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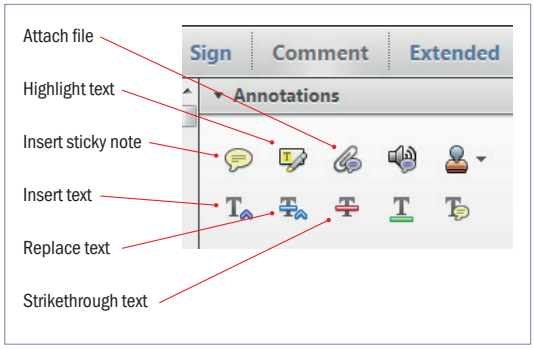

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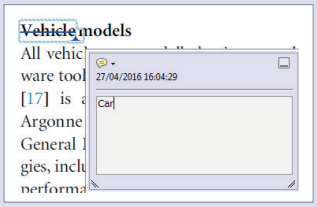

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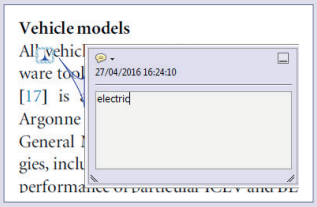

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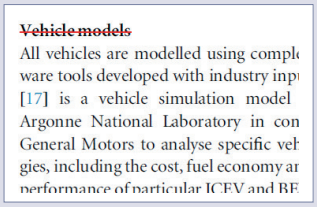

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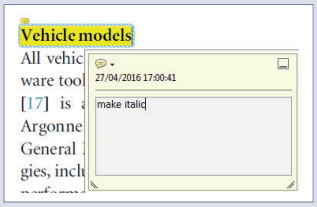

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RESEARCH ARTICLE

Socio-economic differences in remote schoolwork during the COVID-19 pandemic: a trend analysis of the 2020 and 2021 school-closure periods using the UK Understanding Society data

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In the United Kingdom, the COVID-19 pandemic in 2020 and 2021 led to two extended periods of school closures. Research on inequality of learning opportunity as a result of these closures used a single indicator of socio-economic status, neglecting important determinants of remote learning. Using data from the Understanding Society (USoc) COVID-19 surveys we analysed the levels and differentials in the uptake of remote schoolwork using parental social class, information technology (IT) availability in the home and parental working patterns to capture the distinct resources that families needed to complete remote schoolwork. This is also the first study to assess the extent to which the differentials between socio-economic groups changed between the first and second school-closure periods caused by the pandemic. We found that each of the three factors showed an independent association with the volume of remote schoolwork and that their effect was magnified by their combination. Children in families where the main parent was in an upper-class occupation, where both parents worked from home and where the children had their own IT spent more time doing remote schoolwork than other groups, particularly compared to children of single parents who work from home, children in families where the main parent was in a working-class occupation, where the child had to share IT, and where the parents did not work regularly from home. The differentials between socio-economic groups in the uptake of schoolwork were found to be stable between the two school-closure periods.

Keywords Understanding Society COVID-19 survey • remote schoolwork and learning • socio-economic differentials • school closures in the UK.

Key messages

- Remote schoolwork during the COVID-19 school closures in the UK was stratified by parental social class, computer availability and parental working patterns.
- The effect of the three factors was magnified by their combination.

- The differentials between socio-economic groups in the uptake of schoolwork were stable between the two school-closure periods.

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Introduction

The COVID-19 pandemic caused great disruption to education systems, forcing schools and students to switch to distance learning very rapidly without (in most cases) any prior experience, preparation or training. Across the UK, the spring of 2020 saw the widespread and prolonged closure of schools and although a phased reopening from the First National Lockdown began in July 2020, students transitioned to distance learning *again* in January 2021, impairing an already difficult learning recovery. The transition to remote schooling affected student learning and transferred a great deal of responsibility for education to families. Research on the extent to which the two school-closure periods and the consequent transitions to remote learning differentially affected students from advantaged and disadvantaged socio-economic background showed that socio-economic background significantly affected schoolwork and achievement[1] during the remote learning period (Andrew et al, 2020; Bayrakdar and Guveli, 2020; Author, 2020; Dietrich et al, 2021; Engzell and Verhagen, 2021). Most research used a single factor to define socio-economic status (SES) such as parental income (Andrew et al, 2020), parental level of education (Bayrakdar and Guveli, 2020; Bol, 2020; Dietrich et al, 2021; Grätz and Lipps, 2021), or eligibility for free school meals (Lucas et al, 2020). However schoolwork and accessing education remotely require information technology (IT) equipment, children's motivation and ability to participate in remote learning and parents' availability and guidance, especially for younger children. This implies that a single factor underestimates the extent of socio-economic disadvantage in the context of the pandemic closures and fails to distinguish between distinct types of material, occupational and cognitive resources and consequently neglects important determinants of remote learning.

This paper uses high-quality, large-scale, representative longitudinal data on remote schoolwork during the two school-closure periods from the UK Understanding Society (USoc) COVID-19 surveys to innovate extant research in two ways. First, it uses a uniquely rich set of variables to measure socio-economic disadvantage: parental social class, IT availability and parental working patterns. We use *parental class* as a proxy indicator of (lack of) learning opportunities during the COVID-19 crisis. We adopt a sociological focus on occupation-based measures (Tilly, 1998) and consider parental social class to be a valid determinant of educational opportunities during these school closures. The notion of social class identifies the worker's position within the relationships of production in firms and labour markets (Erikson et al, 1979; Erikson and Goldthorpe 1992). As social class determines the quality of work conditions (job

security, career opportunities, working hours and stress) it has a specific relevance for children's educational attainment by influencing the quality and quantity of the relationship between family members (Furstenberg and Kiernan, 2001; Menning, 2002; Perry-Jenkins et al, 2007). Parental social class is also related to the likelihood that children are enrolled in better-performing schools.[2] While parental social class captures working conditions generally, the COVID-19 crisis required workers across the occupational stratification such as surgeons, teachers and professional keyworkers as well as bus drivers, refuse collectors, delivery drivers, fast-food and supermarket workers, and train drivers to work outside of the home during the COVID-19 lockdowns. This suggests we should include working patterns – whether working from home, from the office or not working – in addition to social class. We distinguish between parents who are at home because they do not currently work and those who work from home as research has consistently documented a negative association between parents who do not work and children's educational attainments (Lehti et al, 2019; Mari and Keizer, 2021). Because of its pivotal importance for remote schoolwork, we also used IT availability in the home in our analyses. Finally, we considered family structure to capture the fact that assisting children with remote schoolwork is easier when the competing tasks of caring, working and homeschooling were shared among adults in the household.

Second, research in the UK and abroad has mostly focused on remote learning during the first school-closure period, but there is still little research on learning during the second closure period and on the subsequent period. Given the detrimental effects of the school closures on children's learning, analysing how children's learning opportunities changed over the pandemic is key in assessing the extent of learning disruption and how families and schools adapted between the initial and subsequent phases of the pandemic. Our research is one of the few studies that looks at schoolwork during both periods of school closure and for the same students and their families in the UK.

The outcome of interest is time spent doing (remote) schoolwork, which is a predictor of educational achievement (Bellei, 2009; Rivkin and Schiman, 2015), can be consistently measured over time, and does not suffer from grade inflation like examination results.

This paper uses longitudinal USoc COVID-19 survey data collected in April 2020 – one month into the first school-closure period (and first lockdown) – and January 2021 – at the beginning of the second school-closure period (and third lockdown).[3] As both surveys interviewed the same families, were linked to previous USoc surveys, and were representative of the UK, we were able to construct a rich longitudinal data set of approximately 5,300 children: 2,300 in primary school and 3,000 in secondary school. Using both parental social class, parental work patterns and IT availability in the home to define SES, we examined:

- Whether each of the three factors shows an independent association with the volume of remote schoolwork.
- Whether the association between each of the three factors and remote schoolwork is magnified by their combination.
- Whether (and to what extent) the gap in remote schoolwork between the least disadvantaged (high SES) and most disadvantaged (low SES) families changed between the first and the second school-closure periods.

How this study complements other research

The majority of the research on educational inequalities during the pandemic showed that opportunities resulting from remote learning during the COVID-19 school closures are stratified by socio-economic background (Andrew et al, 2020; Bayrakdar and Guveli, 2020; Pensiero et al, 2020; Engzell and Verhagen, 2021).

Engzell and Verhagen (2021) studied the effects of school closure on primary pupil attainment in national examinations in the Netherlands, exploiting the fact that national examinations there took place *immediately before and after* the 2020 school closure. They found marked differences between students with different SES backgrounds. In general, studies that looked at national examinations and academic achievement found a more pronounced learning loss among students with a disadvantaged background (Betthäuser et al, 2022).[4] AQ3

In the UK, during the first school closure from late March 2020 to the start of June 2020, students spent fewer hours doing remote schoolwork than they would have done in normal circumstances (Andrew et al, 2020; Bayrakdar and Guveli, 2020; ONS, 2020; Pensiero et al, 2020) and most schoolwork consisted of offline asynchronous activities rather than live sessions (Green, 2020; Pensiero et al, 2020). This reduction in schoolwork and learning was more severe among disadvantaged (low SES) students whose families were not well-equipped to cope with homeschooling (Andrew et al, 2020; Bayrakdar and Guveli, 2020; Pensiero et al, 2020). Similar effects were found in the Netherlands: Bol (2020) found that less-educated parents felt 'less capable' of helping their children with remote schoolwork; and in Germany where secondary students with lower-educated parents expended less effort in schoolwork than students with higher-educated parents during the school closing period (Dietrich et al, 2021); and in Denmark inequalities between SES groups (using both parental education and income as indicators) were found with respect to library takeout during the lockdown (Jæger and Blaabæk, 2020).

Using survey data collected from teachers in the UK during the first school-closure period, Lucas et al (2020) found that student engagement with remote schoolwork was lower in more deprived schools, among students eligible for free school meals and among those with limited access to computers and study space at home. Andrew et al (2020) found that UK children from families in the top income quintile spent on average 1.3 hours per day longer[5] on educational activities during the first closure period than those in the bottom income quintile, yet inequalities in remote learning time between top and bottom income quintile families reduced during the second school closure (Cattan et al, 2021). Research conducted following the first lockdown AQ4 in 2020 by the Office for National Statistics (ONS) found that children tended to do less remote schoolwork if they were younger and when there was a child under five years old in the household (ONS, 2020).

A handful of studies instead support the alternative view that the pandemic was inequality neutral. According to this view the educational disruption caused by the COVID-19 crisis is random and not systematically based on family SES or school quality (Birkelund and Karlson, 2021; Zinn and Bayer, 2021) so that family SES background exerts little or no impact on remote schoolwork. In Italy, Borgonovi and Ferrara (2022) showed that students experienced either a decline (among 14-year-olds) or a smaller increases (among 11-year-olds) in mathematics and reading attainment in 2021 compared to pre-pandemic years. The study did find that the effects of the pandemic were more detrimental for low-achieving students, but that the pandemic

reduced SES differentials in maths and reading achievement. Similarly in Denmark, Birkelund and Karlson (2021) found no major attainment loss in national reading tests as a result of the pandemic nor did they find widening differentials by parental income and employment status. And in Germany, a large survey on school-related activities confirmed that SES differentials in remote schoolwork among secondary students actually *narrowed* during school-closure periods (Zinn and Bayer, 2021). However, the majority of international studies and the totality of UK-based studies confirm that the opportunities of remote learning during the COVID-19 school closures are stratified by socio-economic background, suggesting the following hypothesis that our research tested:

H1: Parental social class, parental work patterns and IT availability in the home each has an independent association with the hours of remote schoolwork completed.

