Learning losses and educational inequalities in Europe: Mapping the potential consequences of the COVID-19 crisis

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Abstract

It is widely discussed that the pandemic has impacted educational inequalities across the world. However, in contrast to data on health or unemployment, data on education outcomes are not timely. Hence, we have extremely limited knowledge about pandemic-related learning losses at the national and cross-national levels. As it might take years to get suitable comparative data, this study uses the latest large-scale international achievement survey from before the pandemic, the Trends in International Mathematics and Science Study 2019, to answer two research questions. First, which European countries are most likely to have experienced higher learning loss among their children? Second, which European countries have most likely experienced the greatest increases in learning inequalities? Results based on 4th graders' school achievements indicate that educational inequalities between and within countries are likely to have augmented substantially throughout Europe. Some European countries are probably already facing an education crisis.

Keywords

educational inequalities, COVID-19, Europe, learning loss, Trends in International Mathematics and Science Study 2019, pandemic

Introduction

Children have the lowest risk of falling severely ill if exposed to the COVID-19 virus. However, they have suffered in several ways as a result of pandemic-related school closures, which led to around 58 million primary and secondary children being deprived of face-to-face learning for many weeks in the EU-27 countries alone. This study focuses on

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pandemic-related learning loss, which we define as a lack of learning progress that would not have occurred in the absence of physical school closure.

Timely information on the actual educational consequences of the crisis is scarce even at the national level and will most likely remain unavailable for a long time cross-nationally. Given the serious risks the COVID-19 crisis poses to children's learning outcomes and their future lifetime opportunities (Hanuschek and Woessmann, 2020), we cannot afford to wait for the optimal data to arrive. Instead, we need to make the most out of the available data sources to help inform policymakers on the extent of the problem. We therefore exploit the most recent pre-COVID cross-national data set, the Trends in International Mathematics and Science Study (TIMSS) 2019, to examine the potential and relative trajectories of countries in terms of both education outcomes and inequalities. Since research shows that younger pupils lose out the most from distance learning (Fuchs-Schündeln et al., 2020), this study focuses on 4th-grade children in primary schools, who are around 10 years of age. These children require substantial parental support during home schooling and are less likely to overcome learning constraints deriving from a lack of home and school learning resources. In addition, these children still have many years left in school, so the right policy design can support them to overcome possible learning losses experienced during the pandemic.

This study answers two research questions. First, which European countries are most likely to have experienced higher learning loss among their children? Second, in which European countries are learning inequalities most likely to have increased?

The value added of this focus is threefold. First, to the best of our knowledge this study is the first to combine pre-COVID student assessment data with insights taken from COVID-19 studies to better understand the potential implications of the crisis across several European countries. Second, it is the first to map European countries in terms of the relative risk of low educational outcomes and inequality due to the pandemic, thereby highlighting in which countries children are most likely to be left behind. Third, we provide some insights into how policymakers

can support students, at the individual or at the school level.

This article is organized as follows: the next section reviews the literature to discuss possible mechanisms leading to learning loss and increasing inequalities during school closures. Then, given the importance of home and school resources for learning outcomes during school closures, TIMSS data are exploited to describe country differences in the share of children lacking these resources during the pandemic (the third section). Linking these results to pre-pandemic achievement allows us to draw conclusions on possible trajectories of between-country differences regarding average learning loss, thereby answering the first research question (the fourth section). Turning to within-country inequalities, we then discuss the implications of education inequalities on learning outcomes during the pandemic (the fifth section). Assuming that during the pandemic home resources and parental background are even more important than before, we identify those countries in which disadvantaged children are likely to fall even more behind. The sixth section combines the results of the previous two sections, showing how countries compare on both dimensions together, namely, the risk of decreasing average achievement and the inequality of learning outcomes, thereby answering the second research question. The final section concludes and discusses policy implications.

Learning loss and educational inequalities during physical school closure: The literature

From the early days of the COVID-19 pandemic, experts have been concerned that enforced distance learning would lead to massive learning losses in the affected student populations (Blasko and Schnepf, 2020; Blundell et al., 2020; Di Pietro et al., 2020; Hanuschek and Woessmann, 2020). The first evidence underpinning this worry is derived from previous research outcomes on school closure during summer holidays (Paechter et al., 2015; Shinwell and Defeyter, 2017) and the consequences of teacher strikes (Baker, 2011; Belot and Webbink, 2010). This research also points to uneven learning loss during

school closures, leading to a significant increase in the pre-existing socio-economic gaps in education that can continue long into students' education careers (Alexander et al., 2007). It is widely acknowledged that school learning reduces socio-economic inequality in achievement because instruction time in schools tends to be more beneficial for children from families with lower incomes and socio-economic backgrounds (Lavy, 2015; Burger, 2016). Losing the opportunity to mix with peers from different socio-economic backgrounds can further reduce learning opportunities, particularly for disadvantaged children (Agostinelli et al., 2020).

