UNIVERSITY OF LATVIA
FACULTY OF EDUCATION SCIENCES AND PSYCHOLOGY

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The Role of Digital Technologies in Learning: Insights from TIMSS 2019 and 2023

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Information and communication technology (ICT)

Benefits

- ✓ Personalised learning *(Vassilakopoulou & Hustad, 2021; Consoli et al., 2025)*
- ✓ Broader access to education *(Anwar et al., 2024)*
- ✓ Collaborative learning *(UNESCO, 2022; Xu et al., 2025)*

Risks

- ! Digital divide *(Anwar et al., 2024; Forsström et al., 2025)*
- ! Insufficient digital literacy *(Msafiri et al., 2023; Amemasor, 2025)*
- ! Weak alignment with learning objectives *(Vassilakopoulou & Hustad, 2021)*

Access is important, but high-quality use depends on learning goals, teachers' pedagogical choices and students' digital competence.

Research questions

01 **How has the availability of digital technologies changed between 2019 and 2023?**

02 **To what extent is greater digital technology access associated with higher achievement in mathematics and science?**

03 **What differences exist between urban and rural schools?**

Context from Latvia: technology was observed in only 11% of STEM lessons and 12% of Grades 1 – 6 mathematics lessons (Čakāne, Greitāns, et al., 2025; Čakāne, France, et al., 2025).

Methodology

Trends in International Mathematics and Science Study (TIMSS) 2019 & 2023

Grade 4 mathematics and science

Latvian analysis

Measures: Access during lessons, students per computer and achievement

Groups: four urbanisation categories and school achievement quartiles (highest and lowest 25%)

Methods: comparisons by year and group, an access index and significance tests

International analysis

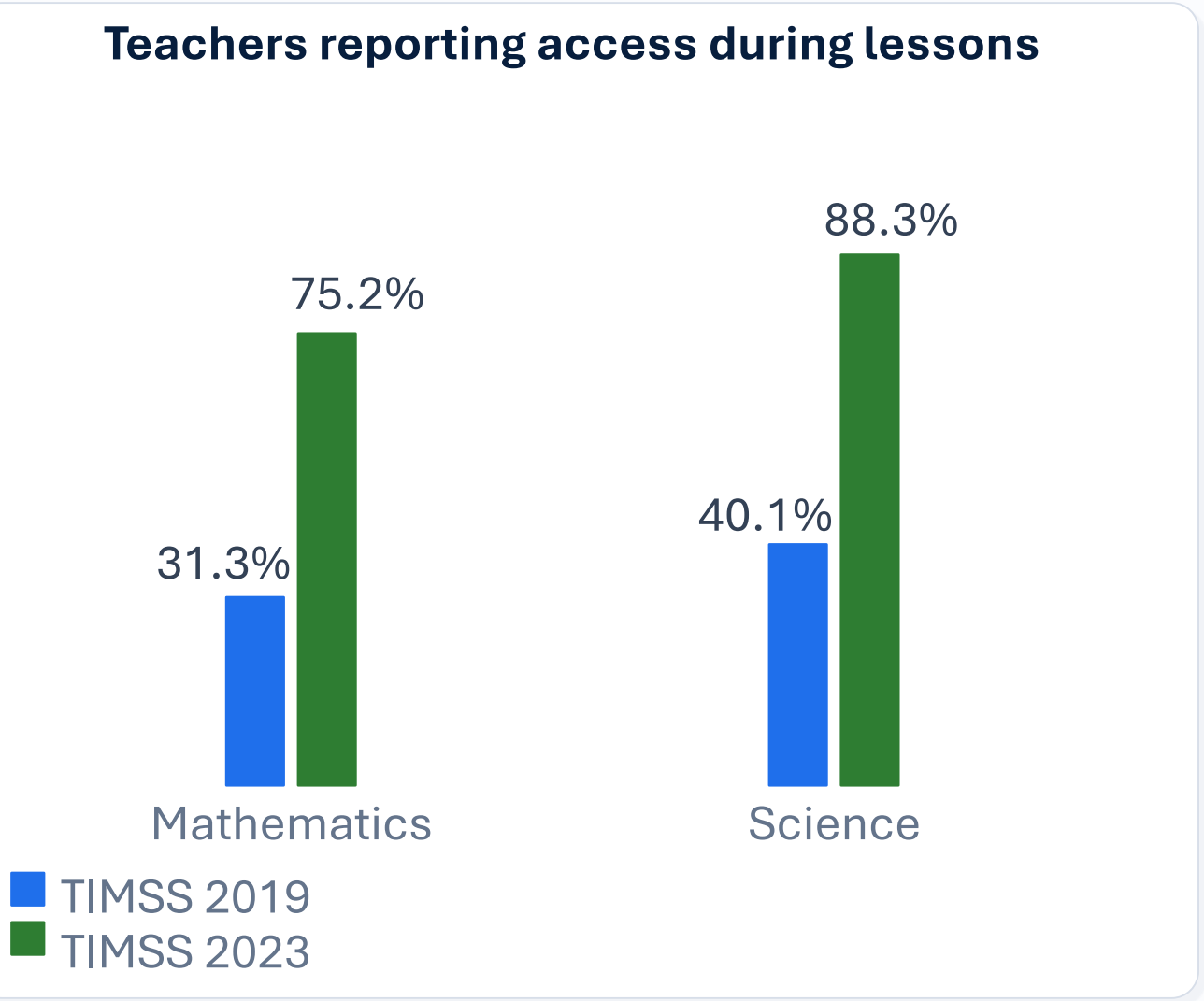
Selection: high access in 2019; top 10 systems by mathematics and science achievement