The review suggests, overall, that SES is consequential for the opportunities to access and uptake remote schoolwork during the school-closure periods; however, most of the studies used a single indicator of SES and none looked at parental working patterns. The ability of families to respond effectively to the demands of remote schoolwork depends on resources captured by social class (quality of the school attended, material resources such as IT equipment and quality of parent–child relationships), yet the unpredictable effect of the pandemic[6] on working patterns and the pivotal importance of IT suggests adding parental working patterns and IT availability along with social class to capture the opportunities of remote schoolwork. It follows from this argument that the three factors can combine their effects. For example, in upper-class households where parents work from home and the children have with their own IT, children are likely to have better opportunities for remote schoolwork compared to similarly upper-class households, but where the parents work outside the house and the children do not have their own IT. Therefore, we tested the following hypothesis:

H2: The association between each of the three factors and the hours of remote schoolwork completed is magnified by their combination.

Research in the UK and abroad has focused on how families and schools responded to distance learning during the first school-closure period, but there is still no research on learning during the second closure period and little research on the subsequent period. We can reasonably speculate that the second school-closure period is different in that schools and families were better prepared for remote learning. During the first school closure, schools provided fewer hours of teaching than they would normally have done, due to lack of IT equipment and insufficient remote teaching skills, but some of these limitations might have been overcome in time for the second closure period. We know that in the period between closures, schools acquired more and better IT equipment from government grants, from necessity the staff skills required to deliver teaching remotely were enhanced and generally all aspects of online provision were better managed. Improved provision has implications for remote schoolwork inequalities between families. It is possible that schools that provided little or poor remote teaching during the first school closure had the largest improvement, thus

reducing the gap in remote provision between schools. Therefore, the effect of socio-economic background through a school's quality might have declined, although there is no evidence to support this speculative hypothesis.

Families also learned from the first school-closure period and were better prepared for remote schoolwork in the second school closure, but it is not clear whether this varied between high-SES and low-SES groups. Cattan et al (2021) found that in the UK, during April and May 2020 when schools were closed, and in June and July 2020 when schools reopened, the total learning time fell for both primary and secondary school students. Reimer et al (2021) found that inequality in reading in Denmark during COVID-19 increased during the first school closure *only*, but that the gap returned to pre-pandemic levels for subsequent school closures. Those results cannot be generalised to remote schoolwork, however. Advantaged families might have used the time spent at home more productively and engaged more with the school provision of remote learning. This is compatible with the theory of maximally maintained inequality (Raftery and Hout, 1993), which argues that in a changing educational environment higher SES families preserve their advantage by mobilising the higher resources at their disposal – knowledge of academic subjects, their understanding of how schools work, the availability of IT and a space to study – to improve their children's learning. Therefore, the question remains whether disadvantaged groups improved their uptake of remote schoolwork more than advantaged groups thus reducing their disadvantage or whether both disadvantaged and advantaged families improved to the same extent. This leads us to the following hypothesis:

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H3: The association between SES and the hours of remote schoolwork completed remained stable between the first and the second school-closure periods.

Data

The Understanding Society surveys

We used the Understanding Society COVID-19 data from the April 2020 and January 2021 waves, which included a module on homeschooling. We linked the participants to the Survey 8 (November 2018), Survey 9 (November 2019) and Survey 10 (November 2020) of the USoc Household main study to obtain information on parental social class. The USoc Household survey is the main UK household longitudinal study exploring how life in the UK is changing over time. The sample size is large, and covers all ages and all educational and social backgrounds across the UK. All adults complete an interview. For children in the household under age ten, parents answer the questions. Children aged 10–15 have their own paper-based questionnaire with questions appropriate to their age group, and when they turn 16 they become eligible for the full adult interview.

The study has been repeatedly considered to be representative of the UK population and of high quality (Fisher et al, 2019; Benzeval et al, 2020). Its response rate is 85–90% which is achieved by directly contacting web non-respondents. The response rate of the April 2020 and January 2021 waves – respectively 49% and 46% – is lower but very good for a voluntary web survey. To make inferences about the population of school-age children, we used the weights provided in the USoc methodology, which

account for attrition and nonresponse. Including only those children who were not in school and excluding those for whom there was incomplete information on relevant variables on both the COVID and USoc household surveys, we generated a sample of approximately 5,330 children: approximately 2,330 in primary school and approximately 3,000 in secondary school.

Variables

Social class in USoc is measured by the eight-category version of the National Statistics Socio-Economic Classification (NS-SEC) system which is the operationalisation of the Goldthorpe schema for the UK (Goldthorpe, 2007; see also ONS, 2018). We measure the children's social-class background using the most recent parental position on the NS-SEC grouped into a three-category variable: (1) upper-class occupations; (2) intermediate-class occupations; and (3) working-class occupations. Students from an upper-class background are those whose parents are large employers, higher managers and professionals; students from a working-class background are students whose parents are in routine or semi-routine sales, service, technical, agricultural and clerical occupations; and students from an intermediate-class background are those whose parents are lower managerial, administrative and professional, small employers and own-account workers. As a robustness check we also used level of parental education as a three-category variable – (1) GCSEs as the highest level of attainment; (2) A-levels; and (2) degree as the highest level of attainment – instead of parental social class.

As part of the USoc COVID-19 surveys, parents were asked to report on their working patterns during lockdown and we used this information to distinguish for each parent between: (1) working from home regularly or being on furlough; (2) working at the office, and (3) not working. In the case of the second parent, we combined categories (2) and (3), because of sample size limitations, thus distinguishing between working from home and not, and added another category to indicate if the second parent is absent (single-parent households). We interact the parents' variables thus capturing family types and parents' working patterns simultaneously.[7]

We additionally looked at sibling birth order, distinguishing between (1) being a single child, (2) an eldest child, (3) a middle child or (4) a youngest child.[8]

We included the following demographic factors: gender, age and ethnic background the main parent identifies with, distinguishing between (1) British and (2) non-British.[9] We also looked at whether the child (1) owned their own personal computer, laptop or tablet (IT), (2) had shared IT or (3) did not have IT at home.

In terms of 'time spent doing work provided by schools' per day, the categories were: (1) less than an hour; (2) 1–2 hours; (3) 2–3 hours; (4) 3–4 hours; (5) 4–5 hours; and (6) 5 or more hours. We used the mid-points of these intervals, with 5.5 for the top category and 0.5 for the bottom category. This means that our top category is right-truncated, introducing uncertainty in the measurement of high-volume remote schoolwork, although it is reasonable to assume that students are unlikely to exceed significantly 5.5 hours of remote schoolwork per day, which is the typical length of a school day across the UK (Education Endowment Foundation, 2018). We tested whether the use of these mid-points generated biased results, by replicating the results using interval regression (Stewart, 1983) to take into account the uncertainty concerning the exact values within each interval and to deal with the

left- and right-censoring in the extreme categories. The results are shown in Appendix Table A1. They were very similar to those obtained using the OLS regression with the mid-points.

In terms of the raw *number* of offline and online lessons offered by the school – which we present as a covariate in the regression analysis – the categories were: (1) none; (2) less than 1 per day; (3) 1 per day; (4) 2 per day; (5) 3 per day; and (6) 4 or more per day. We used 4 for the top category and 0 for the bottom category. We computed the total number of online and offline lessons to quantify the total provision of lessons. The variable is likely to reflect the ability of families to access school lessons over and above the school provision. Indeed, being aware of the provision of lessons is already a form of engagement.

Finally, we included the geographical region of residence.

Analytical approach

The April 2020 and January 2021 USoc COVID-19 survey data were pooled and analysed in Stata 16 using mixed models. Mixed models combine fixed and random effects and are well suited to analysing hierarchically structured data such as the USoc data sets. Mixed models extend linear models by (in our study) taking account of the interdependence between children in any given household. The number of children in households varied from 1 to 5, with an average of 1.6. Within each educational phase (primary school / secondary school) it varied between 1 and 4, with an average of 1.3. A dummy 'wave' variable and its interaction with the covariates of interest (*variable of interest* * *January 2021*) was used to analyse changes between the two school-closure periods. Homeschooling reflects household-specific practices and resources, thus violating the independence assumption of linear regression. Mixed models take household differences as parallel shifts in the regression line using household-specific (random) intercepts. In contrast to fixed models, which control for membership in a family, mixed models estimate the effect of variables that are constant within households, such as parental occupation (Raudenbush and Bryk, 2002). The fixed effect of the model takes the average effect of the independent variables using an overall regression line, which does not vary between households. The random household intercept models between-household variability by shifting the regression line up or down according to each household after controlling for other variables. In line with hypothesis 1 that aims to test the independent effect of parental social class, IT availability and working patterns, we introduce the three indicators of socio-economic resources simultaneously. We estimated two further models for schoolwork including 'number of lessons' as a predictor variable to analyse the extent to which the effect of family and children's characteristics is accounted for by the volume of number of lessons offered by the school. The two sets of models – one baseline and one controlling for the number of lessons for both primary and secondary school students – are presented in Table 1 in models 1 and 2, and 3 and 4.

We are also interested in the combined effect of the three indicators (hypothesis 2) and we use marginal effects to look at specific combinations of these variables. For ease of interpretation, the results of this analysis are presented in the graphs (Figures 1–6) in the main text with the full estimates presented in Appendix B1.[10]

To analyse the changes in inequalities across socio-economic groups between April 2020 and January 2021, we first computed the gaps between socio-economic groups.

