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COVID-19 and Educational Inequality: How School Closures Affect Low- and High-Achieving Students

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Abstract

In spring 2020, governments around the globe shut down schools to mitigate the spread of the novel coronavirus. We argue that low-achieving students may be particularly affected by the lack of educator support during school closures. We collect detailed time-use information on students before and during the school closures in a survey of 1,099 parents in Germany. We find that while students on average reduced their daily learning time of 7.4 hours by about half, the reduction was significantly larger for low-achievers (4.1 hours) than for high-achievers (3.7 hours). Low-achievers disproportionately replaced learning time with detrimental activities such as TV or computer games rather than with activities more conducive to child development. The learning gap was not compensated by parents or schools who provided less support for low-achieving students. The reduction in learning time was not larger for children from lower-educated parents, but it was larger for boys than for girls. For policy, our findings suggest binding distance-teaching concepts particularly targeted at low-achievers.

JEL-Codes: I240, J620, D300.

Keywords: educational inequality, COVID-19, low-achieving students, home schooling, distance teaching.

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1. Introduction

To inhibit the spread of the COVID-19 pandemic, many countries closed their schools for several months during the first half of 2020. These closures affected over 90 percent of school children (1.5 billion) worldwide (UNESCO, 2020a). A defining feature of school closures is that students do not have the same support of teachers as in traditional in-person classroom teaching. Many have argued that the school closures may increase inequality between children from different family backgrounds (e.g., UNESCO, 2020b; European Commission, 2020). But another dimension of inequality that may be particularly relevant for school closures is the one between low- and high-achieving students. Out-of-school learning implies a large amount of self-regulated learning where students must independently acquire and understand the academic content without the support of trained educators. While self-regulated learning may be feasible for high-achieving students during school closures, it may be especially challenging for low-achieving students. In this paper, we provide evidence on how the COVID-19 school closures affected the learning time and other activities of low- and high-achieving students and how parents and schools differentially compensated for the closures.

The COVID-19-related school closures, and the associated temporary discontinuation of traditional in-person teaching, represent an unprecedented disruption of students' educational careers. From an educational production perspective, the school closures induced a sharp decline in what is probably the most important school input factor to produce educational achievement: the support of trained educators. Teachers provide the traditional teaching activities such as explaining new material or providing learning-stimulating feedback. Ample evidence shows that teachers are a key ingredient for students' educational success (e.g., Hanushek, 1971; Rivkin, Hanushek, and Kain, 2005; Chetty et al., 2014). Our data show that direct contact with teachers evaporated during the school closures in Germany, as in many other countries (e.g., Andrew et al., 2020 for England). Instead, students mostly had to embark on self-regulated learning. Since skill formation is a process of dynamic complementarities in the sense that basic skills are necessary to acquire additional skills (e.g., Cunha et al., 2006; Cunha and Heckman, 2007), students with lower initial achievement may lack the knowledge and skill base necessary to generate additional learning gains through self-regulated learning. Consequently, if returns to time invested in independent learning activities are sufficiently low, low-achieving students will spend less time on school-related activities, substituting other activities that are relatively more rewarding to them.

To test this hypothesis, we designed and ran an online survey of 1,099 parents of school-aged children in Germany in June 2020. In our detailed time-use data, we carefully elicit how

many hours students spent with a range of activities per day both *before* and *during* the school closures. We distinguish between (1) *school*-related activities such as going to school or learning at home; (2) activities generally deemed *conducive* to child development such as reading, arts, playing music, or doing sports; and (3) activities generally deemed *detrimental* to child development such as watching TV, playing computer games, or consuming social media.[1] The retrospective panel structure of our data allows us to investigate how the closures affected the gap in learning time between low- and high-achieving students, categorized by their prior school grades. To further investigate the extent to which parents and schools compensated for changes in learning time, we additionally elicited parental involvement in home-schooling activities as well as detailed information on schools' distance-teaching activities.

We find that the school closures had a large negative impact on learning time, particularly for low-achieving students. Overall, students' learning time more than halved from 7.4 hours per day before the closures to 3.6 hours during the closures. While learning time did not differ between low- and high-achieving students before the closures, high-achievers spent a significant 0.5 hours per day more on school-related activities during the school closures than low-achievers. Most of the gap cannot be accounted for by observables such as socioeconomic background or family situation, suggesting that it is genuinely linked to the achievement dimension. Time spent on conducive activities increased only mildly from 2.9 hours before to 3.2 hours during the school closures. Instead, detrimental activities increased from 4.0 to 5.2 hours. This increase is more pronounced among low-achievers (+1.7 hours) than high-achievers (+1.0 hour). Taken together, our results imply that the COVID-19 pandemic fostered educational inequality along the achievement dimension.

The COVID-19-induced learning gap between low- and high-achieving students was not compensated by parents' activities. Already before the school closures, parents of low-achievers spent less learning time together with their children than parents of high-achievers (0.4 versus 0.6 hours per day). The school closures only exacerbated this inequality in parental involvement, as parents of low-achievers increased their time investment in joint learning by less than parents of high-achievers (+0.5 versus +0.6 hours).

The activities of schools did not compensate for the learning gap between low- and high-achieving students either. During the school closures, schools and teachers only carried out a fraction of their usual teaching activities via distance teaching. For instance, only 29 percent of

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[1] Time spent on educational activities has been shown to be the most productive input for cognitive skill development among different activities of children (Fiorini and Kaene, 2014). Our further categorization is in line with parents' beliefs about how beneficial the different activities are for their children's development (section 3.2).

students had shared lessons for the whole class (e.g., by video call) more than once a week, and only 17 percent had individual contact with their teacher more than once a week. This reduction in school activities hit low-achieving students particularly hard: Compared to high-achievers, low-achievers were 13 percentage points less likely to have online lessons and 10 percentage points less likely to have individual teacher contacts more than once a week.

Looking at other dimensions of educational inequality, the COVID-19 school closures did not increase learning-time gaps by parental education, but they affected boys more than girls. First, surprisingly, we do not find a significant difference in the reduction in learning time between children with and without a university-educated parent, despite the fact that parental education is generally a strong predictor for children's educational outcomes in Germany. Second, compared to girls (-3.5 hours), the COVID-19-induced learning disruption was more pronounced for boys (-4.0 hours), who particularly spent more time playing computer games.

By documenting how the discontinuation of in-person teaching differentially affects low- and high-achieving students, we contribute to the broad literatures on educational production (e.g., Hanushek, 2020), skill formation (e.g., Cunha and Heckman, 2007), and educational inequality (e.g., Björklund and Salvanes, 2011). Our results complement the English time-use study during COVID-19 by Andrew et al. (2020) by investigating inequality along the achievement dimension as well as compensating activities of parents and schools. Our study of a range of substituted conducive and detrimental activities also complements several other contemporaneous studies on how COVID-19-induced school closures affected learning inputs and outcomes such as online learning (e.g., Chetty et al., 2020 for online lesson completion and Bacher-Hicks et al., 2020 for household search for online learning resources in the United States) and standardized tests (e.g., Maldonado and de Witte, 2020, for Flemish Belgium and Engzell et al., 2020 for the Netherlands), neither of which has a focus on differential effects by the achievement dimension.[2] Our findings contribute to the rapidly emerging literature on effects of the COVID-19 pandemic on other economic and social outcomes such as labor markets, families, and well-being (e.g., Alon et al., 2020; Chetty et al., 2020; Fetzer et al., 2020).

