

The COVID-19 Shock to Primary Education: Evidence from Ukraine

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Motivation

- **COVID-19 triggered the largest global education disruption in a century**
 - ▶ Over 1.6 billion learners were affected by school closures worldwide (UNICEF, 2021)
 - ▶ Closures lasted more than a year in many low- and middle-income countries
 - ▶ Poor households were particularly limited in their ability to compensate for school closures
 - ▶ Long-term consequences include potential setbacks in human capital and earnings

Research Question

Main Question:

What is the impact of the COVID-19 and associated school closure on primary school children's learning in Ukraine?

Why Should COVID-19 Affect Learning Outcomes?

⇒ **Loss of Instructional Time**

Closures and hybrid schedules sharply reduced effective teaching hours.

⇒ **Digital Divide**

Unequal access to devices, internet, and digital platforms limited participation.

⇒ **Home Learning Constraints**

Parental education, availability, and home study space shaped engagement.

⇒ **Gaps in Teacher Preparedness**

Variation in digital skills and remote teaching methods reduced effectiveness.

⇒ **Amplification of Pre-existing Inequalities**

Family background and school resources intensified learning disparities.

Literature Review

Meta-analyses estimate average learning losses between -0.11 and -0.20 SD
(Wiesenocker et al., 2025; Betthäuser et al., 2023; Di Pietro, 2023a, 2023b; König & Frey, 2022; Storey & Zhang, 2021)

- Evidence remains limited for low- and middle-income countries (LMICs).
- Many estimates rely on simulations or phone-based tests in non-representative samples.

This study joins a small set of research using in-person assessments from large, representative samples (Singh et al., 2024; Hevia et al., 2022; Alasino et al., 2024; Guariso & Björkman Nyqvist, 2023; Ardington et al., 2021; Lichand et al., 2022)

These studies have established that:

- COVID-19 led to large and unequal learning losses—often exceeding 0.3 – 0.5 SD.
- Losses were severe among students with low parental education or limited digital access.
- Basic skills, especially in math and early literacy, were hardest hit.
- Partial recovery is possible with targeted interventions and in-person instruction.

COVID-19 Disruption

- UNESCO's global school-closure tracker, Ukrainian primary schools experienced:
 - ▶ **18 weeks** of full closure and **13 weeks** of partial/hybrid operation
 - ▶ **31 weeks** of disrupted schooling (≈ 155 days), i.e. about **0.9 of a school year**
- PISA 2022: about **60%** of Ukrainian 15-year-olds report that their school was closed for **more than 3 months**, one of the highest shares among peer countries.

Data: National Monitoring of Primary Education

- **Source & sample:** Grade 4 waves of Ukraine's Nationwide External Monitoring of the Quality of Primary Education: 2018 (9 077 students, 486 teachers) and 2021 (7 991 students, 473 teachers).
- **Sampling:** two-stage PPS design – schools selected with probability proportional to size; in each sampled school up to two Grade-4 classes (largest → reading, second-largest → maths); all pupils in sampled classes tested.
- **Instruments:** standardised Mathematics and Reading tests plus student and teacher questionnaires; in 2021, additional distance-learning questionnaires for students and teachers. [▶ questions](#)
- **Scaling & comparability:** same assessment framework and rotated booklets in 2018 and 2021; scores scaled with 2-parameter IRT to a common 100–300 metric with fixed cut scores at 170, 200, 230 (below-basic, basic, middle, high).