Methods: changes in access and achievement; significance tests

Areas: urban areas versus small towns and rural areas

Latvian data

Accesibility of digital technologies in mathematics and science lessons



+43.9 pp

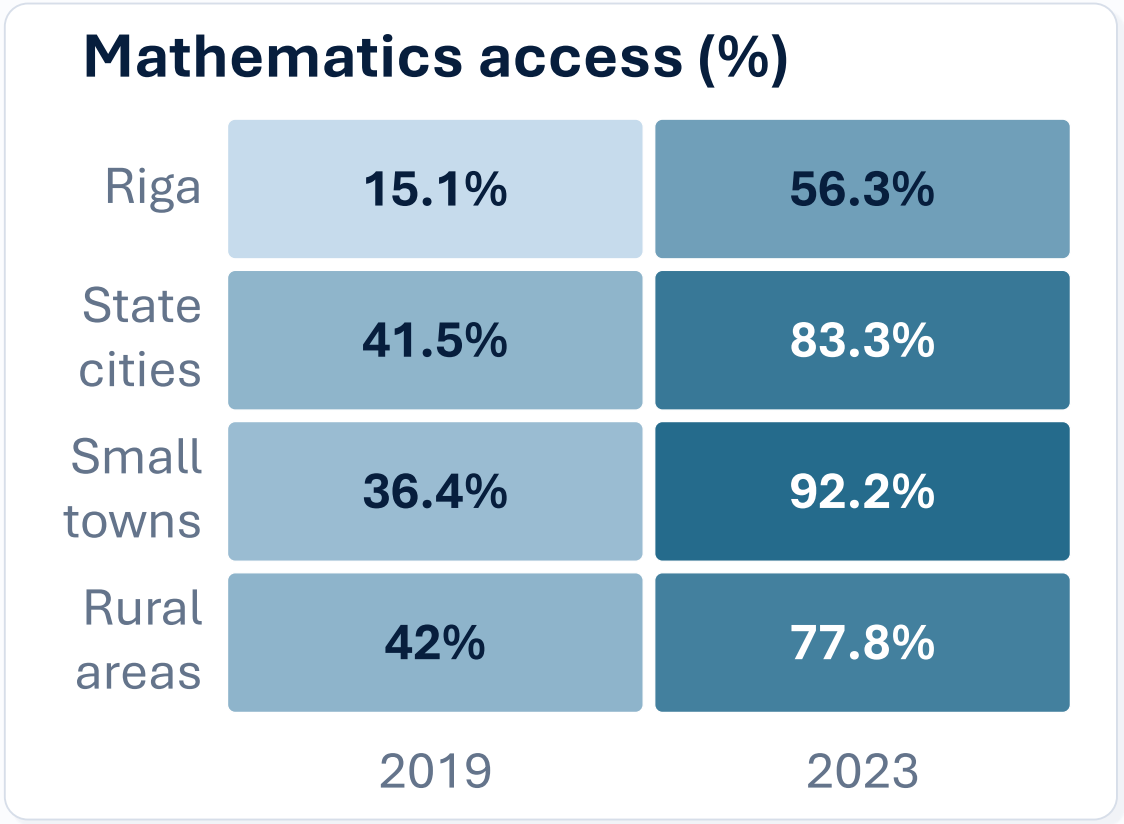
mathematics access increase

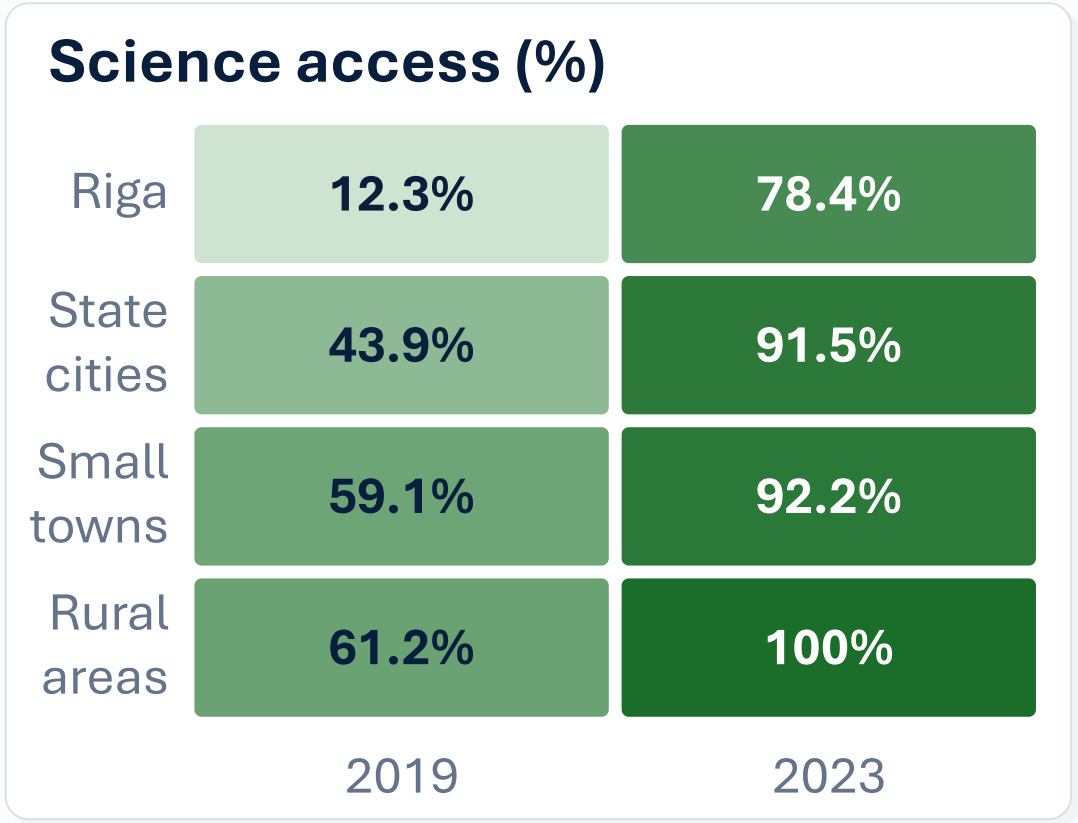
+48.2 pp

science access increase

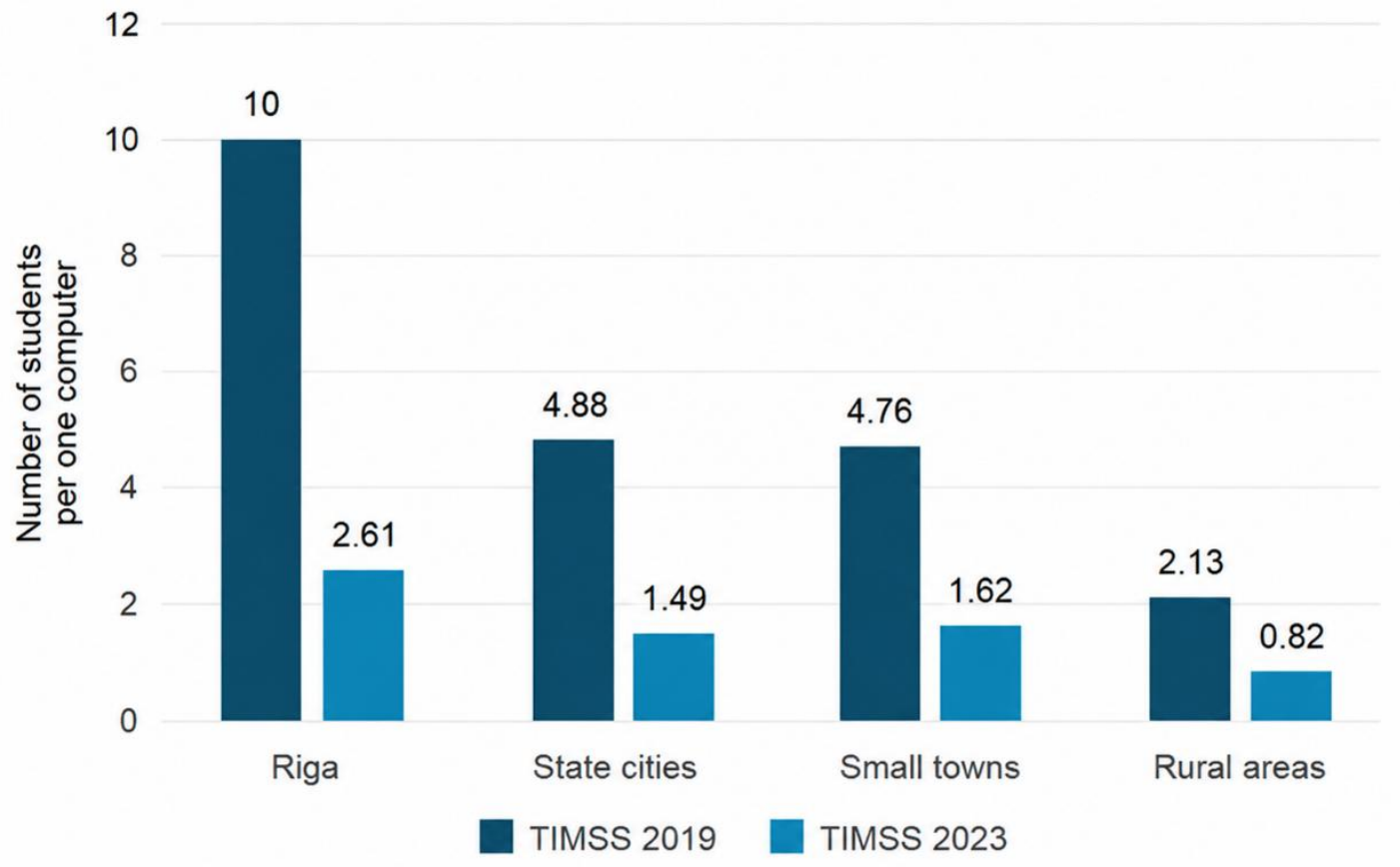
