An Analysis of COVID-19 Student Learning Loss

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Summary

The coronavirus disease 2019 (COVID-19) pandemic led to school closures around the world, affecting almost 1.6 billion students. This caused significant disruption to the global education system. Even short interruptions in a child's schooling have significant negative effects on their learning and can be long lasting. The capacities of education systems to respond to the crisis by delivering remote learning and support to children and families have been diverse and uneven.

In response to this disruption, education researchers are beginning to analyze the impact of these school closures on student learning loss. The term *learning loss* is commonly used in the literature to describe declines in student knowledge and skills. Early reviews of the first wave of lockdowns and school closures suggested significant learning loss in a few countries. A more recent and thorough analysis of recorded learning loss evidence documented since the beginning of the school closures between March 2020 and March 2022 found even more evidence of learning loss. In 36 identified robust studies, the majority identified learning losses that amount to, on average, 0.17 of a standard deviation (SD), equivalent to roughly a one-half school year's worth of learning. This confirms that learning loss is real and significant and has continued to grow after the first year of the COVID-19 pandemic. Most studies observed increases in inequality where certain demographics of students experienced more significant learning losses than others. The longer the schools remained closed, the greater were the learning losses. For the 19 countries for which there are robust learning loss data, average school closures were 15 weeks, leading to average learning losses of 0.18 SD. Put another way, for every week that schools were closed, learning declined by an average of 0.01 SD.

However, there are also outliers—countries that managed to limit the amount of loss. In Nara City, Japan, for example, the initial closures had brought down test scores, but responsive policies largely overcame this decline. In addition, a decreased summer vacation helped. In Denmark, children received good home support and their reading behavior improved significantly. In Sweden, where primary schools did not close during the pandemic, there were no reported learning losses. Further work is needed to increase the quantity of studies produced, particularly in low- and middle-income countries, and to ascertain the reasons for learning loss. Finally, the few cases where learning loss was mitigated should be further investigated to inform continued and future pandemic responses.

Keywords: COVID-19, education, learning loss, systematic review, school closures

Subjects: Health, Education, and Welfare Economics

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Introduction

The coronavirus disease 2019 (COVID-19) pandemic led to school closures around the world, affecting almost 1.6 billion students (United Nations Educational, Scientific and Cultural Organization, 2020). Even short disruptions in a child's schooling have significant negative effects on their learning and can be long lasting. The capacities of education systems to respond to the crisis by delivering remote learning and support to children and families have been diverse and uneven. In response to this disruption, education researchers are beginning to analyze the impact of these school closures on student learning loss. The term *learning loss* is commonly used in the literature to describe declines in student knowledge and skills. Outside of the classroom, these losses may translate to greater long-term impacts (Azevedo et al., 2021; Hanushek & Woessmann, 2020; Psacharopoulos et al., 2021). But there are also outliers, countries that managed to limit the amount of loss.

Research on the actual impact of COVID-19 on learning progress is beginning to emerge. In-person school closures have a large, persistent, and unequal effect on learning. Online education is an imperfect substitute for in-person learning, particularly for children from low-income families. Peer effects also change; schools allow children from different socioeconomic backgrounds to mix, and this effect is lost when schools are closed. Another factor is the response of parents, some of whom compensate for the changed environment through their own efforts, while others are unable to do so. All this leads to the finding that school closures have a large, persistent, and unequal effect on human capital accumulation. In the United States, high school students from low-income communities suffered a learning loss of 0.4 standard deviation (SD) after a 1-year school closure, whereas children from high-income neighborhoods initially remained unscathed (Agostinelli et al., 2022). The channels operating through schools, peers, and parents all contributed to growing educational inequality during the pandemic. Early systematic reviews based on limited data from high-income countries suggested large learning losses and increased learning inequality. Most recently, Donnelly and Patrinos (2021) found average learning losses of about 0.13 SD in seven high-income countries. Hammerstein et al. (2021) identified learning losses of 0.10 SD, Storey and Zhang (2021) estimated losses at 0.15 SD, and Zierer (2021) found losses of 0.14 SD. Moscoviz and Evans (2022) also found that learning losses are mostly negative.