Empirical studies measuring the actual extent of learning loss due to the COVID-19 pandemic confirm early concerns based on pre-pandemic evidence. Such studies are still scarce, however, since they rely on the availability of achievement measures before and after the crisis. These data are only available for countries that collect pupils' achievement results for centrally organized tests. For the Netherlands, Engzell et al. (2020) build on these administrative data and find that in spring 2020 young students aged 7 to 11 suffered a learning loss as high as 3 percentage points, or 0.08 standard deviations compared to students in the same grade in the previous years. Comparable analyses of administrative data in other parts of Europe confirm similarly high magnitudes (see Schult et al., 2021, for Germany) or even greater (Maldonado and Witte, 2020, for Belgium; and Contini et al., 2021, for Italy). This considerable extent of the learning loss is also concerning given the results of a recent study stating that catching up in school after a physical school closure is challenging (Gambi and Witte, 2021).

Some studies exploiting administrative data, however, discuss not only the average learning loss but also its unequal distribution. Students with less-educated parents tend to fall considerably more behind than their more advantaged peers (Engzell et al., 2020; Maldonado and Witte, 2020). These heterogeneous learning losses are likely to be largely driven by varying parental support and access to home-learning resources. When schools remain closed, children must increasingly rely on physical and cultural assets available at home. As these resources are unevenly distributed across families, it is inevitable that children will not benefit equally from distance learning. Research shows that home resources such as the availability of books (Brunello et al., 2016; Sikora et al., 2019), parental time investment, learning support and engagement in educational activities (Araújo and Costa, 2015; Macmillan and Tominey, 2019), and adequate and healthy nutrition (Belot and James, 2011) provide additional learning gains conditional and unconditional on parental education. ICT usage at home has also been linked to positive outcomes (Biagi and Loi, 2013).

While the literature stresses the importance of these resources for predicting educational achievement in normal times, we argue that the resources as well as their distribution across the pupil population gain special importance for learning progress during physical school closures, when online learning is restricted to children's home environments. In the pandemic literature, this increased importance is most widely discussed in relation to access to ICT tools and the internet (Bol, 2020; Andrew et al., 2020; Di Pietro et al., 2020), but also regarding other factors such as the importance of having a quiet place to study (Bol, 2020) or access to regular and healthy meals (Eurochild, 2020). In this study, we examine heterogeneities in the share of students lacking important home resources, thereby providing a measure of disadvantage in learning progress during the pandemic.

In contrast to school closures due to summer vacation and teacher strikes, in distance-learning times schools and teachers aim to help students progress in their learning, even though their means are limited. Different countries have applied different distance-teaching policies and schools have relied on various teaching methods. For example, Champeaux et al. (2020) show that a much higher proportion of primary school children were offered online classes in Italy (65%) than in France (20%). Also focusing on the first lockdown and looking at the distance-learning experiences of students aged 10 to 18 in 11 European countries, Vuorikari et al. (2020) find that the proportion of students who had some form of daily interaction with their schools varied between 34% in Germany and 78% in Norway. These varying implementations of online learning may have

impacted differently on learning outcomes between countries but cannot be examined in this study. We also cannot take into account the impact of varying levels of teachers' digital skills on distance teaching (Cullinane and Montacute, 2020). Nevertheless, this study considers the availability of certain online tools at the school level, which is likely to signal both the technical preparedness of schools for online teaching and teacher familiarity with those tools.

Data and methodology

This study exploits TIMSS 2019 data, which is organized by the International Association for the Evaluation of Education (IEA). The sample design of TIMSS is organized in two stages across participating countries: first, a representative sample of schools is drawn; second, one or more intact classes of students are selected from sampled schools. On average across the 22 European countries analysed here, around 4400 4th graders were sampled per country. (For simplicity, the study refers to 'countries', although in the case of Belgium, the study covers only the country's Flemish population.)

Trends in International Mathematics and Science Study measures maths and science achievement by focusing on curricula-based learning outcomes. This study focuses on maths achievement only, a subject quite likely to have been covered in learning activities during physical school closures. Responding students receive a battery of maths questions. Their answers are summarized to obtain an estimate of a pupil's 'proficiency' in maths. Across all participating students and countries, the constructed mean maths achievement score is around 500, with a standard deviation of 100. Trends in International Mathematics and Science Study data are also rich in background information on parents, teachers and schools. As a consequence, with TIMSS 2019 data it is possible to examine in detail pupils' educational achievements and specific learning environments at home and school just before the pandemic.

For some variables, missing values are not negligible. We have excluded the Netherlands, England and Northern Ireland due to a lack of data on parental characteristics. In Bulgaria, Croatia and the Slovak Republic, less than 5% of student responses are missing information on parental education, but in Germany, Denmark and Norway this amounts to more than 35%. Students with missing values are only excluded if descriptive and regression analyses use the variable. For more information on missing values, see Supplemental Table A1 in the Appendix.