Caution: the 2023 item also included smartphones, limiting strict comparability with 2019

Differences in access to technology in classrooms between urban and rural areas





Number of students per one computer



10 → 2.61

Riga: largest reduction

2.13 → 0.82

Rural areas: best ratio

A lower value means better individual access to computers.

Accessibility of digital technologies

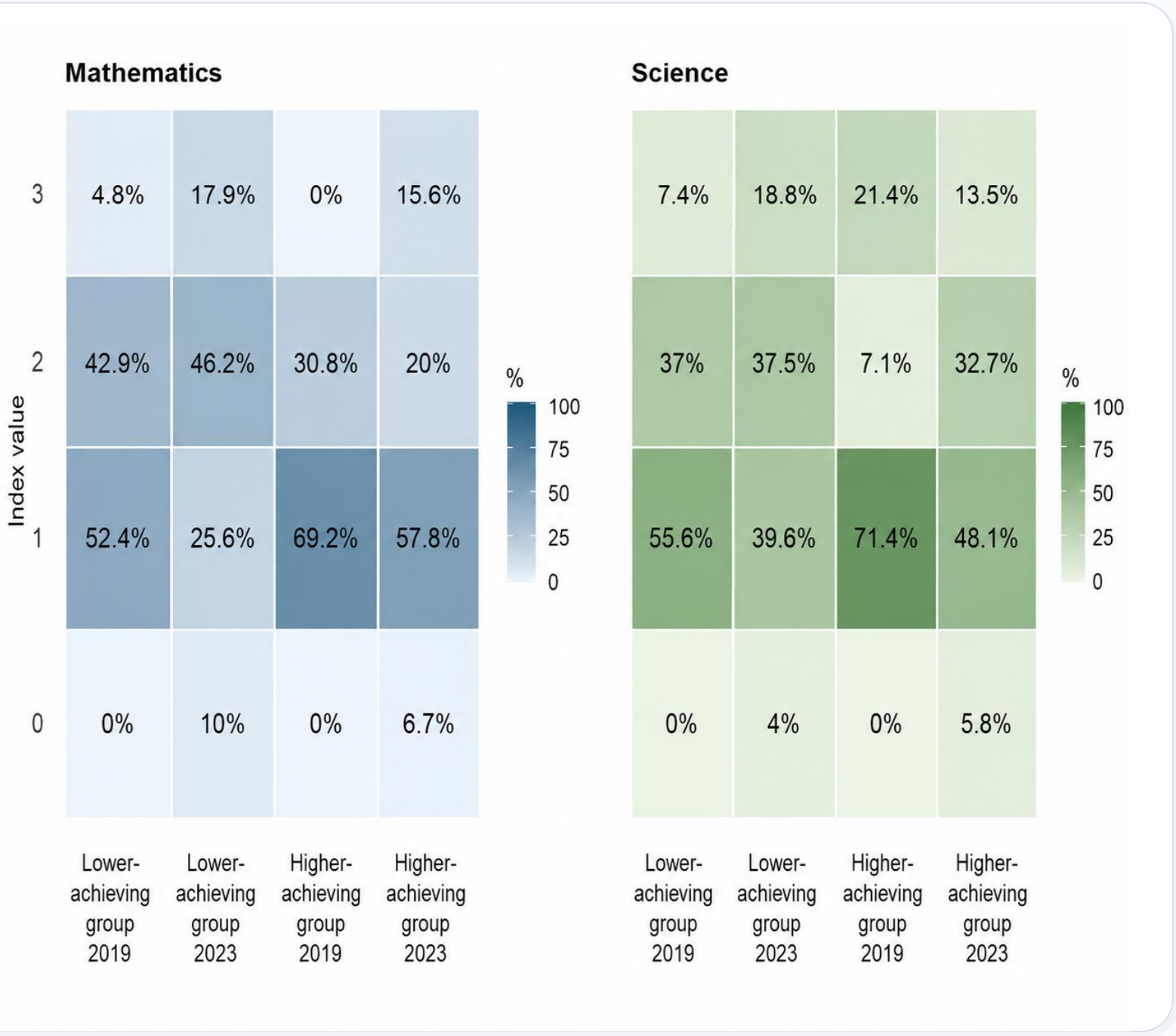
The access index compared lower- and higher-achieving groups