Table 1: Models for hours of schoolwork for primary and secondary students

	Primary		Secondary	
	Hours of schoolwork Model 1	Hours of schoolwork Model 2	Hours of schoolwork Model 3	Hours of schoolwork Model 4
NS-SEC (3 Categories) Ref: Working class				
Upper class	0.42*** (0.11)	0.46*** (0.10)	0.26* (0.11)	0.21* (0.10)
Intermediate class	0.18 (0.12)	0.23* (0.11)	0.17 (0.11)	0.16 (0.10)
January 2021	0.94~(0.56)	0.67 (0.47)	1.33 (0.82)	0.45 (0.76)
Upper class * January 2021	–0.34~(0.20)	–0.39* (0.17)	0.07 (0.15)	0.22 (0.15)
Intermediate class * January 2021	0.13 (0.23)	0.08 (0.21)	–0.08 (0.17)	0.05 (0.16)
Ref.: Working from home (main), Working from home (second)				
Not working (main), Working from home (second)	–0.40 (0.28)	–0.40~(0.23)	0.20 (0.40)	0.20 (0.34)
Not working (main), Other (second)	–0.07 (0.20)	0.15 (0.20)	–0.08 (0.17)	–0.09 (0.16)
Working at office (main), Working from home (second)	–0.13 (0.16)	–0.11 (0.15)	–0.11 (0.15)	–0.06 (0.15)
Working at office (main), Other (second)	0.00 (0.12)	0.05 (0.11)	–0.26** (0.10)	–0.20* (0.09)
Working from home (main), Other (second)	–0.11 (0.15)	–0.07 (0.13)	–0.30~(0.17)	–0.26~(0.15)
Single and not working (main)	–0.09 (0.39)	–0.21 (0.39)	–0.47 (0.39)	–0.17 (0.35)
Single and working at office (main)	–0.02 (0.27)	0.03 (0.27)	–0.26 (0.22)	–0.27 (0.17)
Single and working from home (main)	–0.46* (0.21)	–0.35~(0.20)	0.55** (0.20)	–0.36* (0.17)
Not working (main), Working from home (second) * January 2021	0.32 (0.29)	0.23 (0.28)	–0.08 (0.37)	0.07 (0.38)
Not working (main), Other (second) * January 2021	0.00 (0.31)	–0.16 (0.31)	0.12 (0.21)	0.20 (0.19)
Working at office (main), Working from home (second) * January 2021	0.28 (0.28)	0.47 (0.30)	0.44~(0.22)	0.08 (0.21)
Working at office (main) * Other (second) * January 2021	0.03 (0.21)	–0.02 (0.18)	0.32* (0.14)	0.23~(0.13)
Working from home (main), Other (second) * January 2021	0.46~(0.28)	0.43~(0.25)	0.64** (0.25)	0.48* (0.22)
Single and not working (main) * January 2021	0.50 (0.52)	0.79~(0.47)	0.14 (0.46)	–0.08 (0.37)

(*Continued*)

Table 1: Continued

	Primary		Secondary	
Single and working at office (main) * January 2021	-–0.21 (0.29)	–0.11 (0.29)	–0.08 (0.35)	0.09 (0.29)
Single and working from home (main) * January 2021	0.19 (0.35)	0.09 (0.34)	0.30 (0.34)	0.25 (0.32)
Ref.: No IT				
Child's own	0.56** (0.21)	0.28 (0.18)	0.74* (0.29)	0.53* (0.24)
Shared	0.51* (0.21)	0.24 (0.17)	0.42 (0.29)	0.33 (0.24)
Not required	–1.72*** (0.24)	–1.35*** (0.21)	–2.10*** (0.29)	–1.46*** (0.25)
Child's own * January 2021	0.20 (0.54)	0.07 (0.46)	–0.35 (0.80)	–0.03 (0.74)
Shared * January 2021	–0.02 (0.55)	–0.12 (0.46)	–0.45 (0.80)	–0.17 (0.74)
Not required * January 2021	0.59 (0.65)	0.97~(0.59)	–0.71 (0.88)	0.02 (0.85)
Female	0.14* (0.06)	0.15** (0.05)	0.31*** (0.06)	0.23*** (0.05)
Child's age	0.14*** (0.01)	0.12*** (0.01)	–0.09*** (0.02)	–0.02 (0.02)
Family size	–0.03 (0.04)	–0.03 (0.04)	–0.08* (0.04)	–0.06~(0.03)
Ref.: Oldest child				
Single child	2.22*** (0.39)	2.04*** (0.38)	–0.51** (0.16)	–0.21 (0.14)
Middle child	–0.00 (0.12)	0.03 (0.11)	–0.04 (0.12)	–0.09 (0.10)
Youngest child	0.12 (0.07)	0.15* (0.07)	–0.07 (0.07)	–0.01 (0.06)
British	0.14 (0.10)	0.07 (0.09)	0.02 (0.10)	0.00 (0.09)
Number of lessons		0.29*** (0.02)		0.33*** (0.02)
Constant	0.45 (0.38)	0.12 (0.36)	3.37*** (0.49)	1.66*** (0.43)
Household level residual (variance)	0.59 (0.07)	0.51 (0.06)	0.53 (0.06)	0.39 (0.06)
Individual level residual (variance)	0.78 (0.07)	0.67 (0.06)	1.07 (0.06)	0.89 (0.05)
ICC	0.43	0.43	0.33	0.30
Observations	2,337	2,337	3,056	3,056

AQ6

Notes: Other control variable: Region
~ $p < .10$ * $p < .05$ ** $p < .01$ *** $p < .001$
Standard errors in parentheses

ICC: intra-class correlation (household residual/(household residual+individual residual))

Then using the Z-test (Clogg et al, 1995), we assessed how the gaps had widened or narrowed between April 2020 and January 2021 compared to the reference group where parents are in the upper class, where parents work from home, and student have their own IT.

AQ7

Figure 1: Hours of schoolwork (primary), April 2020

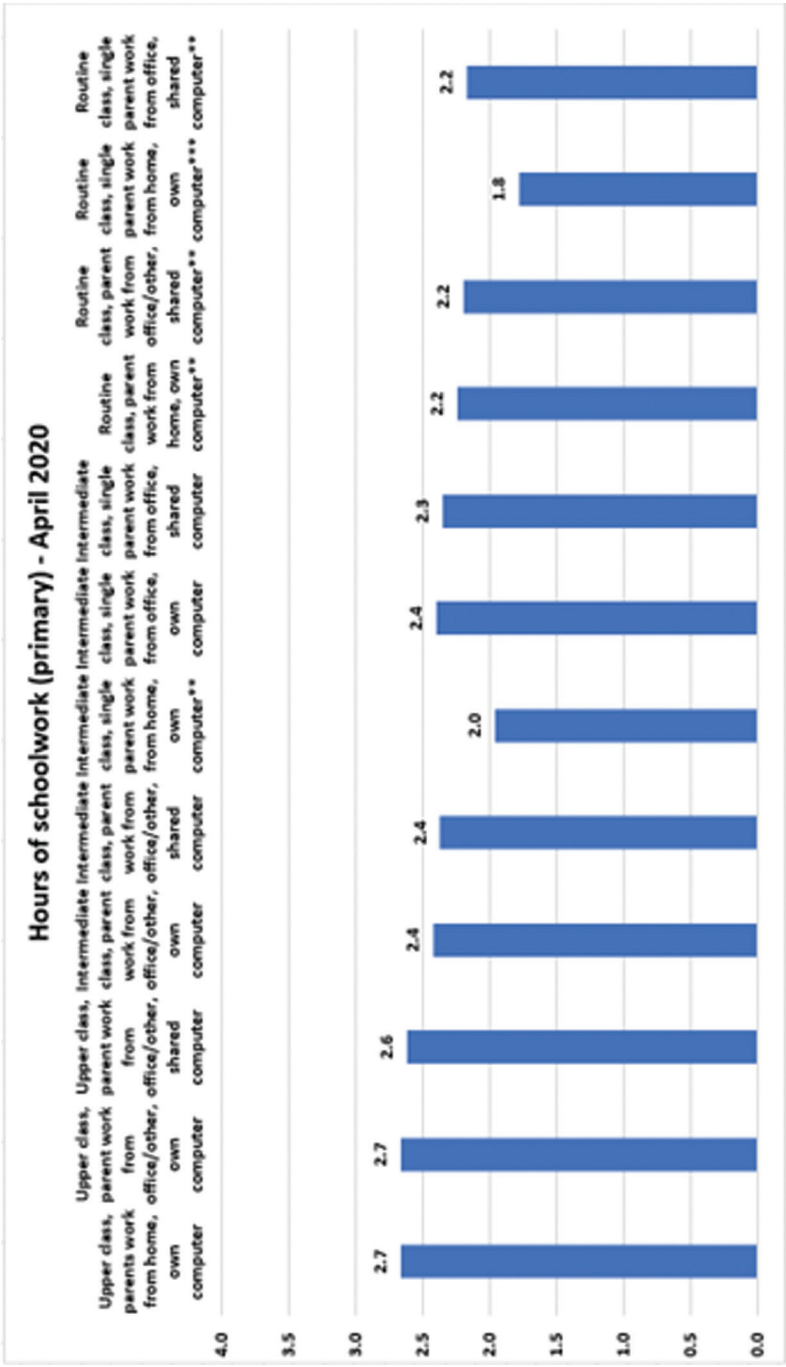
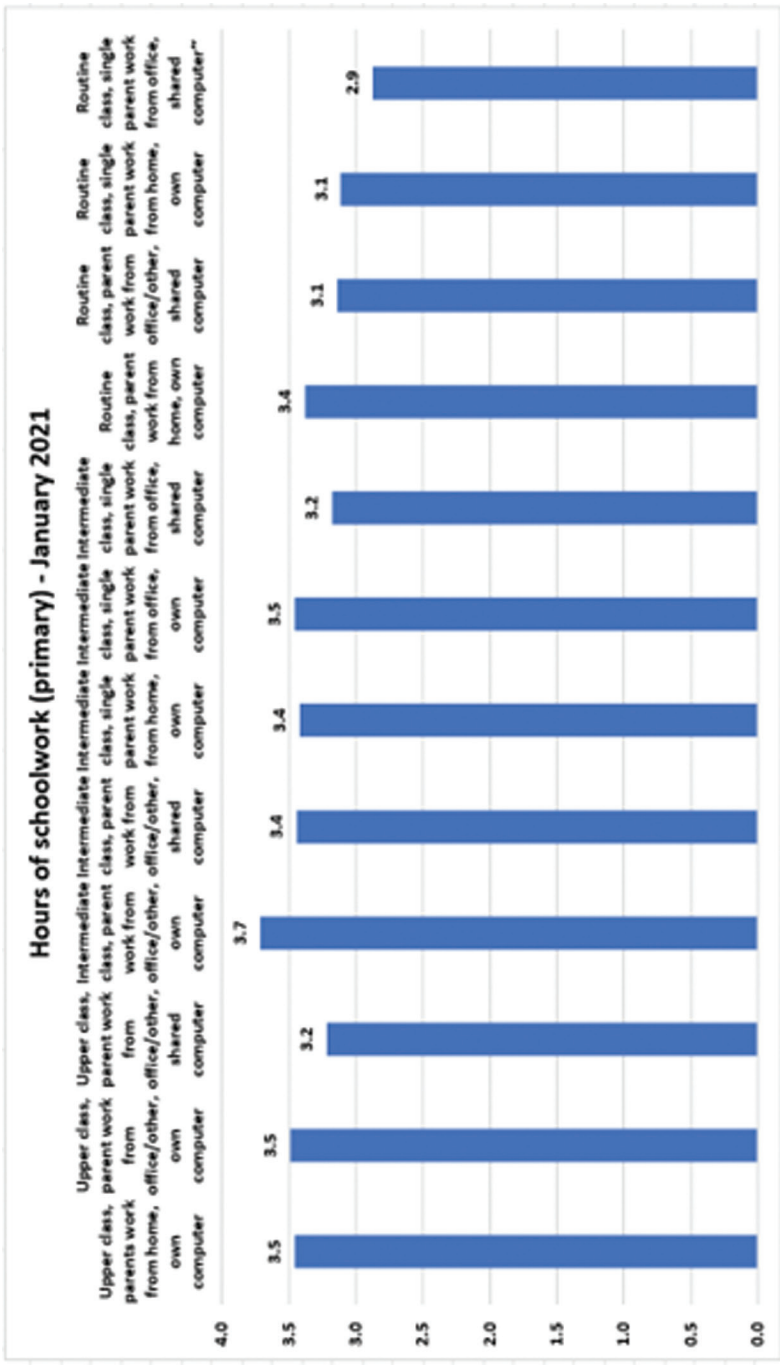