The remainder of the paper is structured as follows. Section 2 provides institutional background on schooling during the COVID-19 pandemic in Germany. Section 3 introduces our data and research design. Section 4 presents results on how the COVID-19 school closures affected learning and other activities of low- and high-achieving students. Section 5 presents results on support structures by parents and schools. Section 6 reports results on differences by

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[2] For additional descriptive evidence on overall learning engagement of students during the school closures in Germany in specific samples, see Anger et al., (2020) and Huber and Helm (2020).

parental education background, child gender, and school type as additional dimensions of inequality. Section 7 discusses the findings, and section 8 concludes.

2. Institutional Background

Germany reported its first official COVID-19 case in late January 2020. As infection numbers continued to grow over the following weeks, federal and local governments adopted a broad range of measures to slow down the spread of the virus, such as social-distancing requirements, contact limitations, quarantine after travelling, and closures of shops and restaurants. A first district with a local spike in infections closed its schools on February 28.

On March 13, the 16 federal states – which hold the legislative and executive power over public education – closed all educational institutions throughout Germany (Anger et al., 2020). Young children of parents in so-called system-relevant occupations (e.g., health, public safety, public transportation, and groceries) were exempt and could attend emergency services in schools (*Notbetreuung*). Due to the school closures, many students lost up to twelve weeks of in-person classroom teaching, equivalent to one third of a school year (Woessmann, 2020).

There were no centralized concepts to implement online school operations during the closures. Decisions on the use of distance-teaching activities were left to the discretion of schools and teachers. To the best of our knowledge, we provide the first encompassing quantitative assessment of distance-teaching activities during the school closures in Germany.

In late April, education ministers decided to gradually re-open schools, with starting dates and procedures differing across states. Accompanied by political controversies given the continued risk of COVID-19 outbreaks, schools initially re-opened only for graduation classes and with strict hygiene rules such as compulsory mouth-nose masks and social distancing. Partial school operations – usually with alternating halves of students per classroom in daily or weekly shifts – were successively expanded to other grades during May and June. Ultimately, most students had a few weeks of in-person teaching before the summer break. After the summer break, schools opened for all students, but there were still no universal guidelines on how to continue school operations through distance teaching in case of future school closures.

3. Research Design and Data Collection

Using a survey of parents (section 3.1), we elicit time-use data on a broad range of students' activities for the periods both before and during the COVID-19-related school closures (section 3.2), complemented by information on parents' and schools' support activities.

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3.1 The Survey

Our survey of parents of school children was fielded as part of the ifo Education Survey 2020, which provides a representative sample of the German population aged 18 to 69 years. Carried out between June 3 and July 1, 2020, by the survey company *Respondi* via online access panels, the total sample consisted of 10,338 respondents.

From the total sample, we asked all parents of school-aged children (N=1,099) to answer a series of questions on their youngest school-aged child before and during the COVID-19-related school closures.[3] As such, the subsample is a convenience sample of parents with students in all types of primary and secondary schools. However, due to the representativeness of the overall sample, it should provide a very good fit for students in Germany. In fact, comparing parental and child characteristics of our analysis sample to all school children in the representative German Microcensus[4] shows that the two samples are very similar in terms of observables (Appendix Table A1), raising confidence in the generalizability of results.[5]

The sociodemographic characteristics of the students and their surveyed parent (Appendix Table A2) indicate an average student age in the sample of 12.5 years and a rather even gender split. The sample is roughly evenly distributed between students in primary (grades 1-4), upper-track secondary (*Gymnasium*), and other types of secondary school. Responding parents are also roughly evenly split by gender, and 27 percent hold a university degree.

To categorize students as low- or high-achievers, we asked parents about their child's school grades in mathematics and German.[6] Computing the median of the average grade in the two subjects separately for the three school types, we classify students at or above this median as high-achievers (55.5 percent) and those below the median as low-achievers (44.5 percent).[7]

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[3] The parent questions were quite detailed and therefore mentally taxing and time consuming. To minimize the risk that survey fatigue undermines data quality, parents with more than one child were only asked about their youngest school-aged child. Studying the youngest child helps to focus on the challenges of self-regulated learning (which are arguably greater for younger children) and on those whose returns to educational investments tend to be highest (e.g., Cunha et al., 2006).

[4] Research Data Centres of the Federal Statistical Office and the statistical offices of the Länder, Microcensus, census year 2015.

[5] Cases where parents reported that the child had zero hours of schooling on a typical weekday before Corona were excluded from the analysis sample as they cannot be identified as students.

[6] The question was worded as follows: "What grades does your youngest child receive in the main subjects (mathematics and German) most frequently?" Respondents reported a separate grade for mathematics and German on the German grade scale (from 1="very good" to 6="failed"). Since students usually do not receive numerical grades at the beginning of primary school, we also included the answer option "My child does not get grades yet."

[7] 10.6 percent of students do not receive numerical grades yet; they are excluded in this sub-group analysis. Because of the rather coarse grading in primary school (33 percent of students have the median average grade of 2.0), a relatively large fraction of primary-school students (64 percent) falls into the category of at-or-above median grades, compared to 51 and 53 percent of upper-track and other secondary-school students, respectively.

A regression of a high-achiever indicator on sociodemographic characteristics (column 2 of Appendix Table A2) indicates few significant observable differences between low- and high-achieving students, with the exceptions that high-achievers are more likely to come from high-income households, have the parent working in home office during Corona, and be younger (an additional bivariate analysis also indicates a larger share of university-educated parents). Child gender, family status, and parent's work hours do not significantly predict better student grades.

3.2 Elicitation of Time-Use Information before and during COVID-19

The core of our analysis is detailed time-use data on student's activities for the period of the COVID-19-related school closures. To be able to investigate whether any differences between low- and high-achieving students already existed before the closures or whether they emerged with the closures, we also elicited the same time-use battery retrospectively for the time before the school closures.

We carefully designed the time-use battery to capture relevant activities that students engaged in before and during the school closures. Parents had to specify how many hours (rounded to the nearest half hour) their child spent during a typical workday on each of the following activities:[8] 1. School attendance; 2. Learning for school; 3. Reading or being read to; 4. Playing music and creative work; 5. Physical exercise; 6. Watching TV; 7. Gaming on computer or smartphone; 8. Social media; 9. Online media; and 10. Time-out (e.g., relaxing). We also provided an open field to specify "Another activity."[9] To be able to study whether and how parents adapted their home-schooling activities vis-à-vis the school closures, we also elicited how much time parents spent together with their child on the respective activities.

For our analysis, we group the activities into three categories: *school*-related activities (activities 1 and 2), other activities generally deemed *conducive* to child development (activities 3-5), and activities generally deemed *detrimental* (activities 6-9). Our categorization is reflected in parents' beliefs about how beneficial each activity is for their child's development, which we elicited after the time-use batteries. Almost all parents consider the two *school*-related activities (97 and 93 percent) and the *conducive* activities (82-95 percent) beneficial (Appendix Table A3). In contrast, only 22-34 percent think that the different *detrimental* activities are

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[8] Question wording: "The following questions are about your youngest child attending school. What activities did your child do on a typical workday (Monday to Friday) before [during] the several weeks of Corona-related school closures?" The battery was inspired by the time-use module in the Family-in-Germany questionnaire of the German Socio-Economic Panel Study (Schröder et al., 2013). The sum of reported hours spent per day was prevented from exceeding 24 hours. In our analysis, outliers in any answer category are top-coded at 12 hours.

[9] In cases where the activity specified in the open field corresponded to existing categories, we re-coded the respective category accordingly.

beneficial. Importantly, these assessments do not differ much between parents of low- and high-achieving students, implying that any difference in time use cannot be assigned to different beliefs about the activities' developmental effects.