Access index: 0–3

+1 device for each student

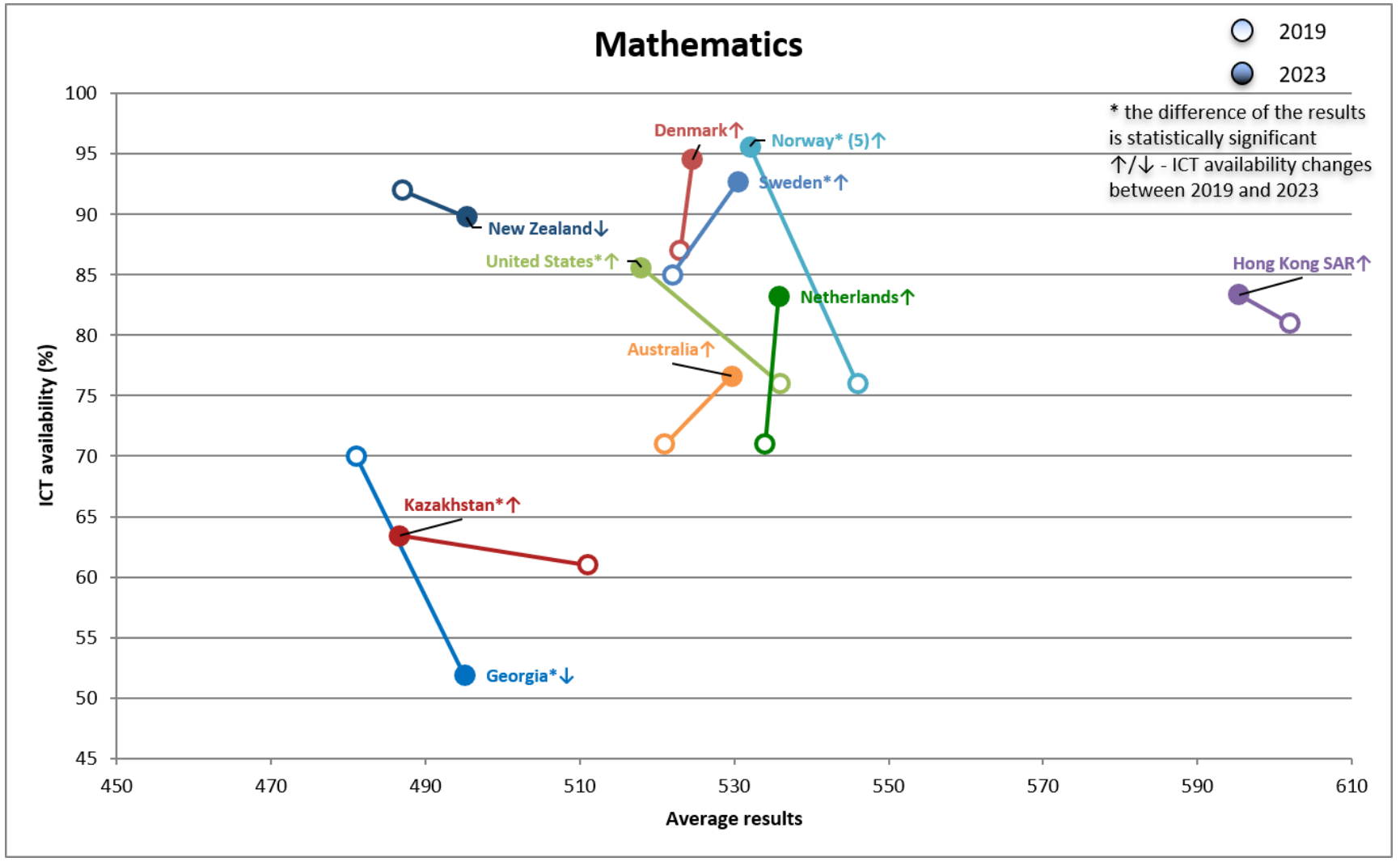
+1 shared technology in the classroom

+1 school devices for occasional use



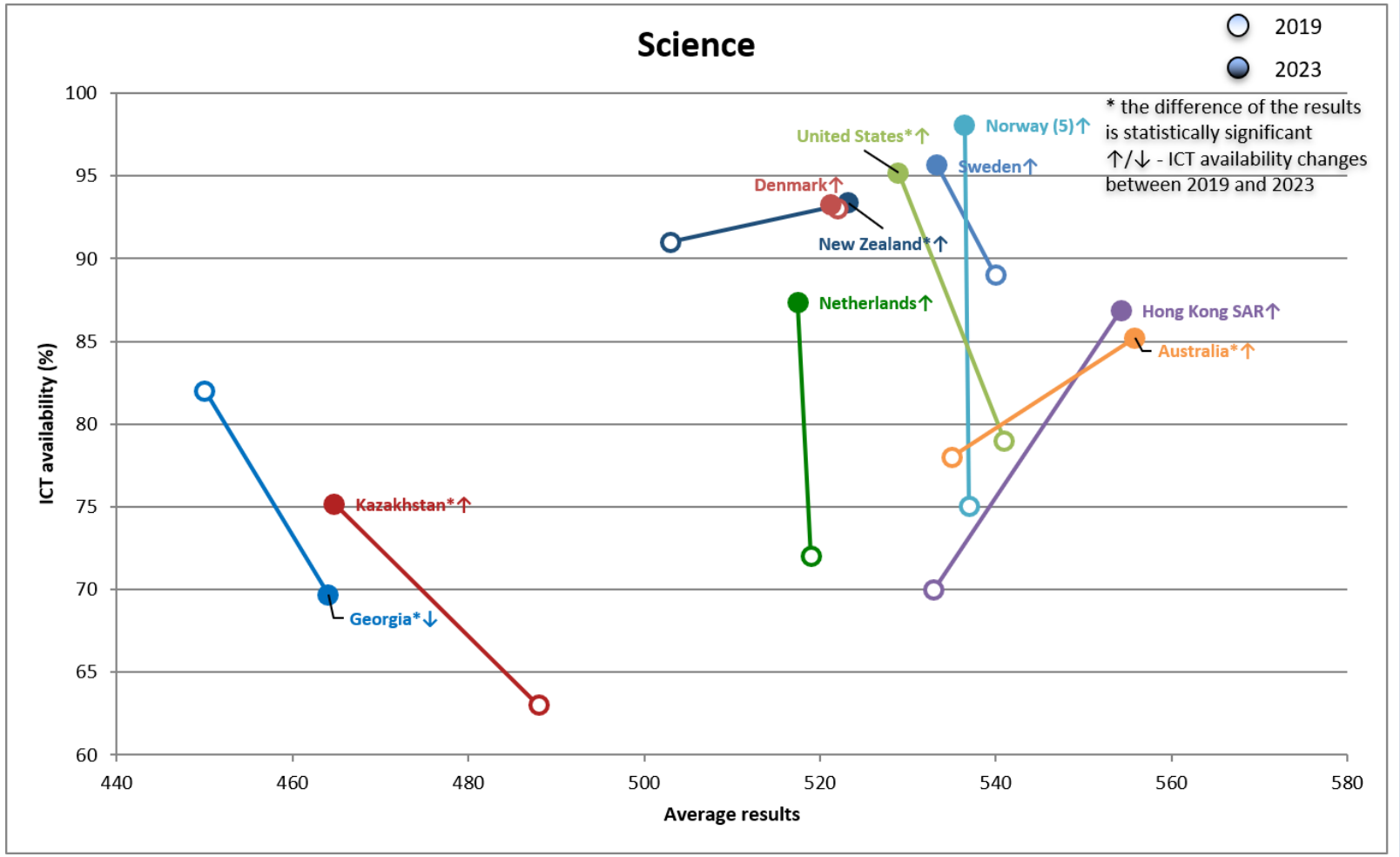
International data

Availability of technology in classrooms (Mathematics)



