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【要旨】

新型コロナパンデミックは、日本を含めた世界中で、学校を閉鎖に追い込んだ。 オンライン学習へのアクセスの不平等に関する既存研究は多いが、オンラインでの学校教育と学校外教育へのアクセスを同時に分析した研究は多くない。そして、需要側である子どもの親による学校教育のオンライン化の要望を分析した研究は存在しない。本研究では、2020年5月と12月に収集されたパネルデータを用い、子供の学校と学校外でのオンライン学習の経験について分析した。私立学校に通う子供、所得の高い家庭の子供ほど、学校が提供するオンライン学習をより多く経験し、所得の高い家庭の子供、高学歴の親をもつ子供ほど、学校外でのオンライン学習を経験している。また、5月から12月にかけて新型コロナ陽性患者が相対的に増加した地域では、私立学校の子供と親の学歴が高い子供において、相対的に、学校外教育でオンライン学習を経験する確率が増加したが、そのような傾向は、学校でのオンライン学習では見られなかった。また、所得の高い家庭、学歴が高い親ほど、学校教育のオンライン化を要望する傾向が確認されたが、母親が正規労働者であったり父親が非正規労働者であった場合には、短期的には、学校教育のオンライン化を要望しない傾向を確認した。

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謝辞：本研究で利用した「新型コロナウイルス感染症の影響下における生活意識・行動の変化に関する調査」データを提供してくださった内閣府に感謝します。また、慶應義塾大学での大学院労働経済論演習の参加者、太田聰一教授、そして「財政拡大を含む緊急経済対策の中長期的帰結とポストコロナ時代の経済政策」研究会の参加者から多くのコメントをいただいたことに感謝します。この研究の実施に際しては、日本学術振興会科研費16H06323および慶應義塾学事振興資金から助成を受けました。

Access to and Demand for Online School Education during the COVID-19 Pandemic in Japan[†]

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Abstract

The COVID-19 pandemic has forced schools around the world to close, and Japanese schools were no exception. While many previous studies have identified an inequality in the access to online school education based on family background, few studies have simultaneously examined the access to online education both at school and outside school, and no study has examined parents' views about online school education, an important demand side factor. Using a panel dataset collected in May and December 2020, we examine the determinants of at-school and outside-school online experience. We observe that children in private schools and those from high-income households received more online education at school, and children from high-income households and those with a highly educated parent experienced more online education outside school. Further, we find that a greater increase of COVID-19 between May and December was associated with increased access to online education outside the school, especially for children in private schools and those with a highly educated parent, while we do not observe this trend in at-school online education. We also find that household income and parent's high educational level are also associated with higher demand for at-school online education, while mothers being employed in regular contracts and fathers in non-regular contracts decreased this demand in the short term.

Keywords: Online education; COVID-19; Family background; Parental work; Japan

JEL Classification: I24, I28, J81

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1. Introduction

With the outbreak of the COVID-19 pandemic, schools worldwide were forced to close leaving out 800 million school-aged children from receiving education as of early 2021 (UNESCO 2021). As the impact of COVID-19 persists and prolongs school closures, the educational opportunity divide between children with and without access to some form of online education becomes apparent. Japan, where school education has been provided with relatively high equity regardless of family background (OECD 2012), is not an exception. With the first wave of COVID-19, Japanese schools nationwide were ordered to close and children were deprived of face-to-face education. Only 5% of Japanese children had access to interactive online education during the period of school closure.[1]

Before the pandemic, Japan ranked the lowest in computer usage for schoolwork outside school in the developed world (OECD 2020a). One of the explanations of low prevalence of online learning is that Japanese parents prefer face-to-face instruction as teachers can pay more attention to each child given a relatively large class size. Traditional teaching style that emphasizes understanding of basic skills and group-oriented socialization has also been highly valued in the Japanese society (OECD 2012). However, forced introduction of online educational practices may permanently change parental attitudes towards online learning both at and outside school while maintaining the equity of access to high quality education. Despite its importance, not much research has been conducted on Japanese children's access to and experience of online education and related parental views during the COVID-19 crisis, especially by family socioeconomic status and type of school attended (public or private) based on a representative sample. The impact of the COVID-19 contagion on online education in Japan remains understudied.

To fill this gap, we aim to document both children's actual experience of online education at school and outside school and parental preferences towards online education during the COVID-19 pandemic, and to report how they were associated with family backgrounds. We use governmental survey data collected at two points during the pandemic from the same households—in May 2020, immediately after the first wave of the pandemic and the end of the associated school closures, and then half a year later, in December 2020, in the middle of the third wave. This data allowed us to examine both the rapid response and the long-term changes in the online educational experience brought about by the pandemic.

First, we analyze and document the online educational experience of children in elementary, junior high and high schools, both at school and outside school, based on the type of school attended, household income and parent's educational level. Second, we use the difference-in-difference and triple difference estimation methods to further highlight the potential inequality in access to online education by aforementioned family backgrounds triggered by increase in COVID-19 cases. Third, we examine the parental preferences towards at-school online education, how they are shaped by the experience of online education and factors such as household income, parental education and parents' employment status and change in work styles during the pandemic, using probit and ordered logit models. For both analyses, the longitudinal nature of our dataset allows us to investigate changes in online educational access and parental attitudes during the pandemic.

