | 24 | 22 | 24 | 17 | 17 | 29 | 41 |
| 2007 | m | 4 | 2 | 20 | 3 | 24 | 3 | 12 | 8 | 22 | 2 | 7 | 6 | **8** | 7 | 2 | m | 5 | m | 1 | 7 | 4 | 5 | 13 | 4 |

*Note*: Darker tones correspond to statistically significant values.
* refers to calculations based on other years, based on data availability.
The OECD average is based on OECD countries with available data in 2007, 2011 and 2015.
*Source*: Authors' calculations based on TIMSS Databases.

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## 3. Using digital devices for practising and drilling such as for foreign language learning and mathematics

### Why it matters

Computers and digital devices are well suited to support the acquisition of procedural knowledge through repetition and drilling. This is true in a variety of domains where computers represent very good tutors: mathematics, algorithmic, but also some aspects of foreign and domestic language acquisition. Computers also already support more or less complex forms of adaptive learning, for example by automatically adjusting the difficulty of the proposed tasks to the current level of mastery of the student.

### Change at the OECD level: moderate

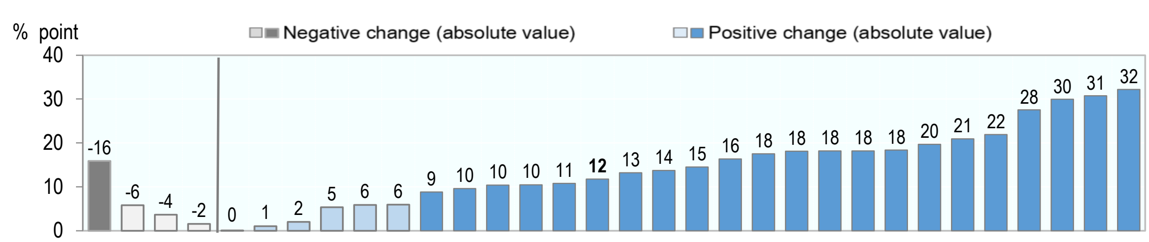
Students in most OECD countries have experienced an increase in the use of digital devices for practising and drilling. Between 2009 and 2015, the share of 15-year-old students using this learning practice at least once a month has increased by 12 percentage points on average. Only in Finland, Spain and Switzerland has it decreased, albeit to a lesser extent. Whether through expansion or contraction, change in the use of this practice was over 14 percentage points on average and represented a moderate effect size of 0.28. This pedagogical activity is frequent in most countries although levels strongly vary across the sample. For instance, in 2015, 10% of students in Japan used it at least once a month, against 74% in Denmark.

### Countries where there has been the most change

Large expansions of this practice were experienced in Latvia, Denmark and Sweden, all three with increases above 30 percentage points. Finland recorded the largest decline in this domain, of about 16 percentage points.

**Figure 2.5. 15 year old students using digital devices for practising and drilling**

Change in and share of students using digital devices at school for practising and drilling, such as for foreign language learning or mathematics, at least once a month, 2006-2015, students report




| % of students | Finland | Spain | Hong Kong, China | Switzerland | Belgium | Korea | Italy | Germany | Greece | Japan | Estonia | Ireland | Singapore | Czech Republic | Chile | **OECD average** | Portugal | Slovenia | Israel | Iceland | Netherlands | Austria | Poland | New Zealand | Hungary | Slovak Republic | Australia | Lithuania | Russian Federation | Sweden | Denmark | Latvia |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2015 | 42 | 48 | 34 | 49 | 38 | 16 | 54 | 32 | 40 | 10 | 38 | 32 | 41 | 54 | 46 | **46** | 47 | 43 | 49 | 58 | 67 | 48 | 47 | 43 | 46 | 59 | 47 | 56 | 62 | 65 | 74 | 59 |
| 2006 | 58 | 54 | 38 | 50 | 38 | 15 | 52 | 26 | 34 | 4 | 30 | 23 | 31 | 43 | 35 | **35** | 34 | 29 | 34 | 41 | 50 | 30 | 29 | 25 | 28 | 39 | 26 | 34 | 34 | 35 | 44 | 27 |

*Note*: Darker tones correspond to statistically significant values.
*Source*: Authors' calculations based on PISA Databases.

StatLink https://doi.org/10.1787/888933903707

## 4. Solving problems without an immediately obvious method of solution

### Why it matters

Many real life problems do not have an immediately obvious solution. Increasingly, most problems people will have to solve in their working life will be certain forms of complex problems: computers and robots will take care of simple problems – and actually some complex ones as well. The preparation to complex problem solving has thus become critical – and is also often more interesting to students.