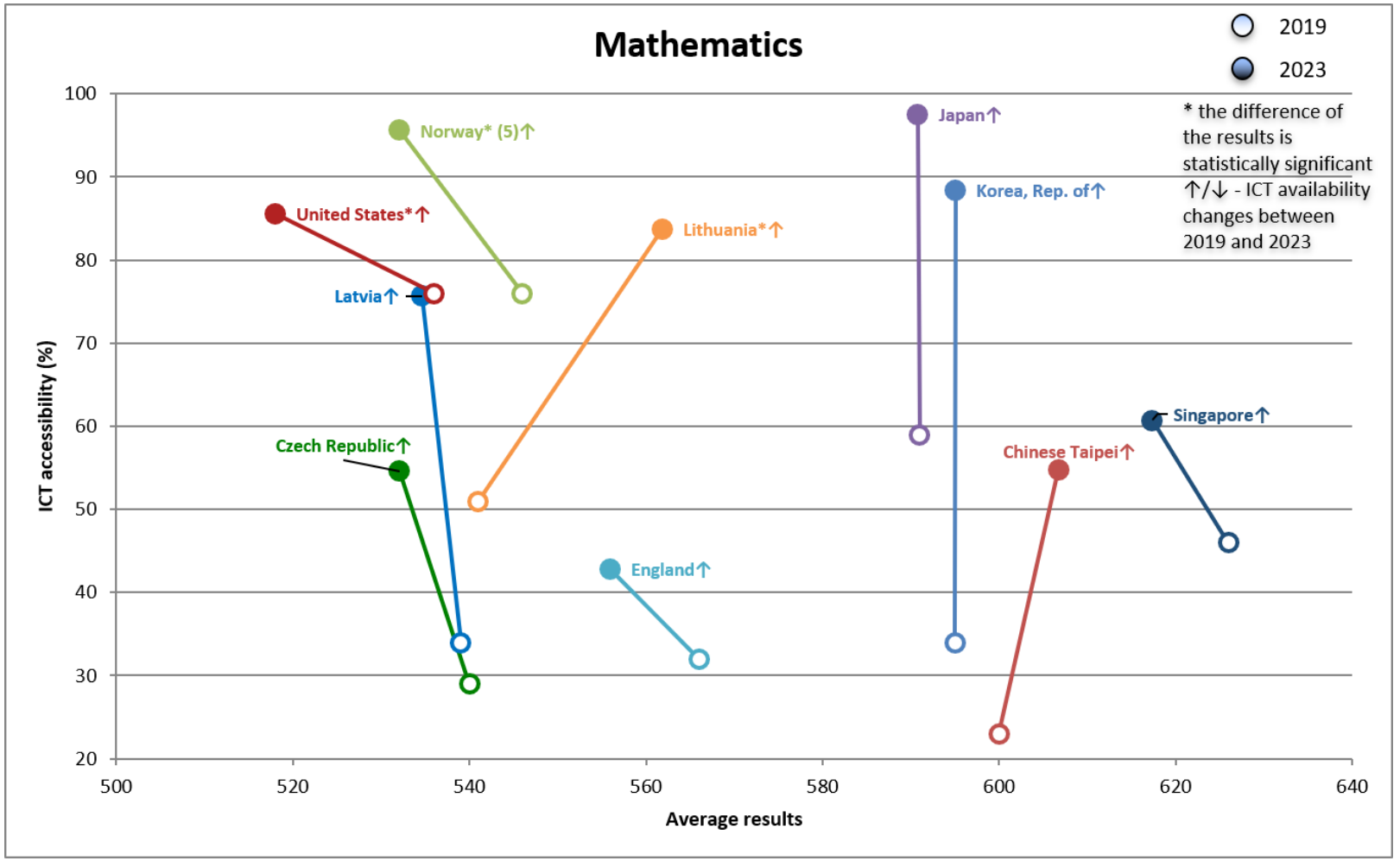
More access did not translate into a common achievement trajectory

Availability of technology in classrooms (Science)



Similar levels of access coincided with very different science outcomes

Technology availability in classrooms in high-achieving countries (Mathematics)