Figure 2: Hours of schoolwork (primary), January 2021

AQ43



AQ8

Figure 3: Hours of schoolwork (secondary), April 2020

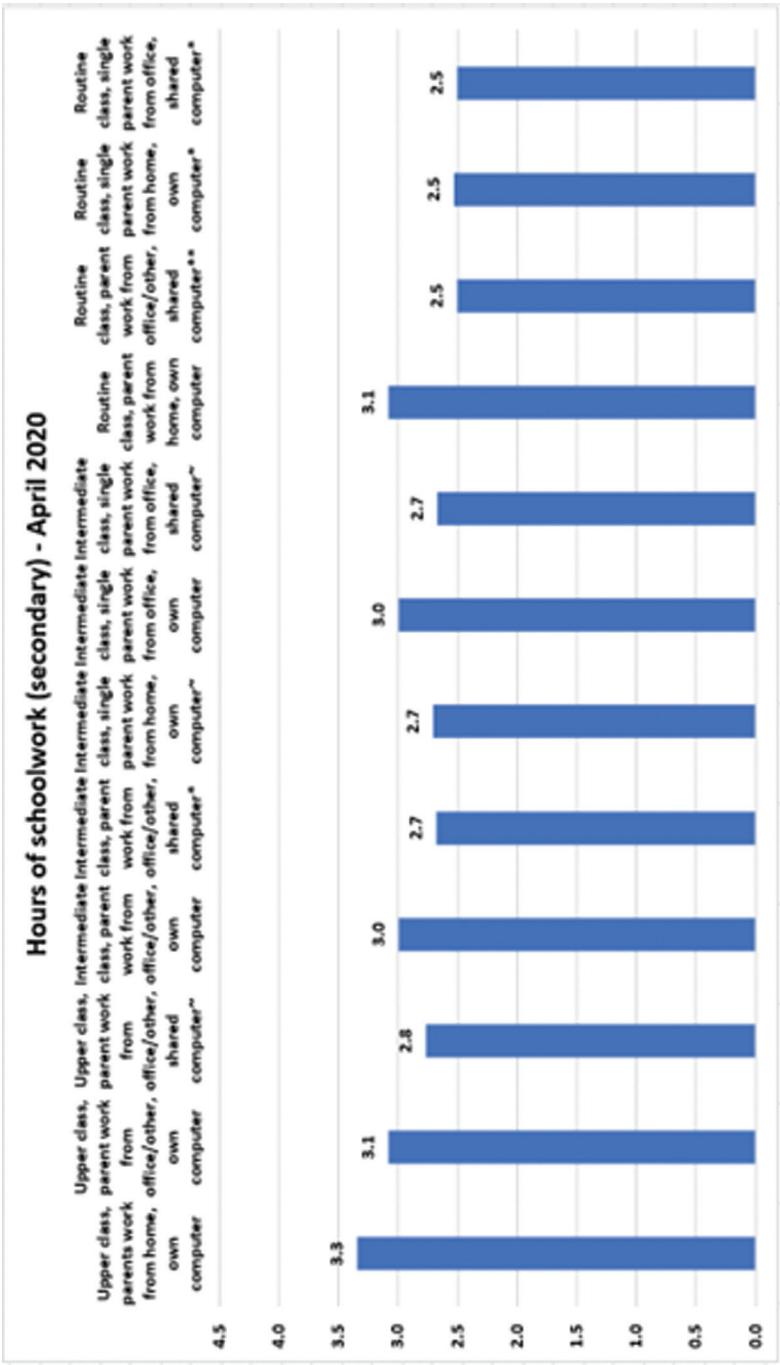


Figure 4: Hours of schoolwork (secondary), January 2021

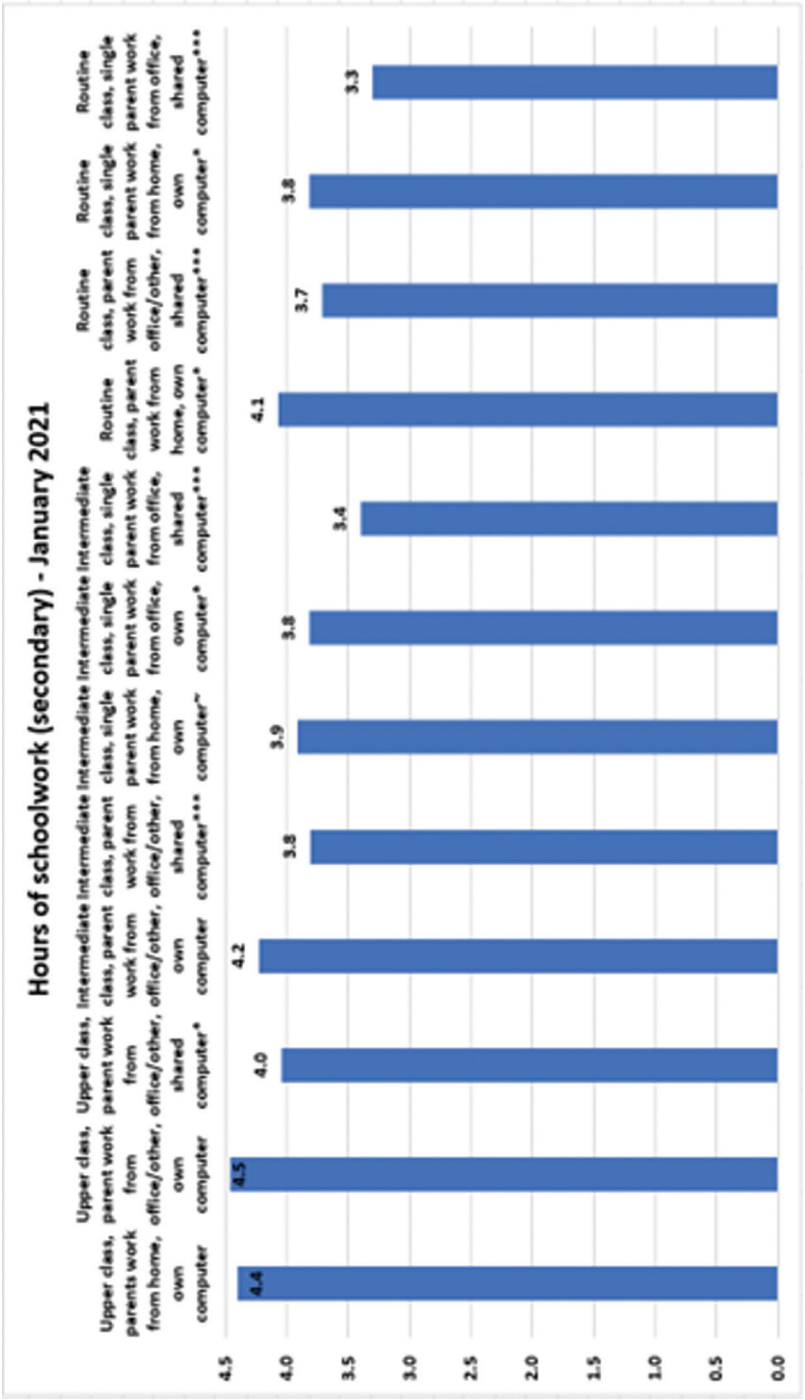


Figure 5: Hours of schoolwork (primary): gaps

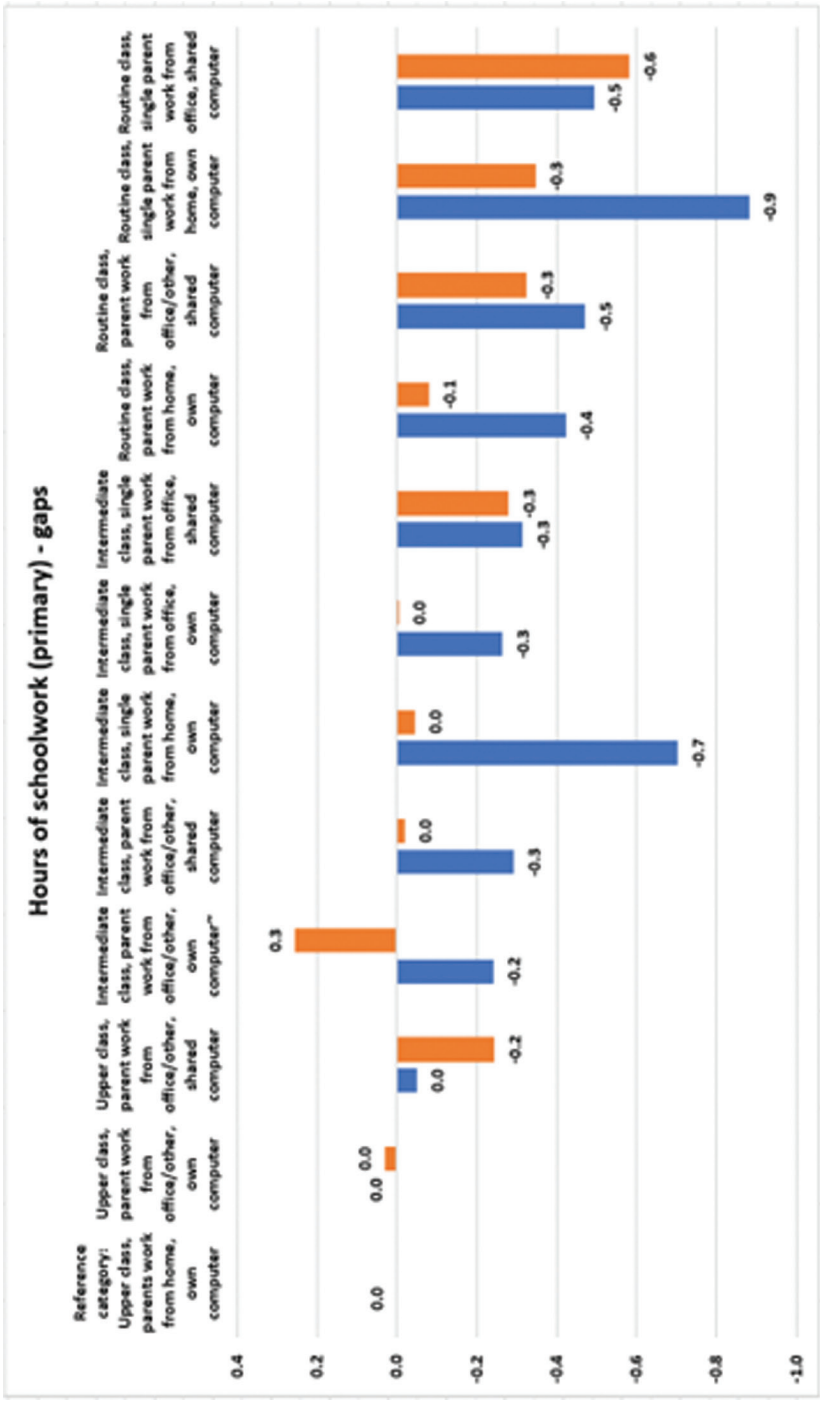
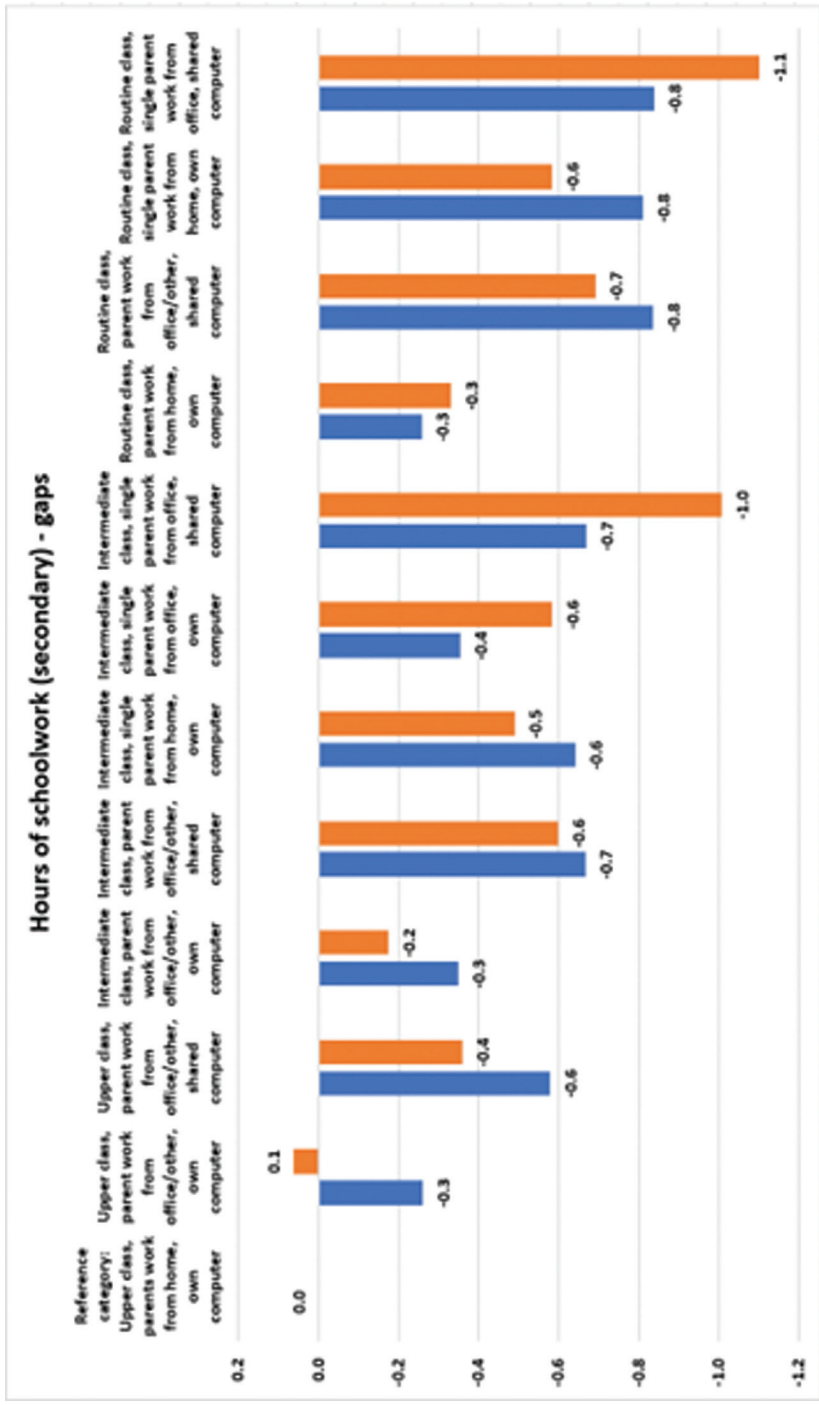


Figure 6: Hours of schoolwork (secondary): gaps



Findings

First, we present descriptive statistics that show the changes in educational provision and take-up from the first wave of USoc COVID-19 survey data in April 2020 to the second wave in January 2021. Second, we present the results from the mixed models to quantify the association between the predictors and our outcome variable, the hours of remote schoolwork. Finally, we look at combined effect of family circumstances using marginal effects.

Descriptive statistics

Students were provided more remote schoolwork in January 2021 than in April 2020. Table 2 shows that this increase is especially pronounced for secondary school students, although levels were already high during the first school-closure period (96% for primary and 86% for secondary). We can conclude from this that almost all students received some form of remote schoolwork from the schools they attended. There was a large increase in total hours provided as UK schools moved from the first to the second school-closure period.

The mean number of hours completed by both primary and secondary school students increased as UK schools moved from the first to the second school-closure period, especially for secondary school students where it went up from 2.6 hours in April 2020 (SD = 1.7) to 4.0 hours in January 2021 (SD = 1.4). In April 2020 primary school students completed on average 2.3 hours of schoolwork (SD = 1.4),

Table 2: Remote schoolwork for primary and secondary school students (USoc Waves 1 and 2)

Provision of remote schoolwork				
Primary	**April 2020**		**January 2021**	
	% (N)		% (N)	
No	4		1	
Yes	96		99	
Total	100 (1,336)		100 (663)	
Secondary	April 2020		January 2021	
	% (N)		% (N)	
No	14		3	
Yes	86		97	
Total	100 (1,622)		100 (1,020)	
Hours of remote schoolwork completed				
Primary	April 2020		January 2021	
	Mean	SD	Mean	SD
	2.3	1.4	3.3	1.4
Total (N)	1,336		663	
Secondary	April 2020		January 2021	
	Mean	SD	Mean	SD
	2.6	1.7	4.0	1.4
Total (N)	1,622		1,020	

which increased to 3.3 hours in January 2021 (SD = 1.4). The spread of average number of hours of schoolwork for secondary school students reduced considerably.

Results of the statistical models

We present results from the mixed models and from the marginal effects computed from those models.[11] We comment on estimates when they are statistically significant or when they identify effects of at least 15 minutes (β = > 0.25).

The intra-class correlation (ICC) coefficients show that the outcomes are clustered at the household level (Table 3). On average the ICCs indicate that 34% of the variance lies at the household level, suggesting that children within the same household have similar outcomes.

The main effect of each socio-economic variable represents the beta coefficient of the effect of that variable in April 2020. The interaction term between each variable and the second wave (dummy variable 'January 2021') represents the extent to which the effect has changed between April 2020 and January 2021. The first row in Table 3 (main effect) shows that students from a working-class background completed fewer hours of schoolwork per day than students from an upper- and intermediate-class background, with the gap being larger for primary pupils. Compared to the children from an upper-class background, the children from a lower-class background completed 25 fewer minutes of schoolwork per day (β = 0.42, 95% CI [0.21, 0.66], $p < .001$, Model 1) in primary schools and 16 fewer minutes per day (β = 0.26, 95% CI [0.04, 0.48], $p < .05$, Model 3) in secondary schools in April 2020. The gap with the intermediate-class students was smaller. In January 2021, the