Addressing the question "to what extent did COVID-19 lead to student learning losses across the world?" is important to develop strategies to mitigate the negative impacts of the COVID-19 school closures. The review covers learning loss evidence documented during the first 2 years of the pandemic. Previous reviews have documented learning loss, and this work builds on those efforts.

The research makes three contributions. First, it develops a comprehensive review that consolidates the research that has been completed related to the impact of COVID-19 on student learning progress and builds a public use database. Second, it responds to the research question of

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the extent to which there is evidence of pandemic-related learning losses. Third, based on the review, we identify significant gaps in the literature and provide relevant guidance for further research.

The article is organized as follows. The section "Search Strategy and Identification Methods" describes the methods used to identify and collect the articles analyzed. The section "Analytical Review and Effects Reporting" discusses the analytical review and strategy for reporting effects, where each article was categorized by its geographical region studied, length of school closure, education level of students analyzed, sample size, subject(s) analyzed, documented learning impact, and presence of increased inequality. The section "Learning Losses Due to COVID-19" presents the findings from the review of the emerging evidence on learning losses. The "Discussion" section briefly summarizes the key findings and discusses areas for future research.

The specific research questions are:

1. What is the impact of the COVID-19 pandemic and school closures on learning progress among school children and youth?
2. How does the impact differ across socioeconomic background, age, gender, subjects, subnational contexts, ethnicity, and so forth (data permitting)?

Search Strategy and Identification Methods

The following scholarly sources were employed to search previous research:

- ECONLIT, Google Scholar, PubMed, Education Resources Information Center, and Cochrane Library
- Coronavirus Research Database, Education Database (ProQuest), Web of Science
- Preprint and working paper repositories: SSRN (Social Science Research Network), MPRA (Munich Personal RePEc Archive), IZA (Institute of Labor Economics), NBER (National Bureau of Economic Research), OSF (Open Science Forum) Preprints, PsyArXiv, SocArXiv, EdArXiv
- Outreach to researchers

To conduct the search, the keywords "Covid-19," "coronavirus," "2019-ncov," "sars-cov-2," or "cov-19" were used in combination with "learning loss," "learning slide," "education gap," or "achievement gap." The focus was on learning loss among school-aged children across all subjects, with special attention to the most reported subjects of math and reading. School-aged children and youth are defined as being between the ages of 5 and 18, thus excluding both kindergarten and higher education.

All observational research was considered, including, but not limited to, studies using quantitative data that are longitudinal or cross-sectional, individual, or aggregate (e.g., at the level of schools) on the effect of the COVID-19 pandemic on learning loss among students.

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To be included in the sample, the outcome measure must be a valid measure of learning progress. These include measures using scores from school-based tests or from assessments administered by researchers or international assessment programs, including early grade reading assessments, and any study that can be scaled to the Harmonized Learning Outcomes measure (Angrist et al., 2021). In addition, studies must have measured learning loss with pre-COVID control data, and during or post-COVID treatment data. Studies using projections and simulations were excluded.

Secondary research such as systematic reviews was excluded from the analysis but used to identify further relevant studies. Given the focus on the COVID-19 pandemic, we restricted our search to papers published between March 1, 2020 and March 1, 2022.

Studies were screened according to the following selection criteria: Studies that conducted student analyses and reported impacts on learning progress (either positive, negative, or insignificant) because of COVID-19 school disruptions were included. Factors for rejecting studies from the review included the absence of student analyses or recorded impacts on learning progress, analyses occurring before the onset of the COVID-19 pandemic, or hypothesized results. Study details were collected such as author name(s), sample size, information on the age of students in sample, length of closures, measures of social background recorded, outcomes measured, follow-up period(s), and the effect sizes. These data were recorded in a Microsoft Excel spreadsheet. We assessed the methodological rigor of each study and subsequently rated the robustness of the overall body of evidence across all outcomes.