The experimental ideal

Population: All Ukrainian primary schools with 4th-grade students

Random Assignment: Randomly assign schools to:

- **Treatment** ($D_s = 1$): Experience COVID-style closures and distance learning
- **Control** ($D_s = 0$): Continue regular in-person instruction
- $D_s \perp \{Y_{is}(1), Y_{is}(0)\}$

Measurement:

- **Baseline:** Y_{is}^{base} measured at start of 4th grade (or earlier)
- **Endline:** Y_{is}^{end} measured at end of 4th grade on a vertically-linked scale

Subscripts: i = student, s = school

Under random assignment of schools and SUTVA, the Average Treatment Effect is:

$$\begin{aligned}\tau^{\text{ATE}} &= \mathbb{E}[Y_{is}(1) - Y_{is}(0)] \\ &= \mathbb{E}[Y_{is}^{\text{end}} \mid D_s = 1] - \mathbb{E}[Y_{is}^{\text{end}} \mid D_s = 0].\end{aligned}$$

What I actually have: empirical design

Data structure

- Two national monitoring waves of 4th-graders in Ukraine:
 - ▶ 2018: pre-COVID cohort.
 - ▶ 2021: cohort whose early primary schooling was disrupted by COVID.

Estimand

- *COVID cohort effect:*

$$Y_{ist} = \alpha + \beta Post_t + X'_{ist}\gamma + \varepsilon_{ist},$$

where $Post_t = 1$ for 2021, 0 for 2018.

⇒ β : reduced-form effect of belonging to the “COVID cohort” .

When is the design (approximately) causal?

A. For the COVID cohort effect (2018 vs 2021)

- A1 **Test comparability:** 2018 and 2021 scores are on a correctly linked scale; no artificial jumps from changes in test content or administration.
- A2 **No other major shocks:** no nationwide reforms or shocks between 2018–2021 that affect 4th-grade learning and are not controlled for.
- A3 **Stable composition:** differences in student mix (SES, language, urban/rural) are either small or captured by observables and survey weights. balance
- A4 **Stable sampling:** similar school participation and response patterns across waves, or properly adjusted by design weights. balance

Cross-cohort differences in math achievement

Outcome: standardized math score (z)

	(M1)	(M2)	(M3)	(M4)	(M5)
2021 cohort	-0.105 (0.067)	-0.104 (0.065)	-0.051 (0.056)	-0.073 (0.052)	0.005 (0.060)
Female					0.015 (0.038)
2021 × Female					-0.146*** (0.051)
School type FE	No	Yes	Yes	Yes	Yes
Settlement FE	No	No	Yes	Yes	Yes
Region FE	No	No	No	Yes	Yes
Observations	8,282	8,282	8,282	8,282	8,128
R ²	0.000	0.023	0.082	0.146	0.146

Notes: Standard errors in parentheses.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Baseline: 2018 boys, reference school type, large city, reference region.

Cross-cohort differences in reading achievement

Outcome: standardized reading score (z)

	(M1)	(M2)	(M3)	(M4)	(M5)
2021 cohort	-0.099*	-0.103*	-0.031	-0.041	-0.012
	(0.059)	(0.057)	(0.054)	(0.049)	(0.055)
Female					0.306*** (0.042)
2021 × Female					-0.066 (0.053)
School type FE	No	Yes	Yes	Yes	Yes
Settlement FE	No	No	Yes	Yes	Yes
Region FE	No	No	No	Yes	Yes
Observations	8,649	8,649	8,649	8,649	8,578
R^2	0.000	0.016	0.077	0.122	0.146

Notes: Standard errors in parentheses.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Baseline: 2018 boys, reference school type, large city, reference region.

Value-added model of math achievement

Outcome: standardized math score (z)

	(M1)	(M2)	(M3)	(M4)
2021 cohort	-0.073 (0.052)	-0.060 (0.052)	-0.011 (0.058)	-0.007 (0.057)
Female			-0.030 (0.035)	-0.035 (0.035)
2021 × Female			-0.095** (0.046)	-0.100** (0.046)
grade_prev_imp		0.277*** (0.013)	0.278*** (0.013)	0.273*** (0.013)
Region FE	Yes	Yes	Yes	Yes
Settlement FE	Yes	Yes	Yes	Yes
School-type FE	Yes	Yes	Yes	Yes
SES (books at home)	No	No	No	Yes
Observations	8,282	8,282	8,128	8,128
R ²	0.146	0.376	0.376	0.385
RMSE	1.00	0.89	0.89	0.88

Notes: Standard errors in parentheses.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Baseline: 2018 boys in the reference region, settlement type, school type, and lowest books-at-home category.