gaps between the working-class background students and the other two groups did not change substantially for secondary students, but in primary schools the disadvantage of working-class background pupils changed relative to the intermediate-class and upper-class background pupils: the gap between upper-class background students and working-class background students reduced from 25 to 5 minutes (β = 0.42 (main effect) −0.34 (interaction term) = 0.8 or 5 minutes) and became non-significant while the one with the intermediate background class students become larger (β = 0.18 (main effect of 'Intermediate class') +0.13 (interaction between 'Intermediate class' and 'January 2021')). Overall, the working-class background students remain the most disadvantaged group.

In Appendix Table A3 we present the results obtained using parental education instead of parental social class. In April 2020, the three-category parental education variable is significantly associated with schoolwork only in secondary schools and coefficients are smaller than those obtained using the three-category parental social class variable. Moving to January 2021 the only change is the increasing gap between the students with parents with GCSEs (as their maximum level of education) and students with parents with A-levels (as their maximum level of education). This suggests that parental social class is a better predictor of schoolwork during the school closures than parental level of education.

Models 2 and 4 (see Table 1) added the total number of lessons offered by the school as predictor. The estimates regarding the social-class background did not change substantially for secondary school children and they even increased for primary school children showing that inequalities in the uptake of schoolwork were not accounted for by differences between schools in the provision of lessons.

Table 3: Parents' social class and working patterns for primary and secondary school students (USoc Waves 1 and 2)

Main parent's social class (NS-SEC, 3 categories)		
Primary	**April 2020**	**January 2021**
	% (N)	% (N)
Upper class	44	50
Intermediate class	31	26
Working class	24	24
Total	100 (1,336)	100 (546)
Secondary	April 2020	January 2021
Upper class	45	48
Intermediate class	30	30
Working class	25	22
Total	100 (1,622)	100 (933)
Parents' working patterns and family type		
Primary	April 2020	January 2021
	% (N)	% (N)
Main parent		
Working at home	54	54
Working at office	33	31
Unemployed	13	15
Total	100 (1,336)	100 (656)
Second parent		
Working at home	49	50
Not working at home	38	38
Absent (single-parent household)	13	12
Total	100 (1,336)	100 (656)
Secondary	April 2020	January 2021
	% (N)	% (N)
Main parent		
Working at home	51	45
Working at office	40	44
Unemployed	9	11
Total	100 (1,622)	100 (1,007)
Second parent		
Working at home	45	41
Not working at home	41	46
Absent (single-parent household)	14	13
Total	100 (1,622)	100 (1,007)

The other two indicators of socio-economic resources also show a positive association with remote schoolwork. Regarding working patterns, the results suggest that during the first school closure it was important for secondary school children to have the main parent at home. Children in families where the main parent worked at the office completed 15 fewer minutes of schoolwork in secondary schools ($\beta = -0.26$, 95% CI [−0.46, −0.06], $p < .01$ in model 3 and $\beta = -0.20$, 95% CI [−0.37, −0.02],

$p < .05$ in model 4) compared to children living with two parents who work from home (reference category), yet this gap disappears in January 2021. Conversely, for primary school children it was important that the main parent worked – possibly proxying that parent's ability to provide support and guidance towards schoolwork. Primary school children are at a disadvantage with respect to reference group when the main parent does not work and the second works from home 25 minutes less, $\beta = -0.40$ in both models 1 (95% CI [−0.95, 0.15], non-significant) and 2 (95% CI [−0.85, 0.05], $p < .10$) although this disadvantage decreases in January 2021.