Data from studies that contained information on individual learning loss were aggregated into a composite measure of learning for the most common specific learning areas examined in all relevant studies (e.g., math, reading). When sufficient evidence was available, estimates of learning loss in other specific learning areas were also aggregated. If there were multiple model specifications including controls, the relevant coefficients from the models that allowed for comparison of effect sizes across studies were extracted.

The initial search consisted of a Google Scholar query using the keywords (“Covid-19” OR “coronavirus” OR “pandemic)” AND (“learning loss” OR “learning slide”), restricted to publications between March 2020 and March 2022. This search revealed 3,840 results. Of these, 167 directly addressed learning loss during the pandemic. Of these studies, 32 attempted to directly measure learning loss caused by the COVID-19 pandemic. Further searches of the other databases, and of the working paper repositories, revealed an additional 13 studies. Finally, while evaluating these studies, 36 studies were pulled from reference lists and other review papers. This resulted in a total of 81 studies that examined learning loss due to the COVID-19 pandemic. Five of these studies were duplicates published in different formats and were dropped from the analysis. Another five studies did not contain a direct measure of learning loss in the form of pre- and postpandemic data and were also dropped from the analysis. Finally, four studies that examined learning loss only at the higher education level were dropped from the analysis.

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Analytical Review and Effects Reporting

The remaining 67 studies were carefully reviewed, and their methods scored on a scale of 1 (lowest-quality methods) to 5 (highest-quality methods). Papers were rated 1 when they presented learning loss through a comparison of pre- and post-COVID means, without statistical analysis for variation to account for potential confounding variables, or random sampling techniques. Papers were rated 2 if they performed difference of means tests but used convenience sampling or had small sample sizes. Papers were rated 3 if they performed difference of means tests, had random or representative sampling, and had a relatively large sample size. Papers were rated 4 if they performed additional statistical analysis beyond a comparison of means, including strong sampling and basic individual- or school-level controls. Finally, papers were rated 5 if they contained sophisticated statistical analysis, with strong controls and sampling. This systemic review focuses on the 35 studies that are scored 3, 4, and 5. The findings of studies scored 1 and 2 are included in Patrinos et al. (2022).

When reporting learning loss effect size, findings are presented in terms of standard deviation (SD) change of the treatment (post-COVID) group from the pre-COVID control group. As each study uses a different measure of learning loss, losses reported in percentiles and points are not easily comparable. A review of tests designed to track student learning over time found that, on average, students learn at a rate of one-third SD per year (Hanushek & Woessmann, 2020). Therefore, the loss of one-third of a school year of learning would equal 11% of an SD of lost test results. Where possible, this formula was used to convert studies' results into SDs to allow for better cross-comparison. Unfortunately, many papers do not present results in SDs or months of learning losses and do not have sufficient information for these to be calculated. The results for these papers are not presented in Table 1 and Figure 1, but the papers are included in the overall analysis. For these papers, discussion of findings is limited to direction of learning loss, as the quantitative values are not comparable to other studies.

Where possible, heterogeneous effects are also presented in SDs. Many studies include only some of these effects, meaning the number of study results reported varies substantially by effect.

Learning Losses Due to COVID-19

The final database is shown in Table 1 and consists of 35 robust studies, documenting learning from 20 countries. Most studies (32) found evidence of learning loss. Of the 35 studies reporting learning loss, 27 reported findings in a comparable effect size format. The studies with incomparable results are listed in Table 1; however, their results are not included in the analysis. While some countries have multiple studies, these studies utilized different measures and had different samples, resulting in varying results within countries. As shown in Figure 1, most studies found learning losses ranging from 0.25 to 0.12 standard deviation (SD). In five studies, learning losses were even greater. The average learning loss across these studies is 0.17 SD—which equates to over half a school year of learning loss.