### Change at the OECD level: moderate-low

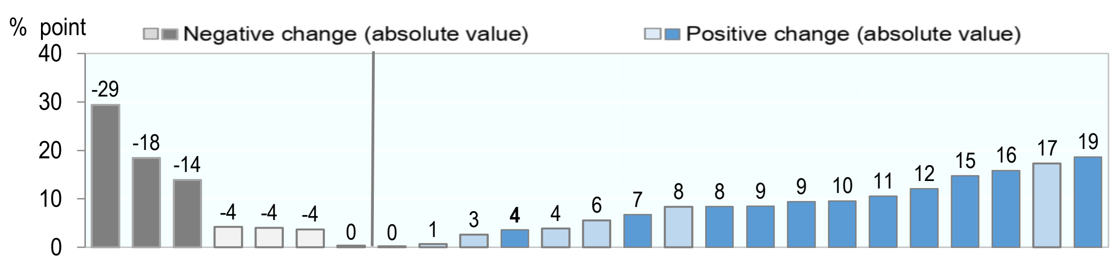
At the OECD level, the use of this practice increased on average by 4 percentage points between 2007 and 2015. With a modest effect size of 0.21, positive and negative changes led to an average absolute change of 9 percentage points. In 2015, this teaching and learning practice was not used in a systematic way in 8th grade mathematics lessons, concerning about 29% of the students on average.

### Countries where there has been the most change

Chile recorded the largest decline in the use of this practice, by almost 30 percentage points (measured between 2011 and 2015). Following Chile, Quebec (Canada) and Turkey registered declines of 18 and 14 percentage points respectively. Positive changes are of a great magnitude in Hong Kong, Minnesota (United States), Australia and Italy, all of them recording increases above 15 percentage points.

**Figure 2.6. 8th grade students solving problems without an immediately obvious method of solution in maths**

Change in and share of students whose teachers ask them to work on problems with no immediately obvious method of solution in at least half the lessons, 2007-2015, teachers report




| | | Chile* | Quebec (CAN) | Turkey | Ontario (CAN) | New Zealand* | Hungary | Lithuania | Sweden | South Africa* | Massachusetts (USA)* | **OECD average** | Japan | Russian Federation | Norway | Indonesia* | Israel | Slovenia | United States | Singapore | Korea | England (UK) | Italy | Australia | Minnesota (USA)* | Hong Kong, China |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % of students | 2015 | 38 | 32 | 23 | 32 | 18 | 18 | 11 | 14 | 37 | m | **29** | 30 | 14 | 17 | m | 32 | 34 | 35 | 20 | 38 | 25 | 51 | 26 | m | 31 |
| | 2011 | 67 | 31 | 52 | 42 | 22 | 20 | 12 | 18 | 36 | 30 | **31** | 27 | 7 | 15 | 27 | 42 | 34 | 37 | 21 | 36 | 24 | 36 | 24 | 36 | 29 |
| | 2007 | m | 50 | 37 | 36 | m | 22 | 11 | 14 | m | 28 | **25** | 26 | 8 | 10 | 18 | 24 | 26 | 25 | 10 | 28 | 13 | 36 | 11 | 18 | 13 |

*Note*: Darker tones correspond to statistically significant values.
* refers to calculations based on other years, based on data availability.
The OECD average is based on OECD countries with available data in 2007, 2011 and 2015.
*Source*: Authors' calculations based on TIMSS Databases.

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## 5. Processing and analysing data on computers

### Why it matters

Nowadays most of the computing and a lot of data processing in mathematics tend to be handled by computers. After all, they have a clear competitive advantage when it comes to computing power. While it does not have to fully replace other forms of data processing in maths, being able to use computers for those purposes has become an important technical skill in mathematics.

### Change at the OECD level: large

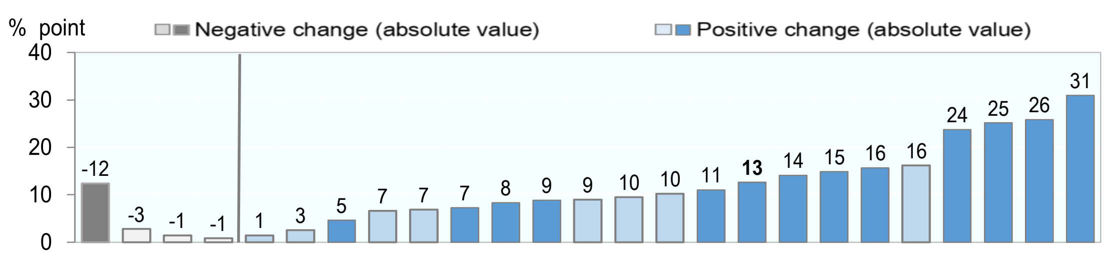
The share of students regularly using computers for processing and analysing data in 8th grade mathematics lessons increased by 13 percentage points on average. The positive and negative variations together amounted to a total absolute change of 13 percentage points, corresponding to a large effect size of 0.44. In most countries, only a small share of students systematically participated in this pedagogical activity in 2015, ranging from 6% in Sweden to 35% in the United States.