The group with the biggest disadvantage is children of single parents. Compared to households where both parents work from home (reference category), single parents working from home are associated with 21 minutes fewer in primary schools ($\beta = -0.35$, 95% CI [−0.74, 0.04], $p < .10$, model 2) and 22 minutes fewer of schoolwork completed in secondary schools ($\beta = -0.36$, 95% CI [−0.69, −0.03], $p < .05$, model 4). According to model 3 which does not control for the number of lessons, in secondary schools, children of single parents working from home tend to complete 33 minutes more ($\beta = 0.55$, 95% CI [0.16, 0.94], $p < .01$) of remote schoolwork compared to the reference groups, probably reflecting the relative ease with which this group can attend lessons. Yet this advantage does not translate into more schoolwork completed (model 4). In January 2021, the amount of schoolwork completed by secondary school children of single parents who work from home improved (β ('Single and working from home' ⋆ 'January 2021') = 0.30 (model 3) and 0.25 (model 4), compared to the reference group, while for primary school children it did not change. AQ10

Having your own IT (Table 4) was also associated with more schoolwork completing on average 33 more minutes of schoolwork in primary ($\beta = 0.56$, 95% CI [0.15, 0.97], $p < .01$, model 1) and 44 more minutes per day in secondary ($\beta = 0.74$, 95% CI [0.17, 1.31], $p < .05$, model 3) schools. Sharing IT with other members of the family is better than not having one's own in terms of doing more hours of schoolwork, although the estimates are statistically significant only in model 1. The size of the estimates is reduced once the number of lessons if controlled for, indicating that IT availability is necessary for accessing lessons but not a sufficient condition for students' engagement with schoolwork. There are no significant changes between April 2020 and January 2021 in the amount of extra schoolwork completed by those who have IT or share a computer compared to those who do not have one.

Table 4: IT availability for primary and secondary school students (USoc Waves 1 and 2)

Incidence of children having their own IT		
Primary	**April 2020**	**January 2021**
	Proportion	**Proportion**
Own IT	0.29	0.47
Total (N)	1,366	663
Secondary	April 2020	January 2021
	Proportion	Proportion
Own IT	0.50	0.79
Total (N)	1,622	1,020

The results show social class, IT availability in the home and parental work patterns all have an independent effect on hours of schoolwork, which is larger for secondary school children, which confirms hypothesis 1. A working-class background, living in a single-parent household, in a household where parents work outside the house (secondary school children) or do not work (primary school children), and not having IT are factors associated with completing less schoolwork. Moving to the exploration of how inequalities have changed between the first and the second school closure (hypothesis 3), the results show that the disadvantage of working-class background children remains unchanged. The disadvantage due to working patterns (working at the office or not working) decreases in the second school closure, indicating an improvement in the parents' ability to adapt to the changing working conditions and help their children with remote schoolwork. The finding that single-parent households where the parent works are the group with the biggest disadvantage remains unchanged for younger, primary school children in January 2021, while there is an improvement among children in secondary schools. We now move to the analysis of the schoolwork differentials between specific groups identified by the combination of the three factors to address hypotheses 2 and 3.

Moving to the control variables, on average across the two school-closure periods being female was associated with spending 8 minutes more in primary schools (β = 0.15, 95% CI [0.05, 0.25], $p < .01$, model 2) and 14 minutes (β = 0.23, 95% CI [0.13, 0.33], $p < .001$, model 4) more in secondary schools on schoolwork. A child's age was found to be weakly associated with the volume of schoolwork in primary schools. At the secondary level the relationship was negative and negligible. Family size was a negative predictor of schoolwork, but the estimate sizes are negligible. In primary schools, children with no siblings completed 2 hours more schoolwork (β = 2.04, 95% CI [1.30, 2.78], $p < .001$, model 2) compared to children who were the oldest in family, but in secondary schools they completed 13 minutes less schoolwork (β = −0.21, 95% CI [−0.48, 0.06], non-significant, model 4). We found that British children did not complete any more or any less schoolwork compared to non-British children.

Inequalities by socio-economic group

The results presented so far for parental social class, IT availability and parental working patterns hold the other variables at their averages. To better understand the trends presented above we analysed the schoolwork for specific socio-economic circumstances given by the combination of those three factors (parental social class, IT availability for children and parental work pattern) using marginal effects. Figures 1 and 2 show the findings for primary schools (model 1) and Figures 3 and 4 show the findings for secondary schools (model 3). For full tables with all combinations and standard errors, we refer to the Appendix Table B1.

Figure 1 shows that the combination of living in a single-parent family and social class generates compounding effects on primary school children's schoolwork. Single parents with an intermediate or working background are associated with the lowest amount of schoolwork completed (respectively 2 hours, 95% CI [1.61, 2.39] (intermediate social class) and 1 hour and 50 minutes (1.8 hours, 95% CI [1.21, 2.39], working class)).[12] Upper-class background students in two-parent households – the most advantaged group – completed 2 hours and 40 minutes (2.7 hours, 95% CI

[2.50, 2.90]) of schoolwork, intermediate-class background students in two-parent households completed 2 hours and 24 minutes (2.4 hours, 95% CI [2.20, 2.60]) and working-class background children in two-parent households completed 2 hours and 12 minutes (2.2 hours, 95% CI [2.01, 2.40]) of schoolwork. In secondary schools, gaps are larger and IT availability is more relevant. Having IT is associated with more schoolwork completed and combined with social class creates a cumulative advantage. Working-class children with their own IT complete 36 minutes more of schoolwork compared to when they have to share one (3.1 hours versus 2.5) which is the same amount as their peers with an intermediate-class background. However, both groups completed less schoolwork than upper-class background students with their own IT (almost 3 hours and 20 minutes). The results show that social class combines with living in a two-parent versus single-parent household for primary school children and with IT availability for secondary school children creating compounding inequalities that magnifies the effect of each factor, which confirms hypothesis 2.

To analyse the changes in inequalities across socio-economic groups between April 2020 and January 2021, we first computed the gaps between the top SES group and the other groups, where upward-oriented bars indicate more hours of schoolwork completed and downward-oriented bars fewer hours of schoolwork compared to the top SES group (Figures 5 and 6). Then we looked at how the gaps had widened or narrowed between April 2020 (blue bars) and January 2021 (orange bars) compared to the reference group where parents are in the upper class, where parents work from home, and students have their own IT. In primary schools, children of single parents, as long as they have their own IT, were able to narrow the schoolwork gap with the most advantaged group, although the estimates lack the statistical power to be statistically significant. The result is consistent with the conclusions obtained from the analysis of family structure, already described. It is also consistent with the previous results that the intermediate-class background groups close their gap with the most advantaged group, and those with their own IT become those with the highest hours of schoolwork. Children who are from a working-class background and have their own IT also narrow the gap with the most advantaged group, yet they widen the gap with the intermediate-class groups. In secondary schools the fluctuations in gaps between the two periods were not substantial, nor statistically significant, which lends support for the hypothesis that there is substantial stability in the socio-economic differentials between the two periods among secondary school students (hypothesis 3). Among primary school pupils, with the notable exception of children in single-parent households who have their own IT, which have substantially reduced their gap with the most advantaged group, we also found stability in the socio-economic differentials between the two periods (hypothesis 3).

Conclusions

This research analysed the extent to which inequalities in the uptake of remote schoolwork changed between the first and second COVID-19–induced school-closure periods in the UK. Our research focused on the hours of remote schoolwork completed by students, which is potentially a predictor of educational achievement and can be reliably measured over time. Using representative, longitudinal, rich and high-quality data sets from the USoc COVID-19 surveys conducted in April 2020 and January 2021, we focused on the main socio-economic factors which are thought

to predict the uptake of remote schoolwork during the school closures: social-class background, IT availability in the home and parental working patterns.

In summary, we found substantial differentials in the quantity of remote schoolwork between socio-economic groups. Each of the three factors showed an independent association with the volume of remote schoolwork, and their effect was magnified by their combination. Children in families where the main parent was in an upper-class occupation (large employer, professional or managerial occupation), where both parents worked from home and where the children had their own IT spent more time doing remote schoolwork than other groups, particularly compared to children in families where the main parent was in a working-class occupation, where the child had to share IT with other family members and where the parents did not work regularly from home. We also found that children of single parents who work from home were particularly disadvantaged.

This research provides support to the use of multiple indicators of socio-economic (dis)advantage in studying educational inequalities (Bukodi and Goldthorpe, 2013; Bukodi et al, 2014; Pensiero and Schoon, 2019). In support of this view, we found that each of the three indicators of SES showed an independent association with remote schoolwork. Most studies on COVID-19 and education (Andrew et al, 2020; Bayrakdar and Guveli, 2020; Bol, 2020; Lucas et al, 2020; Dietrich et al, 2021; Grätz and Lipps, 2021) used a single indicator of SES and therefore are likely to underestimate the extent of educational inequalities as they failed to distinguish between distinct types of material and occupational resources and consequently neglected important determinants of remote learning. We also found that the combination of socio-economic resources creates cumulative (dis)advantages as the greatest gaps are found between groups with multiple advantages versus groups with multiple disadvantages. We showed that specific, policy relevant and quantitatively important socio-economic groups represented with the combination of multiple indicators and identified statistically via marginal effects can be effectively used in the analysis of educational inequalities.

Compared to the first school-closure period, the second closure period showed an improved uptake of remote schoolwork in both primary and secondary schools, which increased from 2.3 per day to 3.3 hours in primary schools, and from 2.6 to 4 hours per day in secondary schools. Our results show that in January 2021 the gaps in primary schoolwork between upper-class background students and working-class background students with their own IT were substantially reduced, while the gap between working-class background students and intermediate-class students widened. Children of single parents who worked from home were also able to reduce the gap in primary schoolwork, but overall inequalities between socio-economic groups remained stable between the two closures.

Given the negative consequences generally of losing formal learning (and socialisation) time in school, our research suggests that it is important for schools to remain open if at all possible during any further phases of high infection in order to avoid a further widening of the achievement gap between socio-economic groups and to avoid a negative impact on the mental well-being of children and their parents (which itself is likely to be associated with SES). Based on the results of our research, we suggest that should schools be forced to close again for whatever reason, inequalities in learning can be remediated by increasing the targeted provision of lessons, providing students with better access to IT, providing targeted parents with

better guidance to online resources and by providing academic tutors to compensate for the absence of parents who cannot work from home. Importantly, our research has identified those groups that are least likely to access remote schoolwork during school-closure periods and are more likely to suffer the largest learning loss.

When providing schoolwork remotely during any future school closures, and in remediating the effects of past closures, schools should consider providing specific guidance and tutoring targeted at children who do not have IT, at children of single parents and at children of parents in working-class occupations who cannot work from home. In terms of school closures and government policy, schools are in a better position than central government to identify those students and families most in need of remediation, and should be provided with the necessary funding and flexibility to adapt their provision to suit the circumstances of the school itself and to suit those students identified by our research as being most at risk.

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Notes

[1] We use 'attainment' to refer to cognitive outcomes in education such as examination results; we use 'achievement' to refer to broader educational outcomes, including attainment.