Methodologically, this study examines the association of home resources and parental background with achievement employing ordinary least square (OLS) regressions. The dependent variable is 4th graders' maths achievement. The explanatory variables cover parental education (differentiating between children with at least one parent educated to the tertiary level and those not having any tertiary-educated parent) and lack of home resources: no room on their own, fewer than 25 books at home and no reading device, no internet access and hungry every day. Probable lack of parental support is estimated – admittedly roughly – by the only variable available on the topic: whether parents read to the child when they were of pre-school age. Ordinary least square regressions take the design features of the survey (plausible values and weighting) into account.

Trajectory of learning loss across European countries

The longer schools are closed and the more time students spend in distance learning, the higher the expected learning loss (Engzell et al., 2020). Furthermore, we can expect countries that invested more in digital education to be well equipped with ICT tools and internet connection and thus be better able to respond to the crisis. These countries are also more likely to have invested in teacher training for digital skills and therefore provide higher quality distance learning, thus minimizing learning losses during the pandemic. Figure 1 links these two pieces of information for all 27 EU member states plus the United Kingdom and Norway.

While acknowledging the diversity of national and even regional pandemic responses in terms of education, in that they go 'far beyond the categorisation of keeping… primary schools "opened" … or "closed"' (Blum and Dobrotić, 2020: 2), we rely on UNESCO data to calculate the length of period
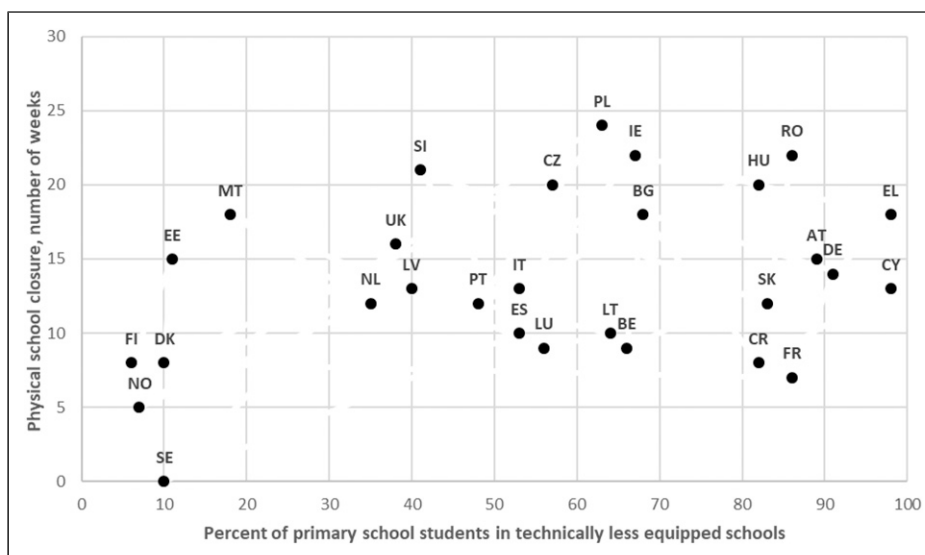
Figure 1. The length of school closures between March 2020 and 31 July 2021 and the proportion of ISCED1 pupils that study in schools that are at most partially equipped with internet and ICT tools.
Source: UNESCO 2021, European Union, 2019.
Note: Physical school closures are measured by the number of weeks schools were closed in the entire country due to COVID-19, according to UNESCO. Internet connection and ICT equipment available in schools are measured through a categorization based on school surveys in 2017/18. For more details, see European Union, 2019. The correlation coefficient is 0.35.

over which schools were fully closed in an entire country due to COVID-19 between March 2020 and July 2021 (UNESCO, 2021). We assume that in times of only partial school closures primary schools were still open. However, primary schools can also be affected by regional or other types of partial school closures in different country contexts. Weeks of full school closure displayed on the *y*-axis of Figure 1 should therefore be considered as lower estimates of the time children spent without in situ teaching due to the COVID-19 pandemic during the 2020/2021 school year.

To assess the technical readiness of countries for distance teaching, the *x*-axis of Figure 1 displays the proportion of primary school children who study in a school that is considered to be at most partially equipped with ICT tools and good-quality internet connection, according to a survey carried out among school headmasters in 2017/18. The indicator is based on a number of measures describing the type and quality of internet access available in the school, as well as the number and functionality of ICT

equipment (for more details, see European Union, 2019).

Figure 1 identifies the Northern European education systems as those in the best position to deal with the crisis since they feature only a short period of school closure and high technical preparedness for online teaching. This analysis also confirms the assessment of Engzell et al. (2020) stating that the Netherlands represent a close-to-best-case European scenario in terms of technical environment and school closure, and thus, their substantial estimate of 0.08 standard deviations of learning loss during 8 weeks of school closure could even be below that of many other European countries. For example, children in countries at the top-right corner of Figure 1, such as those in Romania, Ireland, Poland, Bulgaria and also Austria might fare considerably worse given that schools were less equipped and needed to provide online teaching for a much longer time.

Figure 1 only provides a snapshot of two factors important for guiding learning progress during the

Table 1. Percentage of students lacking home and school resources for distance learning, length of school closure and educational achievement before the crisis in various European countries in 2019.