Complementing our time-use data, we also elicited parents' assessment of how the school closures affected their family and learning environment at home, as well as information on the distance-teaching activities undertaken by schools. The five questionnaire items on the home environment capture topics such as how the family coped with the situation, whether it was a psychological burden for the child and the parents, and an overall assessment of the child's home learning environment (see notes to Appendix Table A6 for question wordings). Schools' distance-teaching activities during school closures were elicited by seven questionnaire items on activities such as shared remote lessons, individual teacher contacts, use of educational videos or software, and providing work sheets (see notes to Table 4 for question wordings).

The survey-based, partially retrospective elicitation of information about children from their parents raises issues of validity and interpretation that we will discuss in section 7 below.

4. Time Use of Low- and High-Achieving Students before and during the School Closures

This section reports results on how the COVID-19 school closures differentially affected low- and high-achieving students' learning time (section 4.1), as well as their time investment in other conducive and detrimental activities (section 4.2).

4.1 Learning Time

To be able to investigate how the gap in learning time between low- and high-achieving students changed over time, we elicited information on time use for school-related activities on a typical workday both before and during the school closures. The school-related activities include the two sub-categories of attending school and learning for school at home.

In the full sample, the school closures more than halved students' learning time. Before the school closures, students spent on average 7.4 hours per day on school-related activities (Appendix Table A4). This number dropped to 3.6 hours during the closures. This reduction is due to a large decline in school attendance – from an average of 5.9 to 0.9 hours (emergency services) per day – that is hardly compensated by a much smaller increase in time spent on learning for school (from 1.5 to 2.7 hours).

Differentiating between low- and high-achieving students reveals that the school closures strongly increased educational inequality. Columns 5-8 of Table 1 indicate that learning time

before the school closures did not differ economically or statistically significantly between students initially achieving below versus at-or-above the median (7.4 versus 7.5 hours per day).[10] By contrast, columns 1-4 show that high-achieving students spent 0.5 hours more on school-related activities during the closures (3.4 versus 3.9 hours, *p*<0.01).[11] Consequently, the increase in the learning-time gap between low- and high-achieving students relative to pre-closure times (columns 9-12) is a significant 0.4 hours per day (-4.1 versus -3.7 hours for low- and high-achievers, respectively; see also Appendix Figure A1). Distinguishing between the two sub-categories of school-related activities, the decrease in school attendance was similar for low- and high-achievers (-5.1 versus -5.0 hours), but low-achievers increased home learning less than high-achievers (+1.0 versus +1.4 hours).

The learning-time gap between low- and high-achieving students can hardly be accounted for by other observed student and parent characteristics. Table 2 shows results of regressions of the learning time during the school closures on a high-achiever dummy, learning time before the school closures, and a series of student and parent characteristics: the student's school type, age, gender, a single-child dummy, the responding parent's gender, education, single-parent status, home-office status and work hours during the school closures, partner at home during the school closures, household income, and a West-Germany dummy. In all cases, including the additional variables leaves the difference between high- and low-achieving students highly significant and of similar magnitude as the unconditional gap.[12] Including all controls simultaneously (column 14) reduces the difference in learning time between high- and low-achieving students by less than one fifth. Thus, most of the large gap does not reflect differences in the observed characteristics, but rather seems to capture the genuine achievement dimension.

4.2 Other Conducive and Detrimental Activities

Substituting the reduced learning time, both low- and high-achieving students only mildly increased the time spent on other activities that are generally viewed as conducive for child development. During the school closures, high-achievers (3.4 hours) spent significantly more

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[10] Throughout, average results for the full sample are not a simple weighted average of high- and low achieving students because they include students who do not yet receive grades.

[11] The difference in learning time between low- and high-achieving students during the school closures is visible throughout the entire distribution (Appendix Table A5). For example, 43 percent of low-achievers spent at most two hours per day on school-related activities, compared to 33 percent of high-achievers. Only 22 versus 30 percent, respectively, spent more than four hours per day on learning. For comparison, before the school closures 89 percent of students spent at least five hours per day on learning.

[12] In fact, the only noteworthy reduction does not come from any of the measures of socioeconomic background or family situation, but rather from student age (column 3), reflecting that younger students tend to get better grades and had a smaller reduction in learning time (due to lower before-Corona levels).

time on reading, playing music, creative work, or physical exercise than low-achievers (2.8 hours; see middle panel of Table 1). However, most of this gap existed already before the closures, so that the difference in the increase in these conducive activities is only marginally significant (+0.2 versus +0.4 hours for low- and high-achievers, respectively, $p<0.1$).

By contrast, low-achieving students particularly used the released time to expand activities such as gaming on the computer or consuming social media. During the school closures, low-achieving students spent 6.3 hours on activities such as watching TV, playing computer games, and consuming social and online media that are generally deemed detrimental to child development (bottom panel of Table 1) – nearly three hours more each day than on school-related activities. In comparison, high-achievers spent 1.5 hours less on the detrimental activities. Roughly half of this gap already existed before the school closures, so that the increase in time spent on detrimental activities was 0.7 hours larger for low- compared to high-achieving students (+1.7 versus +1.0 hours). The increase is mostly driven by increased gaps in computer gaming and social-media use, each of which increased by 0.3 hours.

Together, the results indicate that the school closures exacerbated educational inequality along the achievement dimension. The findings suggest that COVID-19 (i) increased the gap in learning time (and, mildly, in other conducive activities) between high- and low achieving students and (ii) increased detrimental activities especially among low-achieving students. Since low-achieving students are, basically by definition, less effective in turning learning-time inputs into knowledge and skills, we interpret the pronounced effect of the school closures on students' learning-time gaps as lower bound for the impact on gaps in actual learning.[13]

5.   Compensating Activities by Parents and Schools

This section investigates to what extent parents (section 5.1) and schools (section 5.2) acted to compensate for the increased gap in learning time between low- and high-achieving students.

5.1 Parental Support

While parents of both low- and high-achieving students increased the time they spent together with their child on learning during the school closures, both level and increase were smaller for low-achievers.[14] During the school closures, low-achievers spent 0.3 hours per day less learning together with their parents than high-achievers (0.9 versus 1.2 hours, $p<0.01$;

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[13] Consistently, parents of low-achievers are 14 percentage points more likely than parents of high-achievers to report that their child learned "much less" during the school closures than usual (Appendix Table A6).

[14] The importance of parental inputs for children's skill development is underscored by the finding that children's educational activities are particularly productive when parents are involved (Fiorini and Keane, 2014).

Table 3). While part of this gap already existed before the closures, it further increased by 0.1 hours during the school closures ($p<0.1$). Thus, even though parents increased the learning involvement with their children by half an hour per day during the closures, this aggravated rather than compensated for the increase in educational inequality.

By contrast, the increase in time spent together with parents on other conducive and on detrimental activities did not differ statistically significantly between low- and high-achievers. Still, parents of high-achieving students also spent significantly more time with their child on other conducive activities both before and during the school closures.

Parents' assessment of the environment at home reinforces the finding that low-achieving students were more affected by the COVID-19 school closures. While most parents (87 percent) think that their family has coped well with the period of school closures (Appendix Table A6), parents of low-achieving students evaluate the situation slightly worse than parents of high-achieving students (85 versus 90 percent, $p<0.05$). There is no significant difference between low- and high-achieving students in whether parents report that the phase of the school closures was a psychological burden for the child or for themselves (38 percent each on average). By contrast, parents of low-achievers are slightly more likely than parents of high-achievers to report that during the school closures, they argued more than usual with their child (30 versus 24 percent, $p<0.1$). They also assess the overall learning environment at home (e.g., in terms of available computers or working space) worse. These gaps hardly change when conditioning on observable child and parent characteristics (column 6).

