Teaching Practices and Student Mathematics Performance

Evidence from PISA 2022

Giorgio Di Pietro, Zbigniew Karpiński (EC Joint Research Centre)

Using PISA evidence to inform education policies and practices

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Background

Declining performance in mathematics

The rates of underachievement in mathematics increased between 2018 and 2022

In the EU, the rate went up from 22% to 29% in this period.

The increase was larger among disadvantaged students.

In the EU, the underachievement rates of the low-SES students went up from 38% to 48%.

Corresponding figures for the high-SES students are 9% and 11%.

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Underachievement and the Covid-19 pandemic

The increase was partially driven by Covid-19: existing evidence confirms that

   all students suffered a setback in their learning because of the pandemic, but

   the setback was particularly large for mathematics and science (e.g., Di Pietro, 2023).

In some countries/economies, however, the decline started already before the pandemic: Covid-19 simply strengthened an existing negative trend

Significance of basic skills

Basic skills in literacy and numeracy as building blocks for a life of learning and fulfilment:

• Basic skills in mathematics acquired through schooling are consistently found to shape individual success in various areas of their lives

• Underperformance in these skills may lead to poverty and vulnerability

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Educational policies/interventions fostering mathematics performance

Schools and education systems take multiple measures to improve their students' mathematics performance, e.g.:

- technology-aided instruction,

- homework,

- problem-based learning approach,

- reducing class size,

- tutoring programmes

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Digital resources and students' mathematics performance

Digital tools (e.g., devices, relevant software, online content) have become key elements of mathematics instruction

Digital transformation in education increased because of Covid-19

In many countries, the process was already under way before the pandemic

The use of digital resources in teaching and learning continues to be a relevant policy issue

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The effects of technology-aided instruction

No clear-cut picture of the effect of technology-aided instruction on students' performance

- existing studies suggest existence of heterogeneous effects: certain interventions may be more effective, others less so

- some interventions may be more effective when targeted at certain groups of students

All in all, using digital technology in class creates an environment conducive to learning but does not have a direct impact on student achievement.

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Data and methods

Data

PISA 2022, student and school questionnaires

Coverage: OECD countries which included the optional ICT questionnaire in their surveys

- Israel and Costa Rica dropped due to unavailability of some variables

Final sample size: 215,726 across 8,218 schools in 27 countries/economies

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Variables: student level

Dependent variable

- PISA mathematics score

Independent variables

- the use of digital resources in mathematics lessons

- background variables: gender, age, ESCS, migrant status

- motivation: truancy, absenteeism, coming late to school

- attitudes towards mathematics

- perception of school's ICT infrastructure

In addition:

- time spent on mathematics homework

- mathematics teacher support

- the quality of student-teacher relationships

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Variables: school-level

- Private vs public

- Degree of urbanisation: rural area, towns, cities

- Training opportunities for mathematics teachers, especially in the area of integrating digital tools into mathematics instruction

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Treatment of missing data

Some students (more than 60,000 or nearly 30%) fail to answer some of the questions in the background questionnaire.

Rather than dropping them from the analysis, we include a separate category with "Unknown" value for each of the variables.

Same approach applied to school-level data

Potential drawbacks:

- quantitative variables have to be converted into categorical ones for the applied solution to be possible

- there is more than one way to group numerical values in categories

- potential loss of information

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Analytical methods

- Multiple linear regression (with country and school fixed effects) for student-level data;

- Multilevel regression

In both cases, models are fit to pooled data and to country-specific data

- All 10 plausible values used, results aggregated across all PVs

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Descriptive statistics

Average performance in mathematics

The use of digital resources in mathematics lessons

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Results

Results from pooled data

Country-specific results

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Further results

Students who declare that they spend more time using digital schools for learning than for leisure **while at school** are found to perform slightly better (around 5 points on the PISA mathematics test).

Students who hold more positive views of their school's ICT infrastructure perform better (by an overage of around 15 points).

While digital tools can help students in their mathematics learning,

- the tools have to be sufficiently good and

- students must know how to use them for learning.

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Results from multilevel models

Results from multi-level models largely confirm these findings:

- the use of digital resources in math lessons is negative and follows the already familiar U-shaped pattern.

Positive effects of some school-level variables are found:

- students in schools where teachers are offered training opportunities in the area of integrating digital tools in math instruction fare better at the PISA math test than students in schools where such opportunities are not offered

- students in schools in which in-house professional development opportunities for math teachers are provided are found to perform better, on average, than students in schools which do not.

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Conclusions

Conclusions (I)

Overall, the use of digital resources in mathematics lessons does not lead to improvement in students' performance

There is some variation in the effect across the countries included in the analysis

The measure of the proxy for the use of digital tools in math lessons is very general:

- it does not specify the type of tools used or how they are introduced into mathematics lessons

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Conclusions (II)

Students are found to do somewhat better in the PISA math test, on average, if they:

- perceive the school's ICT infrastructure positively

- have some experience in using digital tools for learning

- if their schools provide relevant training opportunities for mathematics teachers

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Thank you

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