### Countries where there has been the most change

This pedagogical activity was a big innovation in the United States where the share of students using it increased by 31 percentage points between 2007 and 2015. In Australia and Ontario (Canada), the prevalence of this practice expanded by about 25 percentage points during the same period. By contrast, Chile registered the only significant decline in this domain, with a contraction by 12 percentage points between 2011 and 2015.

**Figure 2.7. 8th grade students using computers to process and analyse data in math**

Change in and share of students who frequently use computers to process and analyse data during mathematics lessons, 2007-2015, teachers report




| % of students | Chile* | Hong Kong, China | Lithuania | Japan* | Slovenia | Minnesota (USA)* | Sweden | Israel | Indonesia* | Singapore | Korea | Italy | England (UK) | South Africa* | Massachusetts (USA)* | Norway | **OECD average** | Quebec (CAN)* | New Zealand* | Hungary | Turkey | Russian Federation | Ontario (CAN) | Australia | United States |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2015 | 11 | 8 | 5 | m | 7 | m | 6 | 25 | m | 14 | 16 | 15 | 12 | 30 | m | 16 | **18** | 14 | 25 | 22 | 34 | 26 | 27 | 26 | 35 |
| 2011 | 24 | 9 | 10 | 1 | 4 | 5 | 5 | 26 | 20 | 3 | 17 | 12 | 5 | 21 | 12 | 4 | **12** | 6 | 10 | 7 | 41 | 15 | 13 | 16 | 14 |
| 2007 | m | 11 | 7 | 1 | 6 | 2 | 2 | 18 | 14 | 7 | 8 | 7 | 3 | m | 1 | 5 | **6** | m | m | 6 | 18 | 3 | 2 | 0 | 4 |

*Note*: Darker tones correspond to statistically significant values.
* refers to calculations based on other years, based on data availability.
The OECD average is based on OECD countries with available data in 2007, 2011 and 2015.
*Source*: Authors' calculations based on TIMSS Databases.

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**Table 2.1. Effect sizes for changes in practices to develop technical skills in mathematics**