5.2 School Support

During the closures, schools and teachers carried out only a fraction of their usual teaching operations via distance teaching, which led to a drastic reduction in direct communication between teachers and students. Table 4 indicates that only 29 percent of students on average had online lessons for the whole class (e.g., by video call) more than once a week. Only 17 percent of students had individual contact with their teacher more than once a week.[15] The main teaching mode during the school closures was to provide students with exercise sheets for independent processing (87 percent),[16] although only 37 percent received feedback on the completed exercises more than once a week.

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[15] Across the five answer categories, 6 (4) percent had joint online lessons (individual teacher contact) on a daily basis, 23 (14) percent several times a week, 14 (16) percent once a week, 11 (22) percent less than once a week, and 45 (45) percent never.

[16] 96 percent of students received exercises at least once a week.

The distance-teaching measures over-proportionally reached high-achieving students. Low-achievers were 13 percentage points less likely than high-achievers to be taught in online lessons and 10 percentage points less likely to have individual contact with their teachers (column 4). Low-achievers were also less likely to be provided with educational videos or software and to receive feedback on their completed tasks. These gaps do not change noticeably when conditioning on child and parental characteristics (column 6). Thus, schools were not able to compensate for the adverse effects of the closures on educational inequality. To the contrary, those students more in need of additional support to keep up learning during the school closures were less likely to benefit from distance-teaching activities.[17]

6. Other Dimensions of Inequality

This section investigates whether the school closures also amplified educational inequality along other dimensions than students' prior achievement, namely parents' educational background (section 6.1) and students' gender and school type (section 6.2).

6.1 Differences by Parents' Educational Background

In the public debate, there is a lot of concern that the COVID-19-induced school closures could aggravate educational inequality between children from different socioeconomic backgrounds (e.g., UNESCO, 2020b; European Commission, 2020). Family background has been shown to strongly impact students' educational success (e.g., Björklund and Salvanes, 2011). In Germany, parental education is a particularly strong predictor of children's educational outcomes. For example, 79 percent of children with a university-educated parent enroll in university themselves, compared to only 27 percent of children whose parents do not have a university degree (Kracke et al., 2018).

Surprisingly, then, we do not find that children of university-educated parents lose less learning time during the school closures than children of parents without a university degree. The upper panel of Table 5 shows that the reduction in learning time did not differ significantly between children of responding parents with (-3.7 hours per day) or without (-3.8 hours) a university degree.[18] While children of university-educated parents spent marginally significantly more time on school-related activities during the closures (3.8 versus 3.55 hours),

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[17] Consistently, the share of parents reporting to be satisfied with their school's activities during the school closures was 13 percentage points lower for low- than for high-achieving students (Appendix Table A6).

[18] Consistently, learning time during the school closures also did not differ between students with above and below median household income. Due to longer school attendance before the closures, the decline was actually larger for students from high-income households (results available upon request).

most of this gap already existed before COVID-19. Children of university-educated parents did increase their time on other conducive activities more. They also spent less time on detrimental activities both before and during the closures, but the change over time was not significantly different from children of parents without a university degree.

6.2 Differences by Students' Gender and School Type

Analysis by student gender indicates that the school closures reduced boys' learning time more than girls'. Before the closures, there was no significant gender difference in learning time (lower panel of Table 5). By contrast, boys spent half an hour less than girls learning at home during the school closures (3.4 versus 3.9 hours, $p<0.01$). Boys substituted learning time mostly for playing computer games, whereas girls mostly increased their time on social media, reinforcing gender differences in both dimensions. The overall gender effect of the closures may exacerbate the "boy crisis" in education (e.g., Cappelen et al., 2019).

There are also noteworthy differences between students in primary, upper-track secondary (*Gymnasium*), and other secondary school. During Corona, primary-school students were more likely to attend emergency services in schools, which were open only to younger children (Appendix Table A7). Upper-track secondary-school students spent more time learning at home (3.2 hours) than their lower-track and primary-school counterparts (2.5 hours each). Still, in absolute terms, both types of secondary-school students lost learning time to a similar extent. Primary-school students expanded other conducive activities – in particular, physical exercise – more than secondary-school students, who mostly expanded gaming and social media.

7. Discussion

The detailed time-use survey data provide novel and otherwise unavailable information on students' learning during the COVID-19-induced school closures. Still, several points should be kept in mind in interpreting the findings. First, students' time spent on learning and other activities are imperfect proxies for how much they actually learn (e.g., Hanushek and Woessmann, 2008). Arguably, high-achieving students are more effective in turning learning time into knowledge and skills. In this case, our results likely constitute a lower bound for the impact of school closures on skill inequality by student's prior achievement.

Second, survey responses could be subject to social-desirability bias. For instance, parents may inflate reported learning time because they think it is considered socially appropriate. However, research shows that social desirability does not yield major bias in anonymous online surveys as ours (e.g., Das and Laumann, 2010). In fact, parents reported that during the closures,

their child spent much more time on detrimental activities such as watching TV or computer gaming than on learning. This pattern is inconsistent with a major influence of social-desirability bias on answering behavior. Furthermore, any remaining bias would imply that the large discrepancy between school-related and detrimental activities found in our data even underestimates the true difference.

Third, our analyses are partly based on retrospective reports on how much time children spent on different activities before the school closures. While we cannot rule out that selective memory leads to measurement error in the data (e.g., Zimmermann, 2020), it is reassuring that the retrospective answers are plausible in the sense that reported hours spent in school before the closures correspond closely to the hours prescribed in the school curricula.

Fourth, the survey data could suffer from measurement error because parents do not know exactly how much time their child spends on different activities. However, only 21 percent of respondents state that both they and their partner worked at least half a day outside the home during the school closures. The relatively intense parent-child contact in most households increases parents' ability to monitor their child's activities, so that most parents should be able to assess these activities reasonably well.

Fifth, survey fatigue can lead to respondents not answering some questions conscientiously. However, 500 of the 1,099 parents in our sample used the provided open answer field to type in "another activity" in the time-use battery, which indicates that they were very conscientious in filling out the survey.

Finally, the extent to which our results for Germany are informative for other contexts is ultimately an empirical question that we cannot answer with our data. On the one hand, most countries were at least as affected by the COVID-19 pandemic as Germany, had broadly similar school-closure policies, had no previous experience with nation-wide school closures, and had no concepts in place for online school operations. Reports from many countries indicate that the organization of distance-teaching activities was challenging and caused major problems not only in Germany (e.g., Andrew et al., 2020; Chetty et al., 2020; Engzell et al., 2020; Maldonado and de Witte, 2020). On the other hand, there is some indication that Germany lagged other countries in the classroom usage of digital technologies before the pandemic (e.g., Beblavý et al., 2019; Fraillon et al., 2020), raising the possibility that some other countries may have fared better in providing online teaching for their students and particularly support the low-achievers.

8. Conclusion

We present novel time-use data on the activities of more than 1,000 school children before and during the COVID-19 school closures in Germany. On average, the school closures reduced students' learning time by about half. This reduction was significantly larger for low-achieving than for high-achieving students. Especially low-achieving students substituted the learning time for detrimental activities such as watching TV and playing computer games, rather than for conducive activities. Neither parents nor schools compensated for the increased learning gap by students' prior achievement and actually provided less support for low- than for high-achieving students. The reduction in students' learning time did not vary by parents' educational background, but it was larger for boys than for girls.