Robustness to selection: Lee bounds

Group	Lower bound	Upper bound
Boys	-0.14 SD	+0.10 SD
Girls	-0.25 SD	-0.04 SD

- Bounds are computed using the **Lee (2009)** trimming procedure to account for potential differential selection between the 2018 and 2021 samples.
- For **boys**, the bound includes zero (-0.14 to +0.10 SD) \Rightarrow we cannot rule out **no cohort effect**.
- For **girls**, the entire bound is negative (-0.25 to -0.04 SD) \Rightarrow even under worst-case selection assumptions, **girls in 2021 perform worse than girls in 2018**.
- Thus, the main result is robust: **no clear loss for boys, but a persistent learning loss for girls**.

Remote learning exposure and 2021 math scores

Outcome: standardized math score (z), 2021 cohort only

	(M1)	(M2)	(M3)
covid_group 1–2 months	-0.215 (0.140)	-0.079 (0.089)	-0.095 (0.090)
covid_group 3+ months	-0.403** (0.170)	-0.218* (0.122)	-0.243* (0.125)
Female		-0.146*** (0.033)	-0.141*** (0.028)
grade_prev_imp			0.254*** (0.012)
Region FE	No	Yes	Yes
Settlement FE	No	Yes	Yes
School-type FE	No	Yes	Yes
Observations	3,781	3,674	3,674
R ²	0.008	0.158	0.324
RMSE	1.06	0.98	0.88

Notes: Standard errors in parentheses.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Baseline: boys with 0 months of remote learning in the reference region, settlement type, and school type (and average baseline grade in M3).

Online lessons and math achievement (2021)

Outcome: standardized math score (z), 2021 cohort

	(M1)	(M2)	(M3)
Online lessons often	0.490** (0.192)	0.254* (0.138)	0.295** (0.133)
Female		-0.152*** (0.036)	-0.150*** (0.036)
High exposure (3+ months)			-0.267*** (0.092)
Region FE	No	Yes	Yes
Settlement FE	No	Yes	Yes
School-type FE	No	Yes	Yes
Observations	3,315	3,224	3,224
R ²	0.013	0.156	0.161
RMSE	1.06	0.98	0.97

Notes: Standard errors in parentheses.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

“Online lessons often” is a teacher-reported indicator of frequent online teaching. “High exposure” indicates 3+ months of remote learning (vs. 0–2 months).

Smartphone access and achievement (2018 vs 2021)

Outcome: standardized math score (z)

	Coef.	S.E.
At least one smartphone (≥ 1)	0.311***	(0.059)
2021 cohort	-0.392**	(0.120)
Smartphone \times 2021	0.298*	(0.119)
Settlement FE	Yes	
School-type FE	Yes	
Region FE	Yes	

Notes: svyglm with school-level clustering and survey weights.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Effect of smartphones in 2018: 0.31 SD; in 2021: $0.31 + 0.30 \approx 0.61$ SD.

Conclusions

1. Average impact on 4th-grade achievement

- Between 2018 (pre-COVID) and 2021 (COVID cohort), average maths and reading scores decline by about **0.07–0.10 SD**.
- These effects are **modest and often imprecise** once rich controls are included.

2. Unequal losses: girls and more exposed pupils

- Maths losses are **concentrated among girls**: around **0.15–0.16 SD**
- Within the 2021 cohort, pupils with **3+ months of remote learning** score about **0.25 SD** lower than those with little/no remote learning, even conditional on prior grades.