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Table 1. Final Database of Robust Studies of Learning Loss Due to COVID-19

Source	Methods score	Country	Closure length, weeks[1]	Average learning losses, SD	Equity impact	Sample size
Ardington et al. (2021)	5	South Africa	22	−0.22	Yes	5,810
Arenas & Gortazar (2022)	5	Spain	12	−0.05	Yes	41,000
Asakawa & Ohtake (2021)	5	Japan	11		Yes	5,400
Bielinski et al. (2021)	5	United States		−0.14	No	n/a
Birkelund & Karlson (2021)	5	Denmark	8	0	Yes	200,000
Borgonovi & Ferrara (2022)	5	Italy			Yes	850,000
Chaban et al. (2022)	5	Russia	8–20	−0.27	No	165,740
Chen et al. (2022)	3	UAE				1,920
Clark et al. (2021)	4	China	7	−0.22		1,835
Contini et al. (2021)	5	Italy	15	−0.19	Yes	1,539
Domingue et al. (2021)	4	United States		−0.05	No	100,000
Education Policy Institute (2021)	4	England		−0.09	Yes	180,000
Engzell et al. (2021)	5	Netherlands	8	−0.08	Yes	350,000

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Source	Methods score	Country	Closure length, weeks[1]	Average learning losses, SD	Equity impact	Sample size
Erdem & Lesnick (2021)	3	United States				65,000
Gambi & De Witte (2021)	5	Belgium	9–12	−0.23	Yes	213,000
Gore et al. (2021)	5	Australia	8	0	No	100–500
Haelermans et al. (2021)	5	Netherlands	10	−0.17	Yes	201,819
Halloran et al. (2021)	5	United States			Yes	11,700
Hevia et al. (2021)	3	Mexico	48	−0.55	Yes	3,161
Hicks & Faulk (2022)	4	United States			Yes	n/a
Jakubowski et al. (2022)	4	Poland	29	−0.30		4,581
Kogan & Lavertu (2021)	5	United States		−0.23	Yes	124,700
Korbel & Prokop (2021)	4	Czech Republic		−0.11		2,234
Kuhfeld et al. (2022)	4	United States		−0.19	Yes	5,400,000
Lichand et al. (2021)	5	Brazil		−0.32	Yes	7,000,000
Locke et al. (2021)	3	United States		−0.15	No	55,000
Ludewig et al. (2022)	5	Germany		−0.14		4,290

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Source	Methods score	Country	Closure length, weeks[1]	Average learning losses, SD	Equity impact	Sample size
Maldonado & De Witte (2022)	4	Belgium	9	−0.18	Yes	1,300
Pier et al. (2021)	5	United States		−0.08		100,000
Schult et al. (2021)	3	Germany	10	−0.08		80,000
Schuurman et al. (2021)	3	Netherlands	8	−0.09	Yes	886
Skar et al. (2021)	5	Norway	7	−0.24		2,453
Spitzer & Musslick (2020)	4	Germany	8			2,500
Tomasik et al. (2020)	3	Switzerland	8	−0.20		28,685
van der Velde et al. (2021)	4	Netherlands	8			133,450

Note: n/a = not available; SD = standard deviation; UAE = United Arab Emirates.