[2] Parental education is also a good proxy for the ability to provide academic support for children. We tested this in a robustness analysis presented in Appendix A and comment in the results section on whether the use of parental education instead of parental social class would make a difference to the model. We show that social class is a better predictor of schoolwork uptake than parental education.

[3] Research showed that the between April and July 2020 the learning time remained stable (Cattan et al, 2021) showing that the month during in which the data collection took place is unlikely to affect the representativeness of the results. AQ11

[4] . AQ12

[5] 5.8 hours per day compared to 4.5 hours per day. AQ13

[6] Indeed the relationship between the social class and the working pattern of the main parent is nor perfect as 65% of the upper-class parents were working from home against the 47% and 35% of respectively the intermediate- and working-class parents (results available on request).

[7] This interaction accounts for all possible combinations between family type and working patterns. It is therefore not necessary to include the main effects of either variable as a covariate in the models (Landsheer et al, 2006). The second parent's working patterns are only relevant in the case of a two-parent household. For single-parent families the second parent' variable works as a placeholder value and it is coherently coded as 'absent'.

[8] Information was only available on siblings aged 18 and younger.

[9] The sample size prevents us from distinguishing between non-British minorities.

[10] A complementary goal is to test whether the effect of each variable varies across the level of the other variables. This could be tested using interaction terms, which in our case would be a four-way interaction – parental social class × parents' working patterns × IT availability × wave, which is not feasible given the sample size.

[11] We present the models for the *complete* sample including those students who were not offered *any* work by their schools. Although this was only a very small percentage of children, we wanted to check if this group influenced our estimates. Appendix Table A3 shows the results obtained by focusing *only* on children who were offered *some* schoolwork. We found that the results were comparable.

[12] Single-parent, upper-class households are not different than two-parent, upper-class households in the terms of schoolwork completed (Appendix B).

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Ethics

The project was carried out at the University of Southampton, which provided ethics approval, through the Ethics Committee at the Faculty of Social Sciences. The process of gaining approval involves a formal submission and review of potential ethical issues, following peer-review within the School of Education. The USoc data used are anonymised and, like all Understanding Society studies, received ethics approval from the University of Essex Ethics Committee. Data are stored on password-protected laptops. The proposed research complies with the ESRC Framework for Research Ethics, and the University of Southampton's Research Governance policy and procedure.

Declaration of conflicting interests

The author declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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Appendix

A. Additional regression models

Table A1: Interval regression models for primary and secondary students

	Hours of schoolwork	
	Primary	**Secondary**
NS-SEC (3 categories) Ref.: working class		
Upper class	0.42*** (0.11)	0.26* (0.11)
Intermediate class	0.18 (0.12)	0.17 (0.12)
January 2021	0.93~(0.56)	1.35 (0.89)
Upper class * January 2021	–0.33 (0.21)	0.14 (0.18)
Intermediate class * January 2021	0.14 (0.24)	–0.05 (0.20)
Ref.: Working from home (main) * Working from home (second)		
Single and not working (main)	–0.11 (0.40)	–0.48 (0.41)
Not working (main), Working from home (second)	–0.41 (0.28)	0.23 (0.44)
Not working (main), Other (second)	–0.07 (0.20)	–0.05 (0.18)
Single and working at office (main)	–0.03 (0.27)	–0.29 (0.23)
Working at office (main), Working from home (second)	–0.14 (0.16)	–0.13 (0.16)
Working at office (main), Other (second)	–0.01 (0.12)	–0.27** (0.10)
Single and working from home (main)	–0.46* (0.21)	–0.55** (0.20)
Working from home (main), Other (second)	–0.13 (0.15)	–0.35* (0.18)
Single and not working (main) * January 2021	0.67 (0.58)	0.13 (0.51)
Not working (main), Working from home (second) * January 2021	0.33 (0.30)	–0.09 (0.43)
Not working (main), Other (second) * January 2021	0.00 (0.31)	0.17 (0.25)
Single and working at office (main) * January 2021	–0.22 (0.29)	–0.10 (0.37)
Working at office (main), Working from home (second) * January 2021	0.26 (0.28)	0.58* (0.30)
Working at office (main), Other (second) * January 2021	0.05 (0.22)	0.37* (0.17)
Single and working from home (main) * January 2021	0.20 (0.37)	0.29 (0.39)
Working from home (main), Other (second) * January 2021	0.46 (0.30)	0.72* (0.30)
Ref.: No IT		
Child's own IT	0.55** (0.21)	0.76* (0.30)
Shared IT	0.50* (0.21)	0.42 (0.30)
Not required	–1.68*** (0.24)	–2.03*** (0.30)
Child's own IT * January 2021	0.23 (0.54)	–0.25 (0.87)
Shared IT * January 2021	–0.02 (0.55)	–0.45 (0.87)
Not required * January 2021	0.53 (0.65)	–0.80 (0.94)
Female	0.15* (0.06)	0.34*** (0.06)
Child's age	0.14*** (0.02)	–0.09*** (0.02)
Family size	–0.03 (0.04)	–0.09* (0.05)

(*Continued*)

Table A1: Continued

	Hours of schoolwork	
	Primary	**Secondary**
British	0.15 (0.11)	0.03 (0.11)
Ref.: Oldest child		
Single child	2.20*** (0.41)	–0.54** (0.17)
Middle child	–0.00 (0.13)	–0.07 (0.14)
Youngest child	0.12 (0.08)	–0.08 (0.08)
Constant	0.40 (0.39)	3.42*** (0.53)
Household level residual (variance)	0.62 (0.07)	0.71 (0.08)
Individual level residual (variance)	0.73 (0.07)	1.18 (0.08)
ICC	0.46	0.38
Observations	2,337	3,056

AQ39

*Notes:*Other control variable: Region
~ $p < .10$ * $p < .05$ ** $p < .01$ *** $p < .001$
ICC: intra-class correlation (household residual/(household residual+individual residual))

Table A2: All models for subsample of children offered some schoolwork

AQ40

	Primary		Secondary	
	Hours of schoolwork. Model 1	**Hours of schoolwork. Model 2**	**Hours of schoolwork. Model 3**	**Hours of schoolwork. Model 4**
NS-SEC (3 categories) Ref.: Working class				
Upper class	0.46*** (0.12)	0.50*** (0.11)	0.27* (0.12)	0.22* (0.11)
Intermediate class	0.19 (0.12)	0.26* (0.12)	0.18 (0.13)	0.16 (0.12)
January 2021	0.96~(0.56)	0.69 (0.47)	1.32 (0.83)	0.43 (0.77)
Service * January 2021	–0.40~(0.20)	–0.44** (0.17)	0.05 (0.16)	0.21 (0.15)
Intermediate * January 2021	0.09 (0.24)	0.04 (0.21)	–0.11 (0.18)	0.04 (0.16)
Ref.: Working from home (main) * Working from home (main)				
Not working (main), Working from home (second)	–0.03 (0.39)	–0.13 (0.38)	–0.50 (0.43)	–0.20 (0.39)
Not working (main), Other (second)	–0.41 (0.28)	–0.42~(0.23)	0.21 (0.42)	0.19 (0.36)
Single and working at office (main)	–0.07 (0.20)	0.15 (0.20)	–0.17 (0.19)	–0.17 (0.18)
Working at office (main), Working from home (second)	–0.06 (0.29)	–0.02 (0.29)	–0.32 (0.24)	–0.31~(0.18)
Working at office (main), Other (second)	–0.14 (0.17)	–0.12 (0.16)	–0.13 (0.16)	–0.07 (0.16)
Single and working from home (main)	0.01 (0.12)	0.06 (0.11)	–0.29** (0.11)	–0.21* (0.10)

(*Continued*)

Table A2: Continued

	Primary		Secondary	
	Hours of schoolwork. Model 1	**Hours of schoolwork. Model 2**	**Hours of schoolwork. Model 3**	**Hours of schoolwork. Model 4**
Working from home (main), Other (second)	–0.53* (0.22)	–0.42* (0.20)	–0.60* (0.23)	–0.38~(0.20)
Single and not working (main) * January 2021	–0.10 (0.16)	–0.06 (0.14)	–0.25 (0.18)	–0.21 (0.17)
Not working (main), Working from home (second) * January 2021	0.44 (0.52)	0.72 (0.46)	0.23 (0.58)	–0.00 (0.44)
Not working (main), Other (second) * January 2021	0.34 (0.29)	0.24 (0.28)	–0.08 (0.39)	0.08 (0.40)
Single and working at office (main) * January 2021	0.03 (0.31)	–0.14 (0.31)	0.27 (0.23)	0.34~(0.20)
Working at office (main), Working from home (second) * January 2021	–0.19 (0.29)	–0.09 (0.29)	–0.03 (0.36)	0.15 (0.30)
Working at office (main), Other (second) * January 2021	0.29 (0.28)	0.47 (0.30)	0.45~(0.23)	0.09 (0.21)
Single and working from home (main) * January 2021	–0.01 (0.22)	–0.07 (0.19)	0.33* (0.15)	0.24~(0.14)
Working from home (main), Other (second) * January 2021	0.25 (0.35)	0.15 (0.33)	0.34 (0.37)	0.27 (0.34)
Not working (main), Working from home (second)	0.44 (0.28)	0.41~(0.25)	0.59* (0.25)	0.44* (0.22)
Ref.: No IT				
Child's own IT	0.55** (0.21)	0.28 (0.17)	0.73* (0.29)	0.52* (0.24)
Shared IT	0.50* (0.20)	0.23 (0.16)	0.42 (0.29)	0.32 (0.24)
Child's own IT * January 2021	0.22 (0.54)	0.09 (0.46)	–0.33 (0.81)	–0.02 (0.75)
Shared IT * January 2021	–0.01 (0.55)	–0.11 (0.46)	–0.44 (0.81)	–0.16 (0.75)
Female	0.15* (0.06)	0.16** (0.05)	0.37*** (0.06)	0.27*** (0.05)
Child's age	0.15*** (0.02)	0.12*** (0.01)	–0.09*** (0.02)	–0.02 (0.02)
Family size	–0.04 (0.04)	–0.03 (0.04)	–0.09* (0.04)	–0.06 (0.04)
British	0.16 (0.11)	0.09 (0.10)	0.02 (0.10)	0.02 (0.09)
Ref.: Oldest child				
Single child	2.24*** (0.39)	2.07*** (0.38)	–0.68*** (0.20)	–0.30~(0.18)
Middle child	–0.00 (0.13)	0.03 (0.11)	–0.03 (0.13)	–0.09 (0.10)
Youngest child	0.12 (0.08)	0.15* (0.07)	–0.08 (0.08)	–0.03 (0.07)
Number of lessons		0.29*** (0.02)		0.33*** (0.02)

(*Continued*)