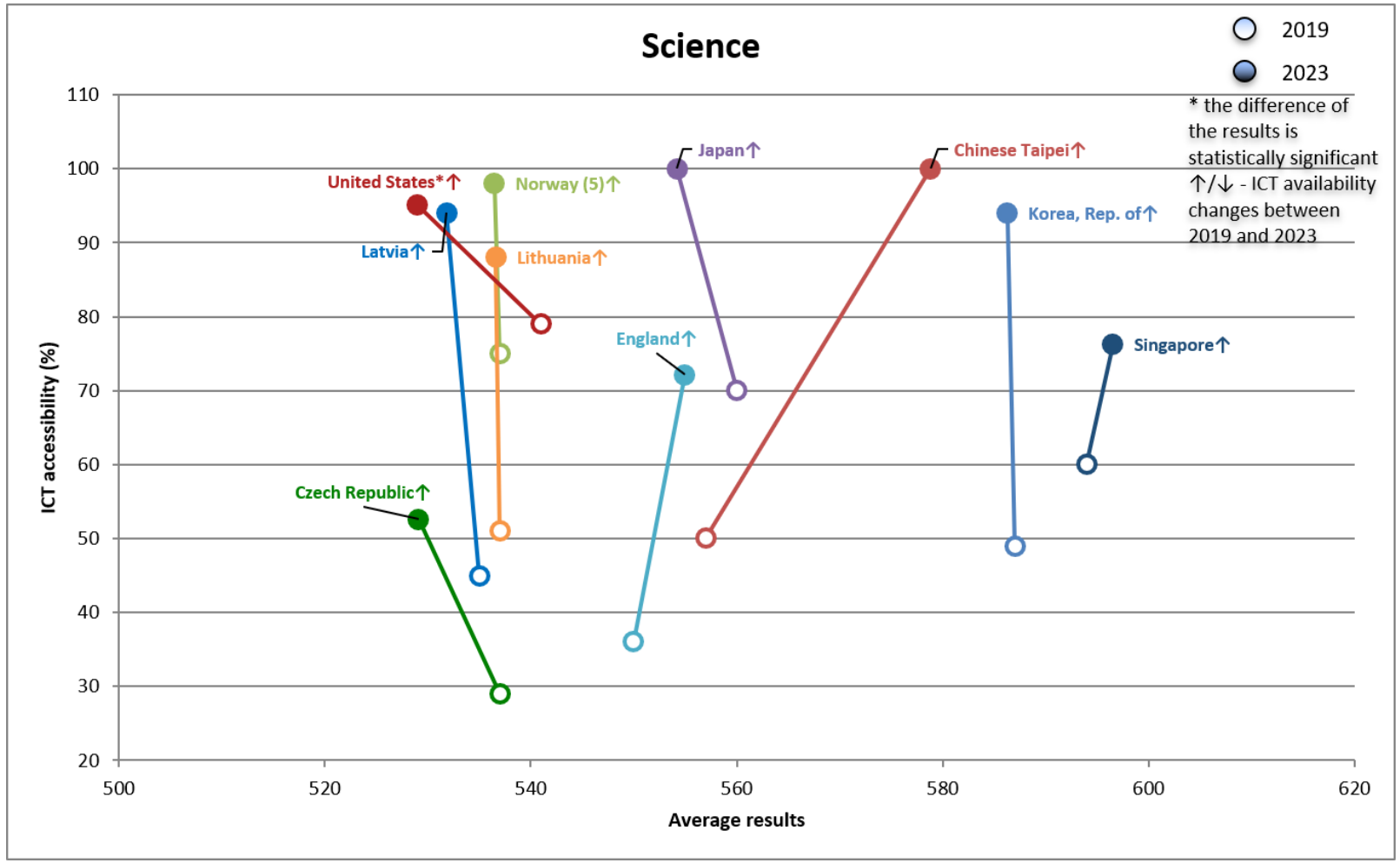


Different selection rule

Top 10 countries were selected by high 2019 achievement among students with technology access.

Even high-performing systems followed divergent trajectories

Technology availability in classrooms in high-achieving countries (Science)



United States

significant change: access ↑, achievement ↓

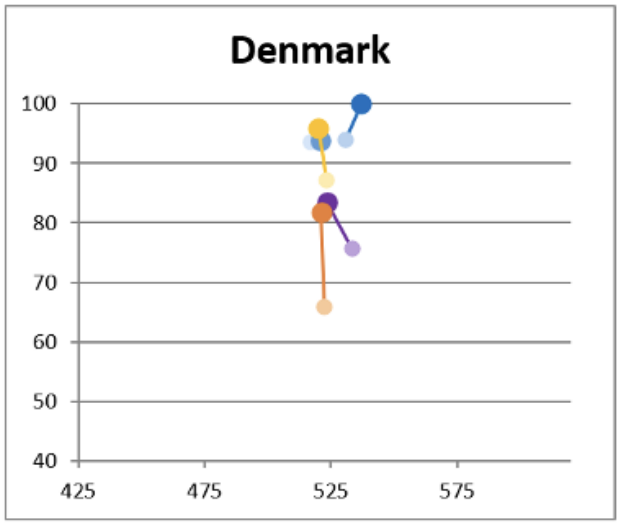
Chinese Taipei

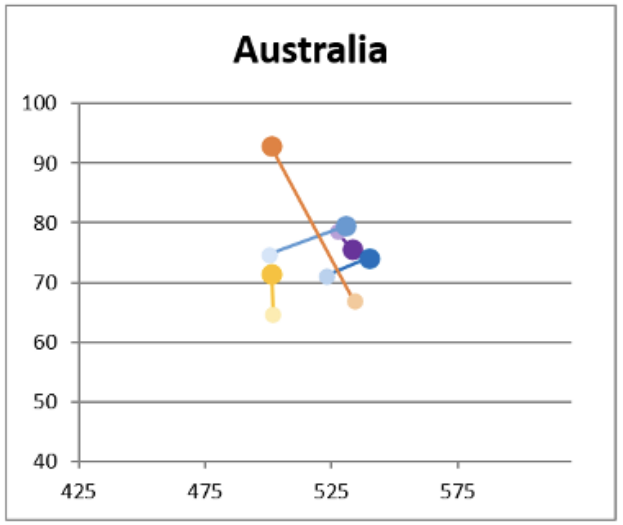
large visual shift, not marked significant