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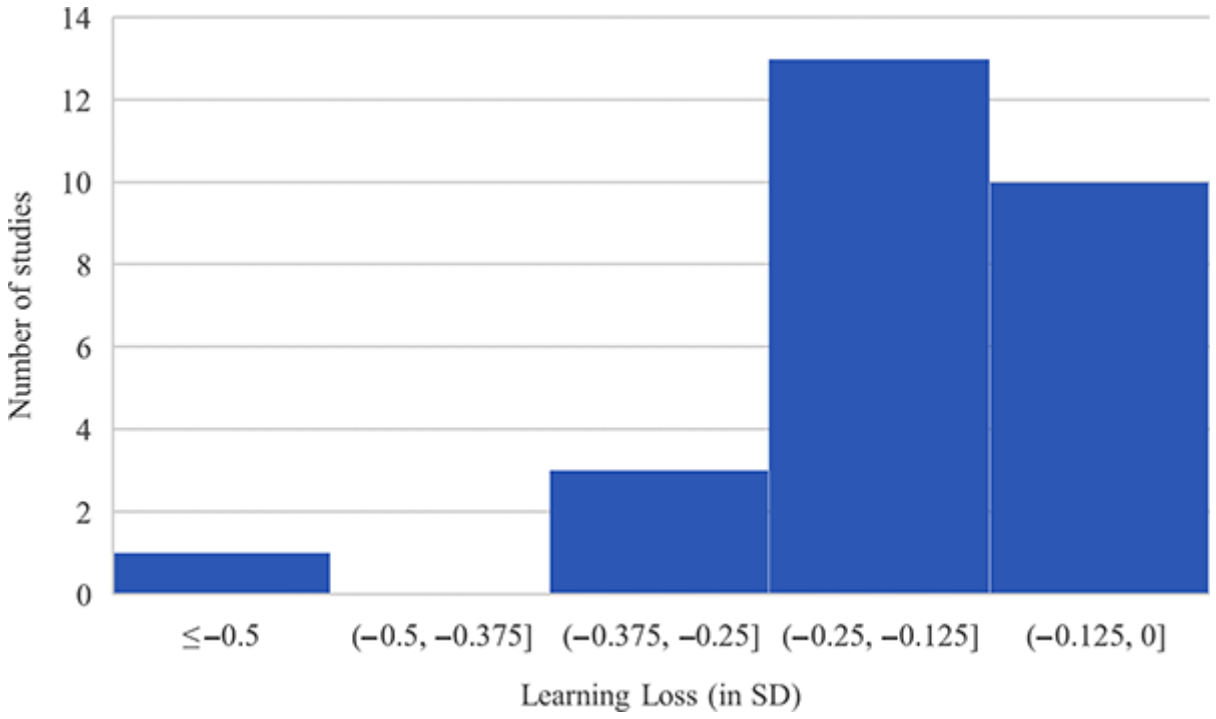


Figure 1. Range of learning loss in the 24 studies reporting comparable effect sizes.

Note: SD = standard deviation.

The studies consistently find heterogenous effects of learning loss by socioeconomic status, past academic learning, and subject of learning. In the review, 20 studies examined learning loss by socioeconomic status. Of these, 15 found greater learning loss among students or schools with lower socioeconomic status, while 5 failed to find a statistically significant difference. Many studies also found learning loss to be worse for students who had struggled academically prior to the pandemic. Of the studies that included this measure, 11 documented greater learning losses for students at lower levels of academic achievement, while 3 documented greater learning losses for students with greater past academic achievement. The subjects most frequently analyzed in the reviewed studies were reading and mathematics. Of the 11 studies to include both, in 9 studies learning loss in mathematics exceeded that of reading, while reading losses exceeded mathematics in 2 studies.

While the studies do not evaluate the causes of these heterogenous effects, the findings are broadly consisted with contemporary research. Research into "summer learning loss" has found that summer breaks have a greater impact on lower-income schools (Kuhfeld, 2019), while this work as well as research on teacher strikes show mathematics learning to be more vulnerable to school closures (Baker, 2013). Scholars predicted at the beginning of the pandemic that school closures would have the greatest negative effect on students already behind (Armitage & Nellums, 2020; Haeck & Lefebvre, 2020), which the evidence of this review supports.

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Many studies have examined learning loss by gender, although the findings are not consistent. While one study reported greater learning loss among girls (Lichand et al., 2021), another found greater learning loss among boys (Birkelund & Karlson, 2021), and a third found varying results by subject (Schuurman et al., 2021). Seven other studies did not find a statistical difference in learning loss by gender.

The COVID-19–related school closures varied in duration across the world. In some countries, school systems were completely shut down for many months—or even years in some cases—while in a few countries schools were closed for very short periods of time. As the pandemic continued, some school systems partially opened some schools for some months. Also, the experience varied by grade level. Some countries kept primary schools open but closed secondary schools. Some countries had good internet connectivity and students had access to devices; these systems were well positioned to provide quality distance education online. Other countries, with limited internet connectivity and access to devices, broadcast lessons and used radio or other mass media to provide remote education.