From a policy perspective, our results call for universal and binding distance-teaching concepts for school closures that are particularly geared towards low-achieving students. Leaving the decision over whether and how to maintain teaching operations during school closures at schools' or teachers' discretion has proven largely unsuccessful in our setting. In fact, proposals to instruct teachers to maintain daily contact with their students, require all schools to switch to online teaching if in-person classes are not possible, and enable online teaching by compulsory teacher training and providing digital equipment to students who cannot afford them have overwhelming majority appeal in the German electorate (Woessmann et al., 2020). Our results suggest that it is particularly the low-achieving students who suffer when support of teachers is lacking, so that any attempt to support their learning when schools have to close is likely to reduce future educational inequality.

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Table 1: Activities of low- and high-achieving students before and during the school closures

	During Corona				Before Corona				Difference during-before			
	Low-achievers	High-achievers	Gap	Std. err.	Low-achievers	High-achievers	Gap	Std. err.	Low-achievers	High-achievers	Gap	Std. err.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
School activities												
Aggregate	3.36	3.85	0.496	*(0.151)****	7.42	7.50	0.079	*(0.130)*	-4.07	-3.65	0.416	*(0.180)***
Attending school	0.82	0.92	0.103	*(0.133)*	5.93	5.93	-0.003	*(0.116)*	-5.11	-5.01	0.105	*(0.177)*
Learning for school	2.54	2.93	0.393	*(0.102)****	1.49	1.58	0.082	*(0.067)*	1.04	1.35	0.311	*(0.108)****
Conducive activities												
Aggregate	2.79	3.37	0.580	*(0.128)****	2.61	3.01	0.403	*(0.107)****	0.19	0.36	0.177	*(0.107)**
Reading	0.63	0.86	0.237	*(0.046)****	0.54	0.74	0.201	*(0.039)****	0.09	0.12	0.036	*(0.041)*
Music and creative work	0.66	0.82	0.164	*(0.061)****	0.53	0.65	0.117	*(0.046)***	0.13	0.17	0.047	*(0.047)*
Physical exercise	1.51	1.69	0.179	*(0.080)***	1.53	1.62	0.085	*(0.067)*	-0.03	0.07	0.094	*(0.077)*
Detrimental activities												
Aggregate	6.29	4.84	-1.452	*(0.210)****	4.58	3.82	-0.762	*(0.156)****	1.71	1.02	-0.691	*(0.146)****
Watching TV	1.50	1.37	-0.126	*(0.070)**	1.24	1.18	-0.059	*(0.058)*	0.26	0.20	-0.067	*(0.051)*
Gaming	1.87	1.32	-0.550	*(0.101)****	1.23	0.99	-0.244	*(0.068)****	0.64	0.34	-0.306	*(0.068)****
Social media	1.77	1.18	-0.593	*(0.097)****	1.22	0.90	-0.321	*(0.067)****	0.55	0.28	-0.272	*(0.067)****
Online media	1.15	0.97	-0.184	*(0.067)****	0.89	0.76	-0.137	*(0.047)****	0.26	0.21	-0.046	*(0.056)*

Notes: Average hours spent on different activities on a typical workday. During Corona: period of school closures due to COVID-19. Before Corona: period before the school closures. Low- versus high-achievers: students with an average grade in mathematics and German below versus at-or-above the median for their respective school type. Std. err.: standard errors stemming from regressions of hours spent on each activity on a high-achiever indicator. Significance levels: *** $p<0.01$, ** $p<0.5$, * $p<0.1$. Data source: ifo Education Survey 2020.

Table 2: Gap in learning time between low- and high-achieving students conditional on student and parent characteristics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
High-achiever	0.478***	0.474***	0.417***	0.455***	0.478***	0.460***	0.463***	0.498***	0.460***	0.478***	0.475***	0.492***	0.461***	0.385**
	(0.149)	(0.149)	(0.151)	(0.148)	(0.149)	(0.149)	(0.149)	(0.153)	(0.150)	(0.149)	(0.149)	(0.149)	(0.149)	(0.155)
School activities before Corona	0.224***	0.218***	0.244***	0.219***	0.224***	0.229***	0.222***	0.222***	0.227***	0.224***	0.224***	0.232***	0.219***	0.245***
	(0.036)	(0.037)	(0.037)	(0.036)	(0.036)	(0.036)	(0.036)	(0.038)	(0.036)	(0.037)	(0.036)	(0.037)	(0.036)	(0.040)
Upper-track secondary school (*Gymnasium*)		0.120												0.702***
		(0.191)												(0.258)
Other secondary school		-0.286												0.301
		(0.183)												(0.238)
Age			-0.053**											-0.109***
			(0.023)											(0.033)
Girl				0.477***										0.503***
				(0.147)										(0.151)
Single child					-0.062									-0.097
					(0.152)									(0.158)
Parent female						-0.286*								-0.286*
						(0.148)								(0.163)
Parent has university degree							0.185							0.174
							(0.167)							(0.192)
Single parent								-0.088						-0.049
								(0.203)						(0.221)
Parent in home office									0.183					0.146
									(0.157)					(0.179)
Parent work hours										0.000				-0.002
										(0.004)				(0.005)
Partner at home											0.172			0.091
											(0.189)			(0.198)
Household income												-0.001*		-0.001**
												(0.000)		(0.000)
West Germany													-0.399**	-0.291
													(0.184)	(0.190)
Constant	1.692	1.805	2.260	1.504	1.719	1.809	1.665	1.710	1.616	1.692	1.662	1.881	2.058	3.163
Observations	983	983	983	982	983	983	983	915	982	983	983	980	983	910
R^2	0.0476	0.0530	0.0527	0.0570	0.0477	0.0512	0.0488	0.0471	0.0501	0.0476	0.0484	0.0504	0.0521	0.0874

Notes: Dependent variable: average hours spent on "attending school" and "learning for school" on a typical workday during the period of school closures due to COVID-19. Before Corona: period before the school closures. Low- versus high-achievers: students with an average grade in mathematics and German below versus at-or-above the median for their respective school type. Significance levels: *** $p<0.01$, ** $p<0.5$, * $p<0.1$. Data source: ifo Education Survey 2020.

Table 3: Parental involvement in activities of low- and high-achieving students

	During Corona				Before Corona				Difference during-before			
	Low-achievers	High-achievers	Gap	Std. err.	Low-achievers	High-achievers	Gap	Std. err.	Low-achievers	High-achievers	Gap	Std. err.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
School activities												
Aggregate	0.89	1.20	0.311	$(0.079)^{***}$	0.42	0.62	0.193	$(0.044)^{***}$	0.47	0.59	0.118	$(0.069)^{*}$
Conducive activities												
Aggregate	1.07	1.47	0.398	$(0.099)^{***}$	0.78	1.11	0.325	$(0.087)^{***}$	0.29	0.36	0.073	(0.077)
Reading	0.22	0.34	0.121	$(0.033)^{***}$	0.18	0.30	0.124	$(0.030)^{***}$	0.04	0.04	-0.002	(0.026)
Music and creative work	0.20	0.28	0.086	$(0.033)^{***}$	0.17	0.23	0.060	$(0.028)^{**}$	0.03	0.06	0.026	(0.030)
Physical exercise	0.66	0.85	0.191	$(0.063)^{***}$	0.44	0.58	0.142	$(0.050)^{***}$	0.22	0.27	0.050	(0.057)
Detrimental activities												
Aggregate	1.36	1.45	0.094	(0.132)	1.03	1.23	0.200	$(0.109)^{*}$	0.32	0.22	-0.106	(0.090)
Watching TV	0.68	0.73	0.047	(0.058)	0.52	0.62	0.101	$(0.049)^{**}$	0.16	0.11	-0.053	(0.047)
Gaming	0.23	0.24	0.003	(0.044)	0.18	0.22	0.037	(0.035)	0.05	0.02	-0.035	(0.033)
Social media	0.24	0.24	-0.005	(0.053)	0.18	0.20	0.016	(0.040)	0.06	0.04	-0.021	(0.039)
Online media	0.19	0.24	0.049	(0.034)	0.15	0.19	0.046	(0.028)	0.05	0.05	0.003	(0.030)