	PERCENTAGE OF STUDENTS LACKING HOME RESOURCES					PERCENTAGE STUDENTS LACKING SCHOOL RESOURCES		SUMMARY INDICATOR		SCHOOL CLOSURE, NO OF	TIMSS MEAN MATHS SCORE
	No internet at home	No own room	No books and reading device	Regularly hungry in the morning	Limited parental support	No online learning management	Lack of access to digital resources	Mean z-score all		WEEKS UP TO 31/07/2021	
IT	14	49	5	22	52	49	35	1.47		13	515
BG	9	31	10	19	61	22	18	1.13		18	515
FR	8	29	3	18	40	82	51	0.81		7	485
CR	8	32	4	15	57	50	20	0.65		8	509
DE	12	17	3	15	26	81	57	0.61		14	521
CY	8	16	4	14	44	78	24	0.38		13	532
CZ	4	32	2	17	32	32	46	0.23		20	533
SK	4	37	4	15	40	18	22	0.17		12	510
ES	7	23	3	14	52	44	9	0.16		10	502
PT	4	22	4	13	56	38	16	0.11		12	525
LV	4	29	4	15	40	9	19	-0.01		13	546
HU	5	25	4	14	32	6	41	-0.04		20	523
MT	2	24	1	26	40	16	12	-0.1		18	509
PL	9	27	2	9	36	18	14	-0.22		24	520
BE - FI	4	18	1	13	51	18	12	-0.29		9	532
IE	5	24	3	10	28	36	21	-0.29		22	548
LT	3	38	3	4	42	1	17	-0.37		10	542
AT	3	3	2	14	34	42	32	-0.38		15	539
SE	2	15	1	10	33	6	3	-0.94		0	521
DK	2	10	1	12	29	0	1	-0.98		8	525
NO	1	10	1	10	30	10	4	-1.05		5	543
FI	2	18	1	6	25	5	10	-1.06		8	532

Source: TIMSS 2019. UNESCO 2021, *authors' calculations.*
Note: Countries are ordered by the summary indicator, which is the countries' mean z-score for all seven home and school variables to its left-hand side (see Appendix Supplemental Table A3). 'No books and reading device' means that students have fewer than 25 books at home and no digital reading device. 'Regularly hungry in the morning' refers to students who say that they arrive at school hungry every day or almost every day. 'Limited parental support' is a proxy measure referring to the percentage of students whose parents did not read to them often when they were of pre-school age. 'No online learning management' refers to the responses of headmasters to the questions 'Does your school use an online learning management system to support learning (e.g. teacher–student communication, management of grades, student access to course materials)?' and 'Does your school provide students access to digital learning resources (e.g. books, videos)?'

pandemic. However, even in a school equipped with learning technology and digitally skilled teachers, students' home resources are key to learning when not attending school. Exploiting TIMSS 2019 data for 22 European countries, Table 1 compares countries in terms of the lack of both individual and school learning resources. Regarding individual resources, it shows the share of children lacking internet access at home, a room on their own, reading material (measured as not having more than 25 books at home and no reading device), regular nutrition (measured as being hungry when arriving at school) and parental support (proxied by parents not reading often to children during pre-school age). Regarding school resources, Table 1 presents the percentage of 4th

graders who attend a school without an online learning management tool and without access to digital resources. To make the table easier to read, we mark countries in the most disadvantaged third of the specific resource with dark grey, while those that belong to the best-equipped third are in white and countries in a middle position are in light grey. (On purpose, Table 1 only looks at the average lack of resources across countries. Students with less-educated parents tend to lack more resources than their better-off peers (see Appendix Supplemental Table A2), which will be discussed later on.)

To synthetize this information, we calculate the z-scores associated with each of the resources for each country (Supplemental Table A3 in the Appendix provides these z-scores) and take the mean of the z-scores (Table 1, 8th column). The value of the z-score indicates the standard deviations above (positive) or below (negative) the mean of the countries' distribution. The last two columns of Table 1 display the contextual information: 4th graders' average maths achievement and weeks of total school closure.

While the use of the z-score is helpful in summarizing complex information, it has its drawbacks. First, countries' relative positions depend on the 22 TIMSS countries covered. Second, the resources are not weighted by their actual importance for successful online learning, which is unobservable. We therefore weight each variable equally to derive the overall z-score, which includes an implicit value statement. To evaluate countries' specific positions, it is more useful to work with the colour shading that reflects in which third of the distribution countries are ranked. Countries with many pupils lacking the necessary resources for distance learning include Italy, Bulgaria, France, Croatia, Germany, Cyprus and Czechia. Countries that fare relatively well include Finland, Norway, Denmark and Sweden. Third, the TIMSS variable coverage is greater for student than for school variables, so for schools we only have two rough indicators proxying how well the schools were technically prepared for distance teaching. At the same time, we have no measures of teacher capability.