As Table 2 shows, the longer the schools remained closed, the greater were the learning losses. For the 19 countries for which there are robust learning loss data, average school closures were 15 weeks, leading to average learning losses of 0.18 SD. Put another way, for every week that schools were closed, learning declined by an average of 0.01 SD. (See Table 3 for studies excluded from our analysis).

The most robust data come from 12 European countries. Given similar starting conditions overall (e.g., gross domestic product per capita, access to connectivity and devices), these countries provide compelling evidence that pandemic-related school closures led to learning losses. In these European countries, average school closures were 11 weeks in duration, and average learning losses were 0.16 SD. Therefore, for every week of school closure, learning losses were about 0.015 SD.

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Table 2. Length of School Closures and Average Learning Losses, by Country

Country	Closure length, weeks	Average learning losses, SD	Source
Mexico	48	−0.55	Hevia et al. (2021)
Brazil	26	−0.32	Lichand et al. (2021)
Poland	20	−0.3	Jakubowski (2022)
Russia	14	−0.27	Chaban et al. (2022)
Norway	7	−0.24	Skar et al. (2021)
China	7	−0.22	Clark et al. (2021)
South Africa	22	−0.22	Ardington et al. (2021)
Switzerland	8	−0.2	Tomasik et al. (2020)
Italy	15	−0.19	Contini et al. (2021)
Belgium	9–12	−0.18	Gambi & De Witte (2021), Maldonado & De Witte (2022)
Netherlands	10	−0.17	Haelermans et al. (2021)
Germany	10	−0.14	Ludewig et al. (2022)

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Country	Closure length, weeks	Average learning losses, SD	Source
United States	23	−0.14	Average of: Bielinski et al. (2021), Domingue et al. (2021), Kogan & Lavertu (2021), Kuhfeld et al. (2022), Locke et al. (2021), Pier et al. (2021)
Czech Republic	9	−0.11	Korbel & Prokop (2021)
England	10	−0.09	Education Policy Institute (2021)
Spain	12	−0.05	Arenas & Gortazar (2022)
Australia	8	0.00	Gore et al. (2021)
Denmark	8	0.00	Birkelund & Karlson (2021)
Japan	11	0.0	Asakawa & Ohtake (2021)

Note: SD = standard deviation.

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Table 3. Summary of Findings of Studies Excluded From Our Analytic Sample

Source	Country	Length of school closure, weeks	Evidence of learning loss	Average learning loss (SD)
Amin et al. (2021)	Bangladesh		Yes	
ASER (2021c)	Pakistan	26	Yes	
Depping et al. (2021)	Germany	8	Yes	−0.18
Empower (2021)	United States		Yes	
Feng et al. (2021)	China		Yes	−0.68
Kim, Lee, et al. (2021)	Korea		Yes	
Kozakowski et al. (2021)	United States		Yes	
Moliner & Alegre (2022)	Spain		Yes	
Rose et al. (2021)	England		Yes	−0.17
Sayeejan & Nithlavarnan (2018)	Sri Lanka		Yes	
Thomas (2021)	Austria		No	0
Amelia et al. (2020)	Indonesia		Yes	−0.11
Amplify Education (2021)	United States		Yes	

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Source	Country	Length of school closure, weeks	Evidence of learning loss	Average learning loss (SD)
ASER (2021a)	India		Yes	
Blainey & Hannay (2021)	England		Yes	−0.158
Curriculum Associates (2020)	United States		Yes	
Dorn et al. (2021)	United States		Yes	−0.16
Fälth et al. (2021)	Sweden	0	No	0
Georgiou (2021)	Canada		Yes	
Juniper Education (2021)	United States		Yes	
Kim, Rose, et al. (2021)	Ethiopia		Yes	−0.11
NAPE (2021)	Uganda		Yes	
Oktariani et al. (2022)	Indonesia		Yes	
Rahman (2021)	Indonesia	32	Yes	
Uwezo (2021)	Uganda		Yes	
Whizz Education (2021)	Kenya		Yes	−0.36
Korbel & Prokop (2021)	Czech Republic		Yes	−0.11

Note: ASER = Annual Status of Education Report; NAPE = National Assessment of Progress in Education; SD = standard deviation.