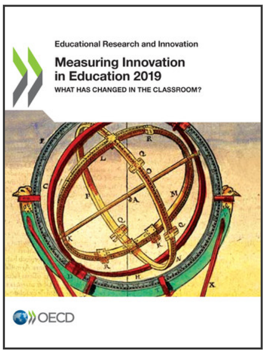
| | Memorising rules, procedures and facts as a pedagogical technique | | Practising skills and procedures on computers | | Use of digital devices for practising and drilling | Solving problems with no obvious method of solution | Processing and analysing data on computers |
|---|---|---|---|---|---|---|---|
| | 4th grade | 8th Grade | 4th grade | 8th Grade | 8th grade | 8th Grade | 8th Grade |
| Australia | 0.60 | 0.64 | 1.46 | 1.14 | 0.44 | 0.42 | 1.01 |
| Austria | 0.14 | m | 0.82 | m | 0.37 | m | m |
| Belgium | m | m | m | m | 0.00 | m | m |
| Belgium (Fl.) | -0.07 | m | -0.29 | m | m | m | m |
| Canada (Alberta) | 0.10 | m | 0.91 | m | m | m | m |
| Canada (Ontario) | -0.07 | -0.06 | 0.71 | 1.06 | m | -0.09 | 0.80 |
| Canada (Quebec) | -0.25 | 0.16 | 1.30 | 1.01 | m | -0.38 | 0.77 |
| Chile | -0.07 | 0.20 | -0.31 | -0.39 | 0.22 | -0.60 | -0.33 |
| Czech Republic | 0.58 | m | 0.66 | m | 0.21 | m | m |
| Denmark | 0.27 | m | 0.91 | m | 0.64 | m | m |
| Estonia | m | m | m | m | 0.19 | m | m |
| Finland | -0.03 | m | 0.35 | m | -0.32 | m | m |
| Germany | 0.36 | m | 0.51 | m | 0.12 | m | m |
| Greece | m | m | m | m | 0.12 | m | m |
| Hungary | 0.30 | 0.11 | 1.01 | 1.02 | 0.38 | -0.09 | 0.47 |
| Iceland | m | m | m | m | 0.33 | m | m |
| Ireland | -0.08 | m | 0.08 | m | 0.22 | m | m |
| Israel | m | 0.21 | m | 0.40 | 0.30 | 0.19 | 0.16 |
| Italy | 0.29 | 0.85 | 1.15 | 0.57 | 0.04 | 0.30 | 0.29 |
| Japan | -0.05 | 0.28 | 0.25 | -0.02 | 0.24 | 0.09 | -0.18 |
| Korea | -0.05 | -0.03 | -0.39 | 0.50 | 0.03 | 0.23 | 0.26 |
| Latvia | m | m | m | m | 0.66 | m | m |
| Lithuania | 0.74 | 0.20 | 1.09 | -0.02 | 0.44 | -0.01 | -0.06 |
| Netherlands | 0.71 | m | 1.18 | m | 0.36 | m | m |
| New Zealand | 0.29 | -0.13 | 1.65 | 0.61 | 0.39 | -0.10 | 0.00 |
| Norway | 0.56 | 0.41 | 1.26 | 0.55 | m | 0.20 | 0.37 |
| Poland | 0.30 | m | 0.20 | m | 0.38 | m | m |
| Portugal | 0.19 | m | -0.26 | m | 0.27 | m | m |
| Slovak Republic | 0.64 | m | 1.10 | m | 0.40 | m | m |
| Slovenia | 1.07 | 0.88 | 0.65 | 0.24 | 0.29 | 0.19 | 0.06 |
| Spain | -0.37 | m | -0.18 | m | -0.12 | m | m |
| Sweden | 0.81 | 0.71 | 0.94 | 0.67 | 0.61 | 0.01 | 0.25 |
| Switzerland | m | m | m | m | -0.03 | m | m |
| Turkey | -0.73 | -0.60 | 0.19 | 0.17 | m | -0.30 | 0.37 |

| | Memorising rules, procedures and facts as a pedagogical technique | | Practising skills and procedures on computers | | Use of digital devices for practising and drilling | Solving problems with no obvious method of solution | Processing and analysing data on computers |
|---|---|---|---|---|---|---|---|
| | 4th grade | 8th Grade | 4th grade | 8th Grade | 8th Grade | 8th Grade | 8th Grade |
| UK (England) | m | 0.64 | 0.77 | 0.65 | m | 0.31 | 0.36 |
| UK (Northern Ireland) | -0.12 | m | -0.11 | m | m | m | m |
| United States | 0.22 | 0.08 | 1.32 | 0.97 | m | 0.21 | 0.85 |
| US (Massachusetts) | m | 0.34 | m | 0.84 | m | 0.06 | 0.46 |
| US (Minnesota) | m | 0.03 | m | 0.80 | m | 0.39 | 0.14 |
| **OECD (average)** | **0.45** | **0.28** | **0.98** | **0.62** | **0.24** | **0.08** | **0.40** |
| **OECD (average absolute)** | **0.49** | **0.40** | **1.02** | **0.64** | **0.28** | **0.21** | **0.44** |
| Hong Kong, China | -0.09 | 0.34 | 0.68 | 0.06 | -0.08 | 0.46 | -0.09 |
| Indonesia | m | 0.74 | m | 0.35 | m | 0.20 | 0.18 |
| Russian Federation | 0.30 | 0.06 | 0.93 | 0.86 | 0.56 | 0.18 | 0.75 |
| Singapore | 0.17 | 0.36 | 0.60 | 0.43 | 0.22 | 0.27 | 0.24 |
| South Africa | m | 0.08 | m | 0.63 | m | 0.01 | 0.22 |

Effect size from -0.5 to -0.2 and from 0.2 and 0.5
Effect size from -0.8 to -0.5 and from 0.5 and 0.8
Effect size equals or less than -0.8 and equals or greater than 0.8

*Source:* Authors' calculations based on TIMSS (2007, 2011 and 2015) and PISA (2006, 2009 and 2015).

StatLink https://doi.org/10.1787/888933903764






# Measuring Innovation in Education 2019

## What Has Changed in the Classroom?



**Please cite this chapter as:**

Vincent-Lancrin, Stéphan*, et al.* (2019), “Innovation in practices to develop technical skills in mathematics”, in Stéphan Vincent-Lancrin*, et al.*, *Measuring Innovation in Education 2019: What Has Changed in the Classroom?*, OECD Publishing, Paris.

DOI: https://doi.org/10.1787/fd435db5-en