3. Role of remote instruction and digital access

- **Frequent online lessons** are associated with **0.25–0.30 SD higher** maths scores in 2021
- **Smartphone ownership** strongly predicts achievement: the “smartphone premium” rises from about **0.3 SD in 2018** to **0.6 SD in 2021**
- These patterns are **consistent with digital access cushioning COVID-era learning losses**, though they remain associative rather than fully causal.

Questionnaires: Student and Teacher Modules

▶ back

Student questionnaire

- **Background & SES**

Sex, age, language at home, books and assets.

- **Early learning & enrichment**

Kindergarten, preparation for Grade 1, extracurriculars.

- **Home learning environment**

Parental interest, homework help, asking parents for help.

- **School climate & safety**

Feelings about school, classmates, teachers, bullying.

- **Subject attitudes, effort & achievement**

Attitudes and self-concept in maths/reading, time on homework, self-reported grades, perceived test difficulty.

Teacher questionnaire

- **Background & qualifications**

Sex, age, experience, education, category/title.

- **Class & school context**

Class size, admission to Grade 1, class composition, school structure and climate.

- **Collaboration & development**

Cooperation with colleagues, professional development.

- **Well-being & social status**

Stress, fatigue, satisfaction, perceived status of teachers.

- **Subject-specific teaching**

Lessons per week, classroom organisation, teaching methods, use of tools/aids, curriculum and textbooks.

Distance learning questionnaires

back

Student (distance learning)

- **Exposure & modes**

Time spent in distance learning; ways of communicating with teacher

- **Learning activities & autonomy**

Online lessons, TV/YouTube lessons, textbook tasks, online practice, tests; independent work vs teacher-guided work.

- **Digital access & constraints**

Devices at home, internet access/quality, competing demand for devices, own ICT skills.

- **Support & explanations**

Whether teacher explains new topics; role of parents in explaining content.

- **Perceived difficulties & preferences**

Difficulties with DL and view that it is better to study at school than at home.

Teacher (distance learning)

- **Exposure & workload**

Duration of distance learning for the class; length of working day in DL vs face-to-face.

- **Infrastructure & tools**

Devices used (home/school, with/without internet); usefulness of platforms (phone, messengers, Zoom, Google Classroom, LMS, email, etc.).

- **Instructional practices**

Online lessons, individual communication, independent work assignments, online tests, use of textbook/own tasks/online practice, use of national TV/online lessons.

- **Perceived impact**

Change in organisation of DL over time; perceived impact of DL on student achievement.

Table: Timeline of school-year start dates, monitoring cycles, and COVID-19 closures in Ukraine

Date	Event
1 Sep 2017	Start of the 2017/18 school year
17 Apr – 18 May 2018	1st Assessment (Control cohort 2018)
1 Sep 2019	Start of the 2019/20 school year (pandemic strikes mid-year)
COVID-19	
12 Mar – 29 May 2020	Nationwide full shutdown (79 days, 11 weeks fully remote)
1 Sep 2020	Start of the 2020/21 “adaptive-quarantine” school year
8 Jan – 24 Jan 2021	Winter lockdown (17 days, 2.5 weeks fully remote)
25 Jan – 15 Apr 2021	Adaptive-quarantine resumes
16 Apr – 17 May 2021	2nd Assessment (Treated cohort 2021)

Balance by cohort: outcomes, students, schools

[back](#)