Results show that countries with on average lower-achieving children also have a higher share of students lacking home and school learning resources,

as measured by the overall z-score (correlation co-efficient $r = -0.51$). This association is not surprising as higher school achievements are often found in more affluent countries, where there are also fewer students without access to basic resources. However, the implications during the COVID-19 crisis are highly worrying, as low access to resources will most probably intensify learning losses precisely in those countries that were already lower-achieving before the crisis. European disparities in average learning outcomes are therefore expected to increase.

This conclusion is further supported by comparing countries' positions in terms of the lack of learning resources and duration of school closure. While the two countries with the longest period of distance teaching (Ireland and Poland) are comparatively well equipped with the resources necessary for online learning, the overall correlation coefficient of the z-score and duration of school closure is nevertheless significant, with $r = 0.31$. Hence, countries with longer school closures tend to have more poorly equipped students and schools. Consequently, the overall results indicate that Europe will face widening differences in educational outcomes between countries.

Trajectories of educational inequalities within European countries

Up to now, we discussed increasing differences between countries regarding their pupils' average educational achievement during physical school closure. This section instead focuses on pandemic-induced trajectories of inequality within countries. To set the scene, we look first at pre-pandemic social gaps in educational achievement. Clearly, in countries where children with fewer resources were already disadvantaged before the pandemic, they are likely to experience a higher risk of performing worse during the pandemic. This would then lead to an even lower level of achievement for disadvantaged groups and, consequently, rising within-country educational inequality.

Although this variable has its drawbacks, in line with existing research we define high socioeconomic background students as those who have

at least one tertiary-educated parent and low socio-economic background students as those who have no tertiary-educated parent (Jerrim et al., 2019). Employing an OLS regression with maths achievement as the dependent variable, parental education as the only explanatory variable, and using country fixed effects, we find that on average in the 22 countries in Europe, children with low-educated parents have a mean TIMSS maths score 48 points lower than that of their counterparts with more highly educated parents (Model 1). This European pre-pandemic socio-economic learning gap accounts for about 10% of mean achievement and is therefore substantial (see Appendix Supplemental Table A4 for Model 1 results).

Learning progress during the pandemic is determined by access to home resources, which are related to the parents' educational level (home resources are often used as additional proxies for socio-economic status), although the strength of this association varies both across countries and resources (as shown in Supplemental Table A2 in the Appendix).

Conditional on parental education, how important were home-learning resources before the pandemic in explaining educational outcomes? We assume that during the pandemic the association between home resources and learning progress become even stronger compared to that estimated for 2019. We therefore run Model 2, which adds the home resources we discussed in the previous section (lack of internet access, own room, reading resources, nutrition and parental support) to Model 1 as explanatory variables for learning outcomes. Focusing on the merged 22-country sample, the results first indicate that the parental gap in achievement (estimated at 48 points) decreases by 9 points conditional on home resources. Second, the lack of any of the learning resources (or their possible characteristic as a proxy measure for aspects of socio-economic status other than parental education) is associated with a significant decrease in achievement already before the crisis, ranging from about a 7-point lower achievement for children lacking their own room to as much as 40 points for those lacking reading resources.

Up to now, the focus has been on the merged European TIMSS sample, but how do European countries differ? A selection of country-specific regression results is displayed in Table 2, showing the regression coefficients for all explanatory variables in the first six columns (the full regression results of Model 2 are reported in Supplemental Table A4 in the Appendix). Results of country-specific regressions show that the lack of any home-learning resource except 'own room' is significantly associated with lower achievement in all countries. Conditional on parental education, before the pandemic students who had no access to the internet and therefore have a very small chance of attending online learning during the pandemic were already lagging behind as much as between 16 and 44 TIMSS maths points compared to children with the resource (see column 2 in Table 2).

Synthesizing the regression coefficients, Table 2 provides the 'overall home gap', equal to the sum of all regression coefficients in column 7. This value denotes the decrease in the maths achievement score of a child who lacks all resources and has lower-educated parents compared to a child who does not lack any resources and has tertiary-educated parents. Only a small share of children is lacking all resources. In the overall European TIMSS sample, 37% of pupils are equipped with all of the resources, 39% are missing one of them, 19% are missing two, 4% lack three and 0.6% lack four or more. As such, it is important to interpret the overall home gap as the 'worst possible' scenario of disadvantage that can occur in a country and not as the 'actual gap' experienced.

Similar to Table 1, we group countries distinguishing between countries with high (dark grey), medium (light grey) and low (white) resource coefficients. In Lithuania, Ireland, Hungary, Bulgaria, Slovakia, Germany, Finland and Malta, the association between the lack of home resources and learning outcomes was already particularly large in the European context before the crisis.

Notably, the current regression coefficients displayed in Table 2 assume that home resources are equally important for children with and without tertiary-educated parents. In order to check this assumption, we run an additional OLS regression model that includes an interaction between parental education and home resources. We find that when pooling all countries together and using fixed effects

Table 2. The association between students' home resources and math achievement by country.