Notes: Average hours parents spent with their child on different activities on a typical workday. During Corona: period of school closures due to COVID-19. Before Corona: period before the school closures. Low- versus high-achievers: students with an average grade in mathematics and German below versus at-or-above the median for their respective school type. Std. err.: standard errors stemming from regressions of hours spent on each activity on a high-achiever indicator. Significance levels: *** $p<0.01$, ** $p<0.5$, * $p<0.1$. Data source: ifo Education Survey 2020.

Table 4: Schools' distance-teaching activities during the school closures for low- and high-achieving students

	Average (1)	Low-achievers (2)	High-achievers (3)	Unconditional gap Gap (4)	Unconditional gap Std. err. (5)	Conditional gap Gap (6)	Conditional gap Std. err. (7)
Shared lessons (e.g., by video call)	0.29	0.24	0.37	0.131	$(0.029)^{***}$	0.131	$(0.031)^{***}$
Individual contact with teacher	0.17	0.13	0.23	0.102	$(0.025)^{***}$	0.081	$(0.026)^{***}$
Educational videos or texts	0.53	0.47	0.59	0.118	$(0.032)^{***}$	0.115	$(0.034)^{***}$
Educational software	0.43	0.40	0.47	0.078	$(0.032)^{**}$	0.068	$(0.034)^{**}$
Child received exercises	0.87	0.84	0.89	0.049	$(0.022)^{**}$	0.042	$(0.023)^{*}$
Child had to submit exercises	0.51	0.51	0.55	0.033	(0.032)	0.054	(0.033)
Child received feedback on exercises	0.37	0.34	0.42	0.078	$(0.031)^{**}$	0.096	$(0.033)^{***}$

Notes: Probability that the respective activity was conducted "daily" or "several times a week" (residual category includes "once a week," "less than once a week," and "never"). Question wording: "Which activities did the teachers/school of your child carry out during the several weeks of Corona-related school closures? Shared lessons for the whole class (e.g., by video call or telephone); Individual contact with my child (e.g., by video call or telephone); My child should watch provided educational videos or read texts; My child should use educational software or programs; My child should work on provided exercises; My child had to submit completed exercises; Teachers gave feedback on the completed exercises." Low- versus high-achievers: students with an average grade in mathematics and German below versus at-or-above the median for their respective school type. Std. err.: standard errors stemming from regressions of an indicator that the respective activity was conducted at least several times a week on a high-achiever indicator. Conditional gap: see Table 2 for controls. Significance levels: *** $p<0.01$, ** $p<0.5$, * $p<0.1$. Data source: ifo Education Survey 2020.

Table 5: Student activities before and during the school closures by parental education and by students' gender

	During Corona				Before Corona				Difference during-before			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Low-ed	High-ed	Gap	Std. err.	Low-ed	High-ed	Gap	Std. err.	Low-ed	High-ed	Gap	Std. err.
School activities												
Aggregate	3.55	3.82	0.275	*(0.162)**	7.37	7.55	0.178	*(0.136)*	-3.83	-3.73	0.097	*(0.189)*
Attending school	0.85	1.04	0.190	*(0.143)*	5.91	5.92	0.013	*(0.122)*	-5.06	-4.88	0.177	*(0.185)*
Learning for school	2.70	2.78	0.085	*(0.107)*	1.46	1.63	0.165	*(0.070)***	1.23	1.15	-0.080	*(0.114)*
Conducive activities												
Aggregate	3.10	3.48	0.380	*(0.138)****	2.86	2.98	0.122	*(0.114)*	0.24	0.50	0.258	*(0.113)***
Reading	0.73	0.87	0.141	*(0.048)****	0.63	0.76	0.128	*(0.042)****	0.10	0.11	0.013	*(0.043)*
Music and creative work	0.70	0.95	0.249	*(0.064)****	0.57	0.73	0.161	*(0.048)****	0.13	0.22	0.088	*(0.051)**
Physical exercise	1.67	1.66	-0.010	*(0.088)*	1.66	1.50	-0.166	*(0.072)***	0.01	0.16	0.156	*(0.083)**
Detrimental activities												
Aggregate	5.48	4.54	-0.934	*(0.223)****	4.17	3.41	-0.759	*(0.164)****	1.31	1.13	-0.175	*(0.150)*
Watching TV	1.48	1.25	-0.237	*(0.072)****	1.26	1.04	-0.221	*(0.060)****	0.23	0.21	-0.016	*(0.053)*
Gaming	1.55	1.33	-0.225	*(0.106)***	1.10	0.91	-0.189	*(0.070)****	0.46	0.42	-0.036	*(0.070)*
Social media	1.42	1.01	-0.409	*(0.102)****	1.04	0.72	-0.318	*(0.070)****	0.38	0.29	-0.092	*(0.068)*
Online media	1.02	0.96	-0.062	*(0.070)*	0.78	0.75	-0.031	*(0.050)*	0.24	0.21	-0.031	*(0.057)*
	Boy	Girl	Gap	Std. err.	Boy	Girl	Gap	Std. err.	Boy	Girl	Gap	Std. err.
School activities												
Aggregate	3.36	3.89	0.525	*(0.143)****	7.40	7.44	0.039	*(0.121)*	-4.04	-3.55	0.486	*(0.168)****
Attending school	0.88	0.91	0.026	*(0.127)*	5.91	5.92	0.016	*(0.109)*	-5.02	-5.01	0.010	*(0.164)*
Learning for school	2.48	2.98	0.499	*(0.094)****	1.50	1.52	0.022	*(0.063)*	0.98	1.46	0.476	*(0.100)****
Conducive activities												
Aggregate	3.08	3.34	0.260	*(0.123)***	2.85	2.94	0.087	*(0.102)*	0.23	0.40	0.173	*(0.101)**
Reading	0.72	0.82	0.102	*(0.043)***	0.65	0.68	0.032	*(0.038)*	0.07	0.14	0.071	*(0.038)**
Music and creative work	0.65	0.90	0.253	*(0.057)****	0.55	0.68	0.128	*(0.043)****	0.10	0.22	0.125	*(0.046)****
Physical exercise	1.71	1.62	-0.096	*(0.079)*	1.65	1.58	-0.073	*(0.064)*	0.06	0.04	-0.023	*(0.075)*
Detrimental activities												
Aggregate	5.57	4.85	-0.716	*(0.199)****	4.19	3.72	-0.477	*(0.147)****	1.38	1.14	-0.239	*(0.134)**
Watching TV	1.41	1.43	0.013	*(0.065)*	1.20	1.19	-0.008	*(0.054)*	0.21	0.23	0.021	*(0.048)*
Gaming	1.97	0.98	-0.987	*(0.090)****	1.34	0.73	-0.611	*(0.060)****	0.63	0.25	-0.376	*(0.062)****
Social media	1.19	1.44	0.254	*(0.091)****	0.87	1.03	0.162	*(0.062)****	0.32	0.41	0.092	*(0.061)*
Online media	1.00	1.00	0.004	*(0.063)*	0.78	0.76	-0.020	*(0.044)*	0.22	0.24	0.024	*(0.051)*

Notes: Average hours spent on different activities on a typical workday. During Corona: period of school closures due to COVID-19. Before Corona: period before the school closures. Low-ed: parents without a university degree. High-ed: parents with a university degree. Std. err.: standard errors stemming from regressions of hours spent on each activity on a high-ed and female indicator, respectively. Significance levels: *** $p<0.01$, ** $p<0.5$, * $p<0.1$. Data source: ifo Education Survey 2020.