Table A2: Continued

	Primary		Secondary	
	Hours of schoolwork. Model 1	**Hours of schoolwork. Model 2**	**Hours of schoolwork. Model 3**	**Hours of schoolwork. Model 4**
Constant	0.41 (0.39)	0.06 (0.36)	3.35*** (0.51)	1.65*** (0.44)
Household level residual (variance)	0.62 (0.07)	0.54 (0.07)	0.60 (0.07)	0.44 (0.06)
Individual level residual (variance)	0.78 (0.07)	0.67 (0.07)	1.11 (0.07)	0.93 (0.06)
ICC	0.44	0.45	0.35	0.32
Observations	2,270	2,270	2,819	2,819

Notes: Other control variable: Region
~ $p < .10$ * $p < .05$ ** $p < .01$ *** $p < .001$
Standard errors in parentheses
ICC: intra-class correlation (household residual/(household residual+individual residual))

Table A3: Models with parental education

	Hours of schoolwork	
	Primary	**Secondary**
Parents' education (Ref.: GCSE)		
A-level	–0.08 (0.14)	0.21~(0.12)
Degree	0.11 (0.11)	0.35*** (0.10)
January 2021	0.52 (0.52)	1.35~(0.82)
A-level * January 2021	0.82** (0.26)	0.13 (0.19)
Degree * January 2021	0.17 (0.19)	–0.01 (0.15)
Ref.: Working from home (main) * Working from home (second)		
Single and not working (main)	–0.16 (0.39)	–0.46 (0.39)
Not working (main), Working from home (second)	–0.33 (0.28)	0.24 (0.40)
Not working (main), Other (second)	–0.18 (0.21)	–0.05 (0.18)
Single and working at office (main)	–0.16 (0.28)	–0.29 (0.22)
Working at office (main), Working from home (second)	–0.25 (0.16)	–0.12 (0.15)
Working at office (main), Other (second)	–0.08 (0.11)	–0.21* (0.10)
Single and working from home (main)	–0.48* (0.21)	–0.56** (0.20)
Working from home (main), Other (second)	–0.16 (0.15)	–0.26 (0.17)
Single and not working (main) * January 2021	0.53 (0.54)	0.12 (0.46)
Not working (main), Working from home (second) * January 2021	0.11 (0.31)	–0.16 (0.38)
Not working (main), Other (second) * January 2021	0.20 (0.31)	0.07 (0.22)
Single and working at office (main) * January 2021	–0.05 (0.33)	–0.14 (0.35)
Working at office (main), Working from home (second) * January 2021	0.40 (0.26)	0.40~(0.22)
Working at office (main), Other (second) * January 2021	0.07 (0.20)	0.21 (0.14)

(*Continued*)

Table A3. Continued

	Hours of schoolwork	
	Primary	**Secondary**
Single and working from home (main) * January 2021	0.15 (0.34)	0.27 (0.34)
Working from home (main), Other (second) * January 2021	0.51~(0.29)	0.54* (0.23)
IT availability (Ref.: no IT)		
Child's own	0.47* (0.22)	0.73** (0.28)
Shared	0.45* (0.21)	0.43 (0.28)
Not required	–1.74*** (0.23)	–2.10*** (0.28)
Child's own * January 2021	0.22 (0.52)	–0.33 (0.81)
Shared * January 2021	–0.03 (0.52)	–0.45 (0.81)
Not required * January 2021	0.45 (0.59)	–0.68 (0.89)
Female	0.14* (0.06)	0.33*** (0.06)
Child's age	0.14*** (0.01)	–0.08*** (0.02)
Family size	–0.03 (0.04)	–0.09* (0.04)
British	0.16 (0.10)	0.04 (0.10)
Ref.: oldest child		
Single child	2.25*** (0.38)	–0.48** (0.16)
Middle child	–0.01 (0.12)	–0.06 (0.12)
Youngest child	0.11 (0.08)	–0.05 (0.07)
Constant	0.79* (0.39)	3.29*** (0.48)
Household level residual (variance)	0.61 (0.07)	0.53 (0.06)
Individual level residual (variance)	0.77 (0.07)	1.06 (0.06)
ICC	0.44	0.33
Observations	2,325	3,033

Notes: Other control variable: Region
Standard errors in parentheses
~ $p < .10$, ** $p < .01$, * $p < .05$
ICC: intra-class correlation (household residual/(household residual+individual residual))

B. Marginal effects

Table B1: Marginal effects for hours of schoolwork from Table 3 (models 1 and 3)

	April 2020		January 2021	
	Primary		Primary	
	Hours of schoolwork		Hours of schoolwork	
	Mean	SE	Mean	SE
Upper class, parents work from home, own IT	2.7	0.1	3.5	0.1
Upper class, single parent work from home, own IT	2.2	0.2	3.2	0.3
Intermediate class, parent work from home, own IT	2.4	0.1	3.7	0.2
Intermediate class, single parent work from home, own IT	2.0	0.2	3.4	0.3
Working class, parent work from home, own IT	2.2	0.1	3.4	0.2
Working class, single parent work from home, own IT	1.8	0.2	3.1	0.4
Upper class, parent work from office/other, own IT	2.7	0.1	3.5	0.2
Upper class, single parent work from office, own IT	2.6	0.3	3.2	0.3
Intermediate class, parent work from office/other, own IT	2.4	0.1	3.7	0.2
Intermediate class, single parent work from office, own IT	2.4	0.3	3.5	0.3
Working class, parent work from office/other, own IT	2.2	0.1	3.4	0.2
Working class, single parent work from office, own IT	2.2	0.3	3.2	0.3
Upper class, parent work from office/other, shared IT	2.6	0.1	3.2	0.2
Upper class, single parent work from office, shared IT	2.6	0.3	3.0	0.3
Intermediate class, parent work from office/other, shared IT	2.4	0.1	3.4	0.2
Intermediate class, single parent work from office, shared IT	2.4	0.3	3.2	0.3
Working class, parent work from office/other, shared IT	2.2	0.1	3.1	0.2
Working class, single parent work from office, shared IT	2.2	0.3	2.9	0.3
Upper class, parent work from office/other, no IT	2.1	0.2	2.7	0.5
Upper class, single parent work from office, no IT	2.1	0.3	2.5	0.6
Intermediate class, parent work from office/other, no IT	1.9	0.2	3.0	0.5

(*Continued*)

Table B1: Continued

	April 2020		January 2021	
	Primary		Primary	
	Hours of schoolwork		Hours of schoolwork	
Intermediate class, single parent work from office, no IT	1.8	0.3	2.7	0.6
Working class, parent work from office/other, no IT	1.7	0.2	2.7	0.5
Working class, single parent work from office, no IT	1.7	0.3	2.4	0.6
	April 2020		January 2021	
	Secondary		Secondary	
	Hours of schoolwork		Hours of schoolwork	
	Mean	SE	Mean	SE
Upper class, parents work from home, own IT	3.3	0.1	4.4	0.1
Upper class, single parent work from home, own IT	2.8	0.2	4.2	0.3
Intermediate class, parent work from home, own IT	3.3	0.1	4.2	0.1
Intermediate class, single parent work from home, own IT	2.7	0.2	3.9	0.3
Working class, parent work from home, own IT	3.1	0.1	4.1	0.1
Working class, single parent work from home, own IT	2.5	0.2	3.8	0.3
Upper class, parent work from office/other, own IT	3.1	0.1	4.5	0.1
Upper class, single parent work from office, own IT	3.1	0.2	4.1	0.3
Intermediate class, parent work from office/other, own IT	3.0	0.1	4.2	0.1
Intermediate class, single parent work from office, own IT	3.0	0.2	3.8	0.3
Working class, parent work from office/other, own IT	2.8	0.1	4.1	0.1
Working class, single parent work from office, own IT	2.8	0.2	3.7	0.3
Upper class, parent work from office/other, shared IT	2.8	0.1	4.0	0.1
Upper class, single parent work from office, shared IT	2.8	0.2	3.6	0.3
Intermediate class, parent work from office/other, shared IT	2.7	0.1	3.8	0.1
Intermediate class, single parent work from office, shared IT	2.7	0.2	3.4	0.3

(*Continued*)

Table B1: Continued

	April 2020		January 2021	
	Primary		Primary	
	Hours of schoolwork		Hours of schoolwork	
Working class, parent work from office/other, shared IT	2.5	0.1	3.7	0.2
Working class, single parent work from office, shared IT	2.5	0.2	3.3	0.3
Upper class, parent work from office/other, no IT	2.3	0.3	4.1	0.8
Upper class, single parent work from office, no IT	2.3	0.3	3.7	0.8
Intermediate class, parent work from office/other, no IT	2.3	0.3	3.8	0.8
Intermediate class, single parent work from office, no IT	2.3	0.3	3.4	0.8
Working class, parent work from office/other, no IT	2.1	0.3	3.7	0.8
Working class, single parent work from office, no IT	2.1	0.3	3.3	0.8

AUTHOR QUERIES

Author: Please Answer all Queries

AQ1. I've inserted this to make the title read well and grammatically, but by the opening of your abstract and of the article itself, it appears this was simply an inadvertent omission. OK?.

AQ2. The following reference is not included in the reference list: "Author 2020". Please include the reference in the list with full publication detail.

AQ3. There is no note 4 – we jump from 3 to 5. Please supply the missing text. However, if note 4 has been deleted, please correct the numbering of the notes.

AQ4. Is this 2021a or 2021b, please?.

AQ5. Is this 2021a or 2021b, please?.

AQ6. Attaching a minus sign to zero looks odd. Remove? It occurs four times (I've flagged the other three too, for your convenience), whereas 0.00 on i**TS** own appears also four times.

AQ7. I've taken the captions from the images of the figures themselves. Please check these are OK.

AQ8. I've taken the captions from the images of the figures themselves. Please check these are OK.

AQ9. This is the correct table as now renumbered, but this mention of the 'first row' doesn't appear to apply to any of them. Should it be a reference to an appendix table?.

AQ10. Uneven brackets: there is either a missing closing one, or an incorrect opening one. Please fix.

AQ11. Is this 2021a or 2021b, please?.

AQ12. Details missing.

AQ13. Text for note 4 missing – please supply, or delete the note marker and renumber the remaining notes here and where the markers appear in the text.

AQ14. This has not been cited in the text. Add the citation or delete ref?.

AQ15. This has not been cited in the text. Add the citation or delete ref?.

AQ16. This has not been cited in the text. Add the citation or delete ref?.

AQ17. This has not been cited in the text. Add the citation or delete ref?.

AQ18. This link goes to a 2022 news story. Please check – I've tried Wayback Machine and there are many hits, predating and postdating 29 May 2020, but I can't land on the one with this title. If you can't get back to the original story, say here 'formerly available at:'.

AQ19. This has not been cited in the text. Add the citation or delete ref?.

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AQ22. Only 'Cattan 2021' has been cited in the text. Please correct to 2021a or 2021b in each instance.

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AQ37. This has not been cited in the text. Add the citation or delete ref?.

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AQ39. Attaching a minus sign to zero looks odd. Remove?.

AQ40. Table A2 citation missing.

AQ41. Attaching a minus sign to zero looks odd. Remove?.

AQ42. Attaching a minus sign to zero looks odd. Remove?.

AQ43. In this article, all the supplied figures look low in resolution. Please provide high-quality images to replace.