	CONDITIONAL ASSOCIATION BETWEEN LACK OF THE RESOURCE AND STUDENTS' ACHIEVEMENT						OVERALL HOME GAP	SCHOOL CLOSURE, NO OF WEEKS UP TO 31/07/2021
	Lower parental education	No internet at home	No own room	No books and reading device	Regularly hungry in the morning	Limited parental support		
LT	-53.6	-30.6	1.8	-57.9	-33.6	-23.2	-197.1	10
IE	-33.1	-44.4	-1.0	-46.9	-32.9	-30.7	-188.9	22
HU	-53.4	-33.3	-1.6	-60.9	-15.0	-17.1	-181.2	20
BG	-50.2	-37.4	-3.5	-32.5	-32.8	-24.8	-181.1	18
SK	-42.2	-52.3	5.3	-50.3	-17.4	-23.9	-180.9	12
DE	-29.5	-25.1	-18.0	-51.7	-24.2	-28.9	-177.4	14
FI	-33.8	-28.1	4.0	-56.0	-40.8	-21.2	-175.8	8
MT	-36.6	-34.0	-3.6	-53.4	-23.2	-24.6	-175.3	18
SE	-38.4	-36.7	-24.6	-32.0	-19.0	-19.9	-170.5	0
BE-Fl	-36.0	-34.5	-14.6	-46.9	-14.9	-20.2	-166.7	9
ES	-33.0	-19.0	1.2	-52.9	-31.5	-23.0	-158.1	10
PL	-44.4	-35.4	-3.6	-20.3	-34.9	-18.8	-157.3	24
CZ	-43.3	-15.9	0.1	-56.0	-18.7	-19.0	-152.8	20
FR	-47.8	-20.2	-19.7	-47.3	-22.0	-31.3	-146.5	7
NO	-29.1	-25.8	-8.4	-37.8	-24.6	-19.6	-145.3	5
PT	-41.9	2.9	-2.9	-50.7	-25.4	-24.5	-142.5	12
DK	-27.4	-31.4	5.1	-52.7	-12.3	-22.8	-141.5	8
CY	-32.9	-24.5	3.5	-34.5	-32.2	-16.8	-137.4	13
AT	-34.1	-19.4	-9.5	-16.7	-20.6	-24.4	-124.9	15
CR	-34.4	-24.5	4.4	-13.3	-19.3	-23.0	-110.1	8
LV	-34.0	-16.3	2.2	-20.3	-17.1	-21.8	-107.2	13
IT	-26.1	-16.6	4.7	-26.7	-20.1	-19.1	-103.8	13
Overall	-38.6	-22.9	-6.8	-40.0	-24.4	-24.7	-157.4	-

Source: UNESCO 2021. TIMSS 2019, authors' calculations.
Notes: Regression coefficients derive from Model 2 (see Table A4 in the Appendix). The level of significance of the coefficients is marked as follows: **$p < 0.01$**; $p < 0.05$; <u>$p < 0.1$</u>. Countries are ranked by the 'overall home gap', which is the sum of the regression coefficients related to socio-economic background (parental education + home resources).

there is no significant interaction effect. We find the same result for all countries but Ireland, where children with higher educated parents have a slightly smaller negative association of lack of home resources with learning loss (for more details regarding the regression results, see Appendix Supplemental Table A5). These results might indicate that the social gradient of education outcomes is not necessarily going to increase even though learning inequalities augment during the pandemic. However, without knowing the extent to which the importance of home resources for learning outcomes has grown during

the pandemic and whether this growth is associated with parental education, we cannot investigate properly possible changes of the social gradient within this article.

Another factor to consider is the location of schools. While not significant in other countries, in Bulgaria, Hungary, Latvia, Lithuania and Slovakia, educational achievement in schools in rural areas is considerably lower than in urban areas. Moreover, in these places, controlling for urban status also considerably reduces the coefficients associated with the socio-economic conditions. Consequently, educational support programmes in these countries should pay attention and better target rural areas and schools to mitigate the additional disadvantage that children in these schools face (see Appendix Supplemental Table A6).

Finally, it is important to note that in the analyses presented in Table 2 we do not control for schools (e.g. random school effects) in the models. As such, school 'effects', such as differences in value added by schools, are not isolated from the coefficients displayed. Additional analyses (not shown but available upon request) suggest that between-school differences contribute considerably to the socio-economic gap in a handful of countries. In Bulgaria, between-school variation accounts for over 40% of educational inequality, while in Hungary, Lithuania and Slovakia this amounts to 30%. The importance of school differences is also non-negligible in some countries with smaller socio-economic gaps, most markedly in Germany (26%) but also in Spain, Sweden and Cyprus (around 20%). In these countries, educational policies aiming to reduce the socio-economic gap in education could already go a long way by targeting disadvantaged schools rather than focusing only on families if we assume that pre-pandemic between-school differences in learning outcomes stayed stable (or increased) during physical school closures.