Figure A1: Activities of low- and high-achieving students before and during the school closures
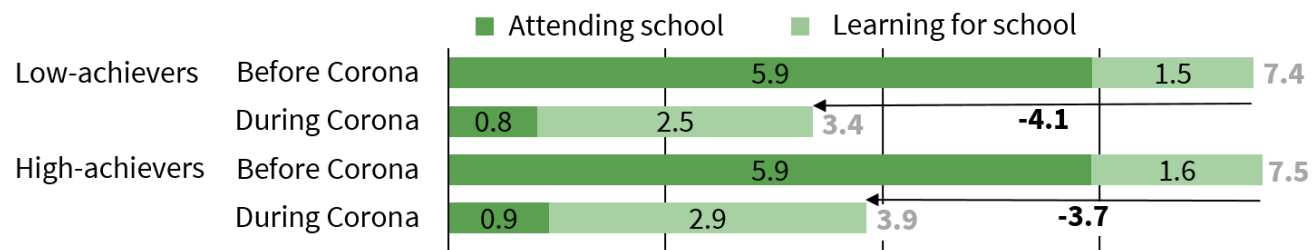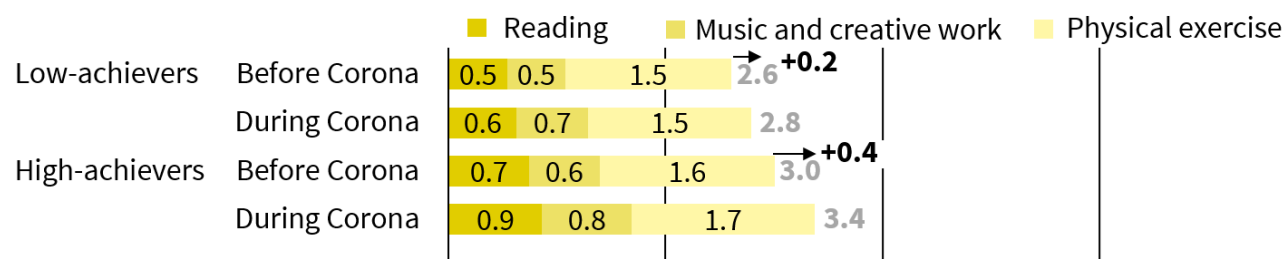
School activities
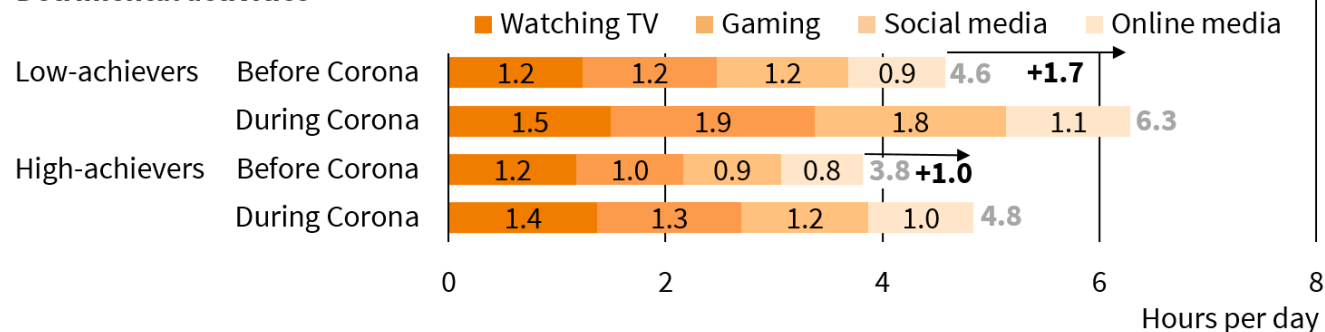
Notes: Average hours spent on different activities on a typical workday. During Corona: period of school closures due to COVID-19. Before Corona: period before the school closures. Low- versus high-achievers: students with an average grade in mathematics and German below versus at-or-above the median for their respective school type. See Table 1 for details. Data source: ifo Education Survey 2020.

Table A1: Comparison of analysis sample to Microcensus data

	Microcensus (1)		Analysis sample (2)	
Child characteristics				
School type				
Primary school	0.335	*(0.002)*	0.361	*(0.014)*
Upper-track secondary school (*Gymnasium*)	0.301	*(0.002)*	0.301	*(0.014)*
Other secondary school	0.364	*(0.002)*	0.338	*(0.014)*
Age	12.07	*(0.016)*	12.48	*(0.106)*
Girl	0.491	*(0.002)*	0.483	*(0.015)*
Living with both parents	0.783	*(0.002)*	0.800	*(0.012)*
Parent characteristics				
Educational attainment				
Mother with *(Fach-)Abitur*	0.362	*(0.002)*	0.437	*(0.021)*
Father with *(Fach-)Abitur*	0.410	*(0.003)*	0.474	*(0.021)*
Working status				
Mother works full-time	0.211	*(0.002)*	0.233	*(0.013)*
Father works full-time	0.876	*(0.002)*	0.671	*(0.015)*
West Germany	0.832	*(0.002)*	0.795	*(0.012)*
Observations	49,621		1,099	

Notes: Means; standard errors in parentheses. Column (1): all children aged below 20 years in general schools in the Microcensus 2015 (representative of the German population). Column (2): our analysis sample, referring to youngest school-aged child of parents in our survey data. Data sources: Microcensus 2015 and ifo Education Survey 2020.

Table A2: Sample characteristics

	Sample means	Regression of high-achiever indicator on sample characteristics	
		Coef.	Std. err.
	(1)	(2)	(3)
Child characteristics			
School type			
Elementary school	0.361		
Upper-track secondary school (*Gymnasium*)	0.301	-0.014	*(0.056)*
Other secondary school	0.338	0.005	*(0.051)*
Age	12.48	-0.022	*(0.006)****
Girl	0.484	0.038	*(0.033)*
Single child	0.383	-0.004	*(0.034)*
Parent characteristics			
Female	0.490	-0.042	*(0.034)*
University degree	0.273	0.013	*(0.041)*
Single parent	0.166	0.028	*(0.048)*
Parent in home office[+]	0.342	0.101	*(0.038)****
Work hours	29.11	0.024	*(0.108)*
Partner at home[++]	0.185	0.028	*(0.043)*
Household income	3370.4	0.018	*(0.011)**
West Germany	0.795	-0.057	*(0.041)*
Observations	1,099	910	
R^2		0.037	

Notes: Column (1): sample means. Columns (2)-(3): dependent variable: dummy for high-achieving student (average grade in mathematics and German at or above the median for respective school type). In the regression, work hours and household income are divided by 100. Significance levels: *** $p<0.01$, ** $p<0.5$, * $p<0.1$. Data source: ifo Education Survey 2020. [+] Parent in home office: responding parent reports a positive number of hours working from home during the period of school closures. [++] Partner at home: dummy=1 if additional adult in household who works less than 20 hours per week during period of school closures, 0 otherwise.