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For many countries, learning losses have only so far been documented through descriptive statistics; however, these losses are large. For example, adolescent girls' literacy and numeracy scores declined by more than 6% in Bangladesh (Amin et al., 2021). In India, the share of grade 3 children in government schools who can perform simple subtraction decreased from 24% in 2018 to only 16% in 2020, and the share who can read a grade 2 level text decreased from 19% in 2018 to 10% in 2020 (Annual Status of Education Report [ASER], 2021b). In Pakistan, the proportion of children in classes 1–5 who can read a story declined from 24% in 2019 to 22% in 2021 (ASER, 2021c). There were reported learning losses in one college in Sri Lanka (Sayeejan & Nithlavarnan, 2018). In Uganda, the percentage of learners rated proficient in literacy in English and numeracy in 2021 dropped by 5% and 13% from that of 2018 (National Assessment of Progress in Education, 2021). In Canada, grade 2 and 3 students' reading assessments declined by 4–5 points (Georgiou, 2021).

Discussion

As a result of the first wave of COVID-19–induced lockdowns and school closures beginning in March 2020, a student has lost on average about one-third to a half school year's worth of learning. These learning losses may impact a student's education trajectory, as the lost learning is likely to limit opportunities to advance to higher levels of schooling. There are also long-term future earnings losses associated with lost human capital, with students potentially losing trillions of dollars in future income (Psacharopoulos et al., 2021).

Nevertheless, there are some causes for optimism from the existing research as many studies were able to point to specific policies that had reduced learning loss. In Nara City, Japan, math achievement scores had increased 6 months after COVID-19–related school closures. While the initial closures had brought down scores, responsive policies largely overcame this decline (Asakawa & Ohtake, 2021). During the school closures, students watched virtual lessons streamed by their teachers, carried out independent work, and submitted paperwork for revision by their teachers. Nara City also decreased its summer vacation in response to the school closures, from 34 days to 16 days. Although a broadly successful response, the school closures still had a greater impact on lower-income students, who showed slower growth than their peers upon returning to school.

Belgium demonstrated the importance of proactive measures to mitigate increases in learning gaps. Targeted supplementary schooling was offered to students who were most vulnerable to learning loss, with notable success for participating students (Gambi & De Witte, 2021). This sort of program has been proposed in unrelated contexts to reduce learning gaps, but here demonstrated its potential during a larger educational shock (von Hippel, 2019). Another cause of optimism is the apparent resilience of students in England, where the Educational Policy Institute found learning loss to decline substantially as time went on after reopening. In Autumn 2020, students were found to be behind by an average of 3.6 months in mathematics, but by the summer of 2021 the loss had decreased to an average of 2.2 months.

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Learning loss evidence is mixed in France, with on average very low levels of learning loss experienced thus far, though there are still equity effects, with more disadvantaged students suffering more (Thorn & Vincent-Lancrin, 2021). However, no learning loss or equity effect was evident in Denmark (Birkelund & Karlson, 2021). It seems that Danish children received good home support and their reading behavior increased significantly because of the lockdown of schools (Reimer et al., 2021). In Sweden, where primary schools did not close during the pandemic, there were no reported learning losses (Falth et al., 2021). In the state of New South Wales, Australia, there were no significant differences between 2019 and 2020 in student achievement growth; however, learning did decrease in the least advantaged schools (Gore et al., 2021).

As this emerging evidence suggests, the impact of COVID-19 on student learning worldwide has been substantial, and inequality in learning across more advantaged and disadvantaged groups is likely going to grow over time. We plan to continue to assess these trends over time and to evaluate longer-term impacts on individuals' education and labor market trajectories as well as productivity and economic development globally.

Further Reading

COVID-19 School Data Hub. (n.d.). *A central database for educators, researchers, and policymakers to understand how the COVID-19 pandemic shaped students' modes of learning in 2020–21* <https://www.covidschooldatahub.com/>.

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Notes

1. We report the number of weeks of school closures as reported in each study. When the study did not report the length of school closures, we also do not report it in Table 1 or use it in our analyses.

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