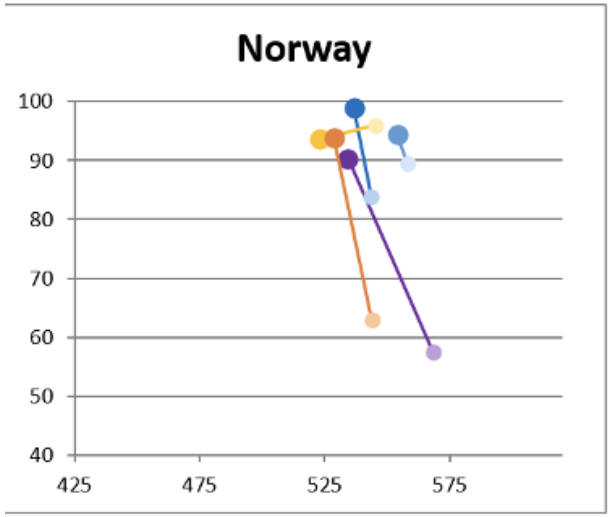
Most countries did not show significant achievement differences between students with and without access.

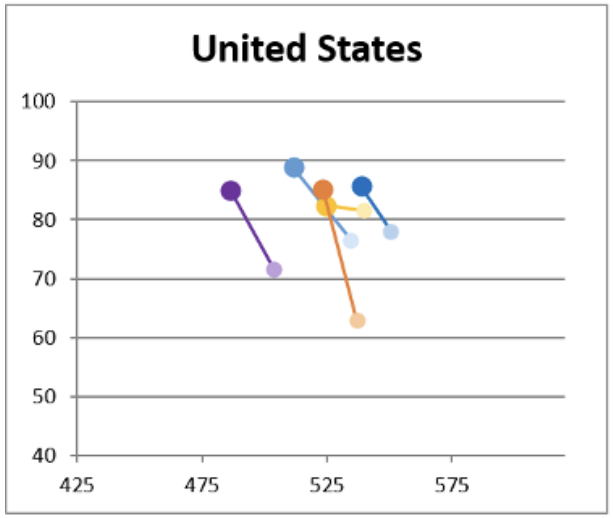
Student achievement and access to technology by region (Mathematics)

Regional convergence in access did not imply convergence in achievement









Average Results

Urban

Suburban

Medium city

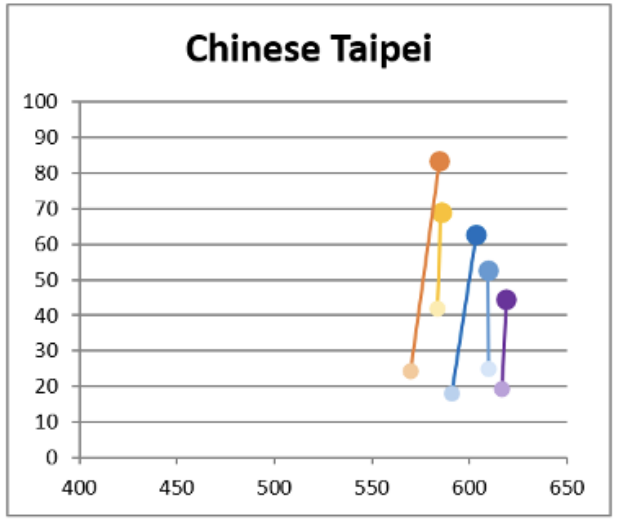
Small town

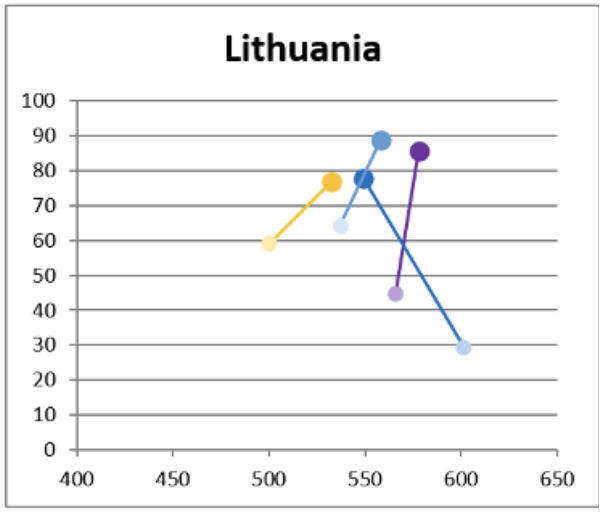
Rural

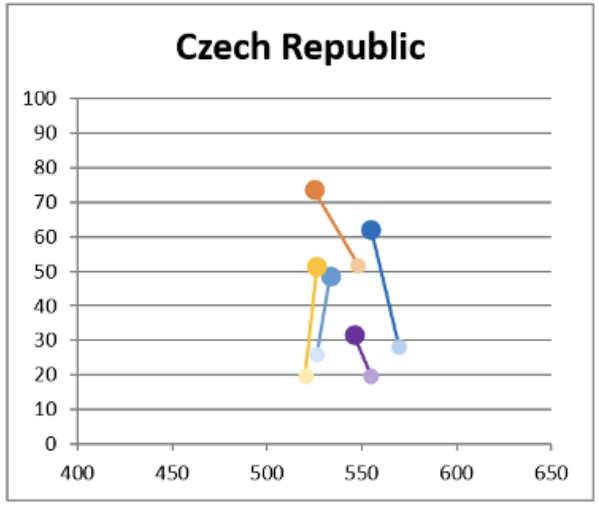
2019 (lighter)

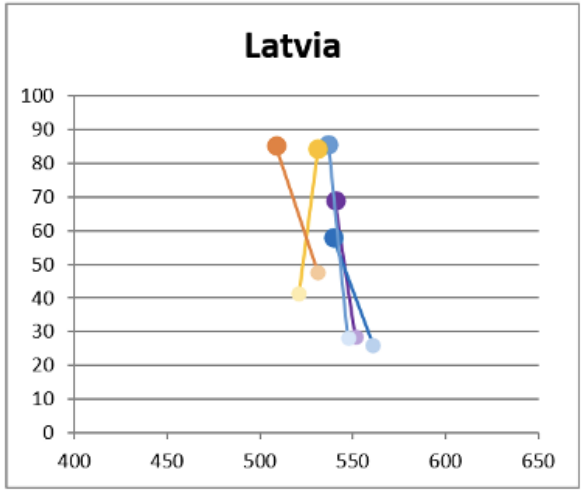
2023 (darker)