	2018 cohort (1)	2021 cohort (2)	Difference (2) – (1)	Std. diff. (SMD)
<i>A. Outcomes</i>				
Test score, z-score	0.00 (1.00)	-0.11 (1.07)	-0.11	0.10
Score, 100–300 scale	202.81 (28.98)	199.76 (30.90)	-3.05	0.10
Pre-basic benchmark (%)	13.7	16.7	3.0	0.10
Basic benchmark (%)	30.4	31.7	1.3	0.03
Intermediate benchmark (%)	38.3	35.8	-2.5	0.05
High benchmark (%)	17.7	15.9	-1.8	0.04
<i>B. Student characteristics</i>				
Female (%)	50.0	50.0	0.0	0.01
Previous grade (1–12)	8.74 (1.89)	8.74 (1.87)	0.00	0.00
<i>C. School location and type</i>				
City of oblast significance (%)	57.6	42.1	-15.5	0.34
Town in district (%)	10.5	15.6	5.1	0.17
Settlement (%)	6.5	12.4	5.9	0.20
Village (%)	25.4	29.8	4.4	0.09
Gymnasium / lyceum (%)	8.7	12.6	3.9	0.15
Ordinary school (%)	76.0	75.4	-0.6	0.01
Specialized school (%)	15.3	12.0	-3.3	0.09
Observations (weighted)	36,912,367	3,781		

Balance by cohort: household resources

	2018 cohort (1)	2021 cohort (2)	Difference (2) – (1)	Std. diff. (SMD)
<i>D. Household resources</i>				
<i>Books at home</i>				
None or very few (0–10) (%)	12.4	17.2	4.8	0.15
One shelf (11–25) (%)	35.1	35.0	-0.1	0.15
One bookcase (26–100) (%)	31.5	29.3	-2.2	0.15
Two bookcases (101–200) (%)	11.9	10.0	-1.9	0.15
More than two bookcases (%)	7.4	7.0	-0.4	0.15
<i>Number of notebooks</i>				
None (%)	9.1	11.7	2.6	0.15
One (%)	53.2	49.0	-4.2	0.15
Two (%)	23.2	21.5	-1.7	0.15
Three or more (%)	8.2	8.8	0.6	0.15
<i>Number of cars</i>				
None (%)	28.4	26.1	-2.3	0.09
One (%)	41.4	41.1	-0.3	0.09
Two (%)	13.8	15.2	1.4	0.09
Three or more (%)	6.1	5.4	-0.7	0.09

Notes: Percentages may not sum to 100 because missing categories are omitted. Standardized differences (SMD) are shown at the variable level and are based on the full distribution of categories. Shares are computed using survey weights W .

Balance by cohort: early childhood and preparation

	2018 cohort (1)	2021 cohort (2)	Difference (2) – (1)	Std. diff. (SMD)
<i>E. Early childhood and preparation</i>				
<i>Time spent in kindergarten</i>				
Several months (%)	7.3	6.7	-0.6	0.14
Do not remember (%)	30.4	29.9	-0.5	0.14
More than two years (%)	42.9	39.1	-3.8	0.14
No kindergarten (%)	9.6	13.5	3.9	0.14
Several months–2 years (%)	8.5	9.5	1.0	0.14
<i>Preparation for school</i>				
Prepared with relatives (%)	50.7	59.3	8.6	0.25
Individual tutor lessons (%)	10.4	10.6	0.2	0.25
Prep courses in kindergarten/school (%)	17.0	14.6	-2.4	0.25
No special preparation (%)	6.6	7.2	0.6	0.25
Other (%)	4.2	2.7	-1.5	0.25

Notes: Percentages may not sum to 100 because missing categories are omitted. Standardized differences (SMD) are shown at the variable level and are based on the full distribution of categories. Shares are computed using survey weights W .

Appendix: Descriptive statistics

Table: Descriptive statistics on enrollment, attrition, and test performance.

	2018	2021	Difference
Panel A: Math			
Math score ^a	0.00 (1.00)	-0.11 (1.07)	-0.11*** (0.02)
Proportion tested	0.91	0.86	
Tested	4501	3781	
Enrolled	4956	4409	
Panel B: Reading			
Reading score ^a	0.00 (1.00)	-0.10 (1.03)	-0.10*** (0.02)
Proportion tested	0.91	0.86	
Tested (wtd)	4506	4143	
Enrolled	4928	4832	

^a Scores are standardized using 2018 as the benchmark year

* Stat. significance at the 1, 5, 10% levels is indicated by ***, **, and *.

▶ Back to results