Learning loss and educational inequalities combined

Given differences between countries in terms of pupils' access to home and school resources (as

discussed in the fourth section) and the actual association of these resources with learning outcomes (as discussed in the previous section), how can we map countries in terms of their chances of experiencing a decrease in overall achievement and an increase in educational inequality during the pandemic? Figure 2 merges our previous results. Its x-axis reports countries' mean z-scores indicating their relative position in terms of children lacking home and school learning resources during the pandemic (derived from Table 1). The y-axis displays the overall home resource learning gap, denoting the highest possible importance of parental education and home resources for learning outcomes (derived from Table 2). The correlation coefficient is positive with 0.27 but not significant.

Countries at lowest risk of learning loss are those in the left upper quadrant. In these countries, comparatively low numbers of students lack resources and these resources are also not so important for learning outcomes (before the pandemic). Norway, Denmark, Austria and Latvia fall into this group. In contrast, countries with many children lacking access to key distance-learning resources and at the same time displaying a substantial learning disadvantage associated with this condition are grouped in the right lower quadrant. Bulgaria stands out. We also find Germany, Slovakia and Spain in this high-risk category and very close to it are Malta, Hungary and Czechia. In addition, across these at-risk countries, several (those marked with a diamond) belong to the worst third of countries with the longest school closure (18 weeks or longer). This additional risk further increases the vulnerability of disadvantaged students in Bulgaria, Czechia, Malta and Hungary. Clearly, in all the worst-affected countries, policymakers need to act quickly to help disadvantaged children not fall further behind.

Discussion and conclusions

While it is commonly assumed that physical school closures have led to substantial learning losses for children during the pandemic, data that would allow for the examination of the actual extent of this in a comparative manner are not available and will not be
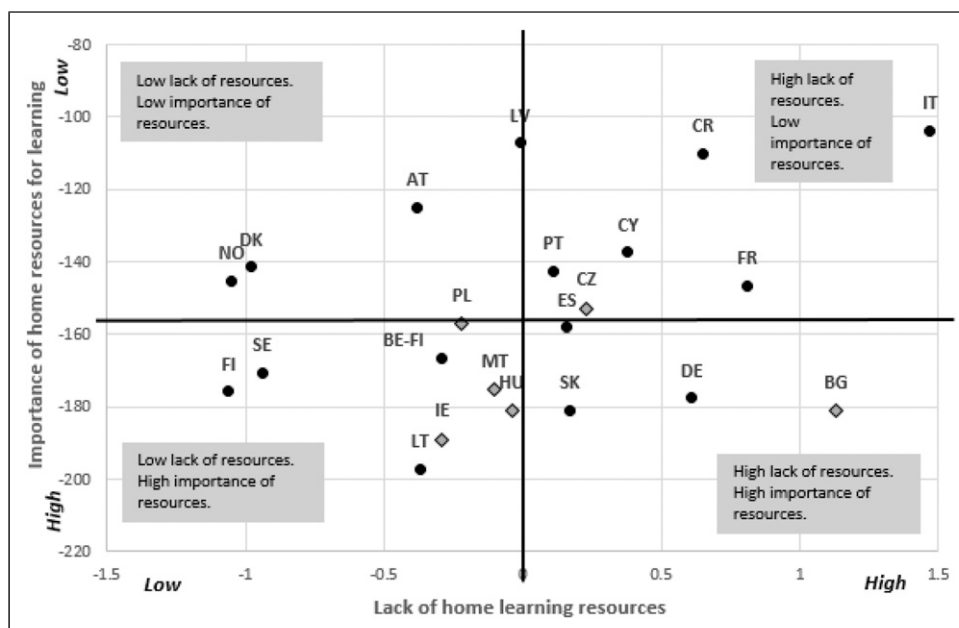
Figure 2. The lack of home resources and their importance for learning outcomes.
Source: TIMSS 2019. Authors' calculations.
Note: The overall home gap derives from Table 2 and hence from OLS regressions (see Supplemental Table A4 in the Appendix, Model 2). Mean z-scores for lack of resources derive from Table 1. Countries with a diamond symbol closed schools fully for 18 or more weeks during the 2020/2021 school year. The correlation coefficient is 0.27.

so for some years. The lack of timely data and hence of our awareness of the problem is likely to delay the development and implementation of policy initiatives to counteract it. This study manoeuvres around the current lack of data by using pre-COVID TIMSS 2019 data and applying descriptive statistics, OLS regressions and logical deductions. By doing so, and with the obvious limitations this approach entails, it provides to the knowledge of the authors a first cross-national mapping of the likely educational implications of the present crisis in Europe, evaluating both the overall expected level of learning loss and inequality.

Since we focus on the most vulnerable children – younger ones who require substantial parental support during home schooling – we build our analyses to a large extent on the idea of home resources being essential for distance learning. Thus, we account for a lack of internet access, books and reading devices, the child's own room, nutrition and parental support. We also examine schools' use of digital resources

and management, which serve as proxies for the technical preparedness of schools for distance learning. Variation in the lengths of school closure across European countries is taken into account as well.