Student achievement and access to technology by region (Mathematics)









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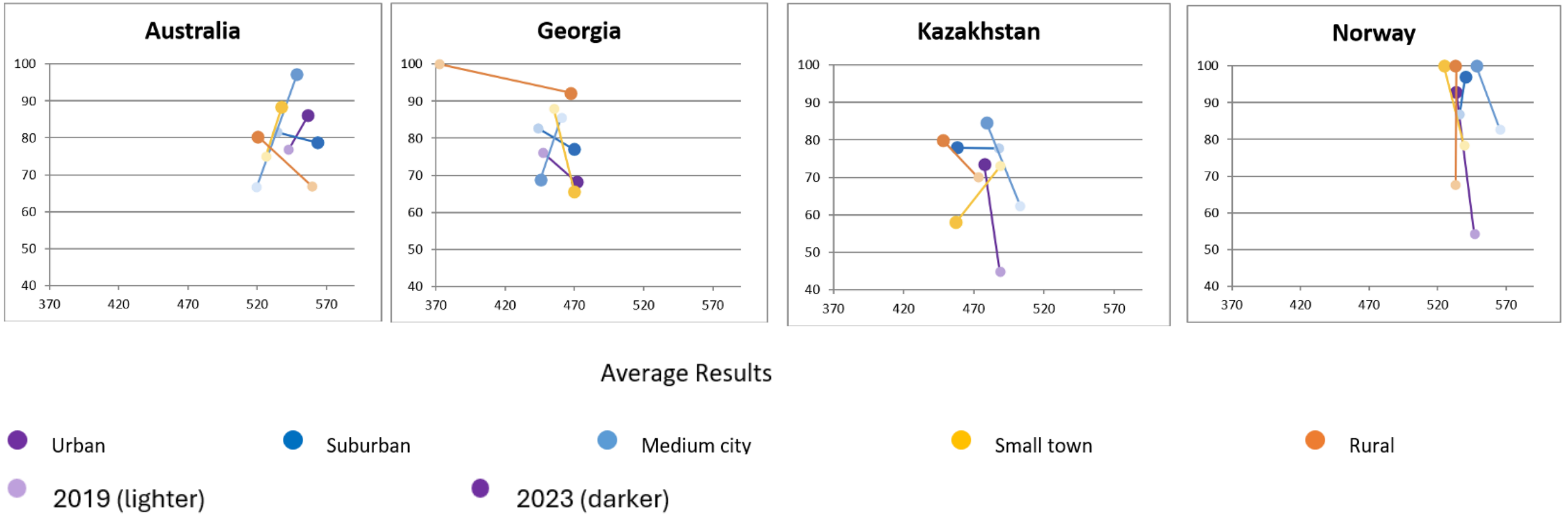
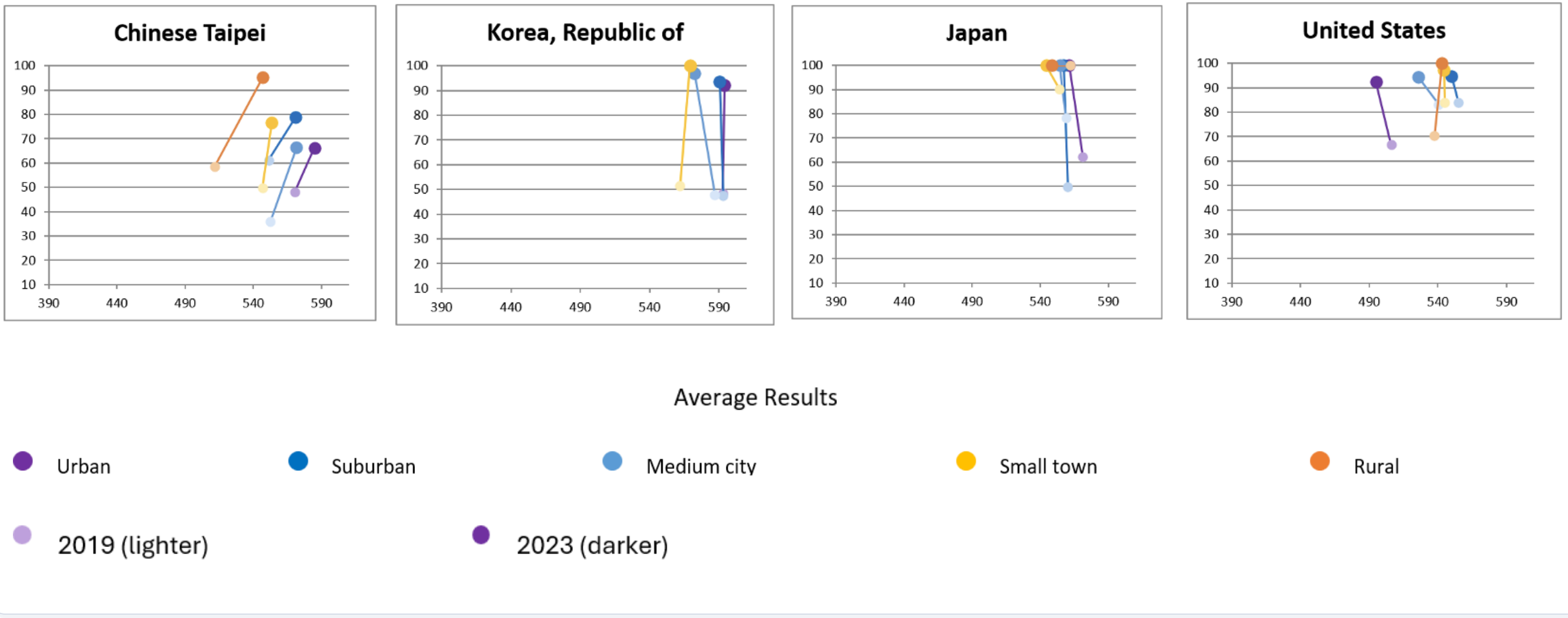


Student achievement and access to technology by region (Science)

Access gaps narrowed faster than achievement gaps



Conclusions

Latvia

Access increased substantially

Riga still had lower access

Greater access alone was not consistently associated with higher achievement

Internationally

Country trajectories diverged

More technology did not ensure better results

Availability alone appears insufficient. Frequency and quality of use need to be examined alongside access

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