Table A3: Parental assessment of whether activities are beneficial for child development

	Average (1)	Low-achievers (2)	High-achievers (3)	Unconditional gap		Conditional gap	
				Gap (4)	Std. err. (5)	Gap (6)	Std. err. (7)
Attending school	0.97	0.96	0.97	0.006	*(0.012)*	-0.000	*(0.012)*
Learning for school	0.93	0.91	0.95	0.034	*(0.016)***	0.032	*(0.017)**
Reading	0.89	0.83	0.91	0.077	*(0.021)****	0.074	*(0.022)****
Music and creative work	0.82	0.78	0.82	0.039	*(0.025)*	0.029	*(0.027)*
Physical exercise	0.95	0.94	0.95	0.009	*(0.015)*	0.015	*(0.015)*
Watching TV	0.30	0.27	0.35	0.083	*(0.030)****	0.066	*(0.031)***
Gaming	0.22	0.19	0.25	0.060	*(0.026)***	0.055	*(0.028)***
Social media	0.24	0.23	0.27	0.036	*(0.028)*	0.029	*(0.030)*
Online media	0.34	0.33	0.39	0.063	*(0.031)***	0.048	*(0.033)*

Notes: Dummy=1 for respondents who say activity is "very beneficial" or "rather beneficial" for the further development of their child (on a five-point scale from "not beneficial at all" to "very beneficial"). Low- versus high-achievers: students with an average grade in mathematics and German below versus at-or-above the median for their respective school type. Std. err.: reports standard errors of regression from dummy=1 for high-achievers on hours in each category. Conditional gap: see Table 2 for controls. Significance levels: *** $p<0.01$, ** $p<0.5$, * $p<0.1$. Data source: ifo Education Survey 2020.

Table A4: Average student activities before and during the school closures

	During Corona (1)	Before Corona (2)	Difference (3)
School activities			
Aggregate	3.62	7.42	-3.80
Attending school	0.90	5.92	-5.01
Learning for school	2.72	1.51	1.21
Conducive activities			
Aggregate	3.20	2.89	0.31
Reading	0.77	0.67	0.10
Music and creative work	0.77	0.61	0.16
Physical exercise	1.67	1.62	0.05
Detrimental activities			
Aggregate	5.22	3.96	1.26
Watching TV	1.42	1.20	0.22
Gaming	1.49	1.04	0.45
Social media	1.31	0.95	0.36
Online media	1.00	0.77	0.23

Notes: Average hours spent on different activities on a typical workday. During Corona: period of school closures due to COVID-19. Before Corona: period before the school closures. Data source: ifo Education Survey 2020.

Table A5: Distribution of school-related activities during the school closures

	At most …								
	0 hours	1 hour	2 hours	3 hours	4 hours	5 hours	6 hours	7 hours	8 hours
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
All	0.023	0.144	0.378	0.568	0.742	0.818	0.881	0.918	0.954
Low-achievers	0.030	0.188	0.435	0.613	0.783	0.849	0.902	0.936	0.961
High-achievers	0.015	0.104	0.326	0.516	0.701	0.791	0.872	0.910	0.954

Notes: Hours spent on "attending school" or "learning for school" on a typical workday during the period of school closures due to COVID-19. Low- versus high-achievers: students with an average grade in mathematics and German below versus at-or-above the median for their respective school type. Data source: ifo Education Survey 2020.

Table A6: Parental assessment of home environment and child's learning

	Average (1)	Low-achievers (2)	High-achievers (3)	Unconditional gap		Conditional gap	
				Gap (4)	Std. err. (5)	Gap (6)	Std. err. (7)
Family coped well	0.87	0.85	0.90	0.049	*(0.021)***	0.060	*(0.022)****
Psychological burden for child	0.38	0.39	0.36	-0.030	*(0.031)*	-0.060	*(0.033)**
Psychological burden for parent	0.38	0.37	0.34	-0.028	*(0.031)*	-0.046	*(0.032)*
Argued more with child	0.28	0.30	0.24	-0.055	*(0.028)**	-0.080	*(0.030)****
Assessment of home learning environment	3.86	3.70	4.01	0.312	*(0.063)****	0.289	*(0.067)****
Satisfied with school activities	0.57	0.49	0.62	0.131	*(0.032)****	0.113	*(0.034)****
Child learned much less	0.64	0.72	0.58	-0.142	*(0.031)****	-0.135	*(0.032)****

Notes: Rows 1-4 and 7: probability that statement "fully applies" or "rather applies" (on a five-point scale from "does not apply at all" to "fully applies"); question wording: "Our family coped well with the situation during the school closures."; "The phase of school closures was a great psychological burden for my child/for me."; "I argued with my child during the school closures more than usual."; "My child has learned much less during the school closures than usual in school." Row 5: average grade provided on 5-point scale (1="insufficient", 5="very good"); question wording: "How would you evaluate your child's learning environment at home during the period of several weeks of Corona-related school closure, e.g., in terms of available computers or space to work?" Row 6: probability that respondents are "very satisfied" or "satisfied" (on a five-point scale from "very unsatisfied" to "very satisfied"); question wording: "Overall, how satisfied are you with the activities your child's school carried out during the several weeks of Corona-related school closure?" Low- versus high-achievers: students with an average grade in mathematics and German below versus at-or-above the median for their respective school type. Std. err.: standard errors stemming from regressions of the respective outcome variable on a high-achiever indicator. Conditional gap: see Table 2 for controls. Significance levels: *** $p<0.01$, ** $p<0.5$, * $p<0.1$. Data source: ifo Education Survey 2020.

Table A7: Student activities before and during the school closures by school type

	During Corona			Before Corona			Difference during-before		
	Primary	Secondary		Primary	Secondary		Primary	Secondary	
		Upper-track	Other		Upper-track	Other		Upper-track	Other
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
School activities									
Aggregate	3.62	3.91	3.37	6.98	7.97	7.40	-3.36	-4.06	-4.03
Attending school	1.08	0.75	0.85	5.63	6.17	5.99	-4.55	-5.42	-5.14
Learning for school	2.54	3.16	2.52	1.35	1.80	1.41	1.19	1.36	1.11
Conducive activities									
Aggregate	3.89	2.84	2.79	3.41	2.50	2.69	0.48	0.34	0.09
Reading	0.93	0.74	0.62	0.82	0.56	0.59	0.10	0.18	0.03
Music and creative work	0.93	0.75	0.61	0.76	0.53	0.53	0.17	0.23	0.08
Physical exercise	2.03	1.35	1.56	1.83	1.41	1.57	0.21	-0.06	-0.02
Detrimental activities									
Aggregate	3.71	5.85	6.29	2.90	4.17	4.92	0.81	1.68	1.37
Watching TV	1.37	1.45	1.45	1.16	1.14	1.28	0.21	0.31	0.17
Gaming	1.11	1.48	1.91	0.83	0.94	1.37	0.28	0.54	0.55
Social media	0.54	1.73	1.76	0.39	1.21	1.32	0.15	0.52	0.44
Online media	0.69	1.19	1.16	0.52	0.87	0.95	0.17	0.32	0.21

Notes: Average hours spent on different activities on a typical workday. During Corona: period of school closures due to COVID-19. Before Corona: period before the school closures. Primary: students in primary school. Upper-track: students in upper-track secondary school (*Gymnasium*). Other: students in other secondary school. Data source: ifo Education Survey 2020.