First, we show that European countries differ greatly in terms of the share of children lacking important distance-learning resources. In Italy, Bulgaria, France, Croatia, Germany, Cyprus and Czechia relatively many students lack important resources for distance learning, and in Finland, Norway, Denmark, Sweden, Austria, Lithuania and Ireland this pertains to relatively few. This positioning of countries is likely to be explained by both the affluence of and inequalities within countries. Countries that are more affluent and have lower inequality levels are more likely to have lower shares of students lacking important home-learning resources. The rest of the European countries we examine are situated somewhere in between. Countries with higher shares of children lacking learning

resources (and hence more children facing a greater risk of falling behind in learning) tend to also have lower average pupil achievement; thus, inequalities between European countries are likely to increase during the pandemic.

Second, we examine how important the lack of these resources and parental background was for achieving highly just before COVID-19 led to physical school closures. The association between low achievement and disadvantage was strongest in Lithuania, Ireland, Hungary, Bulgaria, Slovakia, Germany, Finland and Malta indicating that in these countries, pupils most exposed to learning losses during distance learning, were already lagging behind a lot before the pandemic started. In contrast, the association was weakest in Portugal, Denmark, Cyprus, Austria, Croatia, Latvia and Italy. This positioning of countries is likely to reflect the capacity of their education systems to counteract inequalities, even though the rank of Finland – a country generally acknowledged to reach high equity in education outcomes – appears counterintuitive (Schnepf et al., 2019). We argue that while in many countries, home-learning resources were already important before the pandemic, their importance is considerably higher during the pandemic. This is worrying as countries that could not counteract inequalities related to parental background and resources before might also be less likely to mitigate the increasing importance of these factors during the pandemic. We also show that in some of these places, a significant portion of these inequalities can be attributed to differences between schools. This suggests that in these education systems, targeting worse-achieving schools would go a long way in combating crisis-related low educational achievement.

In a third step, we merge the country patterns of overall lack of resources with their relative importance. Results clearly indicate that Bulgaria, Germany, Slovakia and Spain, but also Hungary, Malta and Czechia, are likely to face substantial decreases in average achievement and increases in inequality. Some of these countries, such as Bulgaria, Hungary, Malta and Czechia tended to have closed their schools longer than other countries in Europe by the end of the school year 2020/2021. Moreover, countries identified as being at high risk of increasing educational inequalities due to the pandemic also share system features that are often discussed as increasing inequalities in general, such as early tracking, a large vocational sector or frequent grade repetition (Volante et al., 2019; Eurydice, 2020). Overall, there remains little doubt that the learning loss of 3 percentage points (or 0.08 standard deviations) for a similar age group calculated based on administrative data in the technically advanced and high-income Netherlands after only 8 weeks of school closure (Engzell et al., 2020) represents a lower estimate for what we can expect in most of the European countries in this study.

In order to support today's children in overcoming COVID-related learning loss and resulting limited future opportunities, effective policy support is needed. First, school closures should be among the very last interventions governments introduce during a pandemic. Nevertheless, schools and teachers must be prepared for possible lockdowns in the future, during which education policies need to target directly the most disadvantaged students to decrease the worst effects of learning inequalities deriving from home schooling. Most attention needs to be dedicated to helping children catch up once they return to school, for example, by offering extra tuition (Gambi and Witte, 2021). Second, this study identified those European countries of highest risk in terms of increasing learning loss and educational inequalities. In these countries, policymakers need to act very fast for helping children who have fallen behind. In general, these countries tend to lack some important education-system features to combat unequal learning outcomes. Adapting education systems to serve all students by reducing early tracking, grade repetition and rigid primary and secondary education pathways while increasing early childhood education and funding for schools with a higher intake of disadvantaged students (i.e. as discussed in Volante et al., 2019) is a fruitful long-term strategy. Third, to deal with the unequal learning losses that have already occurred, it is necessary to closely monitor the progress of children in schools and react depending on monitoring results.

This study has a number of limitations. Our ranking is based on the simple weighting of home and school resources and their association with learning, and

rankings come with limitations. Furthermore, several European countries are missing from the survey and are therefore not included in this ranking. Thus, we cannot claim that our analysis identifies all vulnerable countries across Europe. For example, Romania's position in Figure 1 as well as its comparatively high educational inequality (OECD, 2019) suggests that Romania could also be among the high-risk countries if it had taken part in TIMSS 2019. While we identify which children in which countries are at highest risk of low achievement due to COVID-19, we cannot measure the actual extent of educational inequalities. The physical school closures not only deprived children of learning in schools but also prevented the collection of data on their achievement, as, for example, the postponement of the planned Programme for International Student Assessment (PISA) survey shows. Our limited knowledge and the uncertainty regarding education outcomes are a major concern, especially since robust data on health and the economy crowds out what needs to be our urgent concern: the future of our children. More efforts need to be made to collect data that can help us understand the real extent of the pandemic's effect on children's learning. The logical deductions we make show the potential for an education crisis in a number of European countries. The lack of data and monitoring means that we are at risk of not realizing the extent of the problem and consequently not targeting the necessary efforts according to their needs at the policy level.

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Supplemental material

Supplemental material for this article is available online.

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