The contribution of this study is two-fold. First, to the best of our knowledge, this is the first study to examine the impact of the COVID-19 pandemic on online educational practices in Japan as experienced by children at school and also outside school. It is important to include both at-school and outside-school learning experiences to understand the true impact of this pandemic, especially in a country like Japan where outside school educational options are abundant and highly influence children's academic performance and equity in education. Ignoring potential heterogeneity in access to online education outside school may lead to an underestimation of the extent of inequality in online

[1] "Survey of Study and Instruction (Gakushu Shidou Torikumi Chousa)" conducted on all boards of education, which operate public schools, by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) on April 16, 2020.

learning opportunity among children. Second, adopting a broader perspective than previous studies, using data from a nationally representative survey we simultaneously analyze both children's actual experience and parental preferences towards online education, and how they differed based on socioeconomic backgrounds. Parental preferences can potentially influence children's access to online learning through parents' support of the child and purchases of appropriate Internet-connected devices. Looking at the determinants of parental preferences can help policy makers identify the key factors needed for creating the home environment necessary for children's equitable access to online learning. These two contributions make our study unique while providing the first evidence on online educational access during the COVID-19 pandemic in Japan.

Our main findings are that greater spread of COVID-19 is associated with increased access to online education outside school, especially for children in private schools and those with highly educated parents, while we do not observe this trend in at-school online education. Therefore, ignoring the socioeconomic differences in the access to online education outside school would lead to a substantial bias in the estimates of the inequality in the amount of online learning done by children. Further, our analysis revealed that parents of children who had an experience of online education at school tended to have higher preference for at-school online education. We also observe more positive views on online education in highly educated parents and high-income families, which is consistent with factors associated with better access to outside-school online education. We also observe that mothers employed in regular contracts and fathers in non-regular contracts tended to hold negative views of at-school online education. These findings suggest the need for carefully designed online educational policies to prevent a rise in inequality of educational opportunity, with a focus on building online learning environment accessible to all children and supporting families with difficulties in staying home with children, while considering the hidden inequality in the online educational access outside school.

This paper is organized as follows: section 2 introduces related literature and section 3 provides an overview of the COVID-19 pandemic in Japan and the related school closures. Section 4 introduces our data, section 5 describes the utilized methodology, section 6 discusses the estimation results and findings, and finally, section 7 concludes the study.

2. Related literature

Children's access to online education can be heavily influenced by parents' socioeconomic status, through paid access to both private schooling and private educational services outside school. Correspondingly, parental demand for online education over in-person education is likely to be motivated by parents' overall preferences and their evaluation of the quality of online education their children have been receiving. It is also likely to be affected by the family's lifestyle and living arrangements, such as the employment status of the mother, parents' ability to work remotely or the size and structure of the household. Therefore, the overall impact of the COVID-19 crisis on children's learning can only be comprehensively understood by encompassing all these factors and circumstances simultaneously. To truly meet the complex needs of families which all experience a crisis, such as the COVID-19 pandemic, differently, governments designing policies regarding remote education need to approach this topic with a broad perspective. However, as of the time of drafting this paper in June 2021, very few studies have jointly investigated the relationship between children's online learning experience, both at school and outside school, parents' stated preferences regarding online education, and socioeconomic backgrounds.

There is an increasing number of studies investigating children's online learning activity gap using nationwide time surveys. Grewening et al. (2020) used a time-use survey of school-aged children in Germany to investigate students' learning time. They reported that high-achievers engaged in school online learning activities more frequently than low-achievers. They also found that overall study time reduction during the lockdown was higher for low-achievers than for high-achievers.

Andrew et al. (2020) used the UK Time Use Survey to investigate how the lockdown impacted the time use and learning of children between ages 4 and 15. They suggest that educational gaps between children from poorer and better-off families are likely to have been reinforced. They also present evidence that the frequency of online study activities provided by the school is positively correlated with children's total learning time. Using data from an online learning service company, Ikeda and Yamaguchi (2020) investigated the online study time of junior and high school students in Japan pre-COVID-19 and during COVID-19-related school closures and observed a positive association between online education quality and children's study time.

Although these studies analyzed the actual learning time of children, they did not investigate the heterogeneity in parents' preferences regarding online education due to their work status and work style changes during the pandemic, which can have broad policy implications as to how and to what extent the government should expand the online education activities and access at school.

Next, we introduce several studies that investigated how school closures affected parents' employment during the COVID-19 pandemic lockdowns. Russell and Sun (2020) found evidence that in the US, the unemployment rate of women with young children increased due to the closure of child-care centers. In Japan, Yamamura and Tsustsui (2021) used a unique online survey data and found that school closures were likely to have affected parents' workstyles, especially parents with children in elementary school. Using an online survey data of mothers with children aged between 4 and 10 in Japan, Takaku and Yokoyama (2021) ascertained that school closures led to weight gain in children and mother's increased anxiety over child-rearing.

However, studies using Japanese data mainly relied on data from commercial online surveys or services, typically making use of timing of school closures to evaluate the effect on children, and do not consider access to outside-school education and parental attitudes. Our paper is unique in that, using data from a nationwide representative survey collected by the Japanese government, we document a gap in children's access to online education, both at and outside school, while also examining parents' preferences regarding online schooling, how they are affected by family backgrounds and parents' work styles. In doing so, we contribute to three rapidly expanding areas of research of the ongoing COVID-19 crisis.

3. Background

Japan announced its first confirmed case of the COVID-19 infection on January 16, 2020, in a returnee from China, and the first case of domestic transmission on January 28, 2020. One of the early major measures to prevent the spread of the pandemic in Japan was to close schools about 2 weeks early before the 2-week-long spring break was set to start. On Thursday, February 27, 2020, when the cumulative number of domestic cases stood at 195 at the number of deaths at 4, the government requested all elementary, junior high, and high schools to temporarily close from the following Monday, March 2, 2020, until the beginning of the new school year on April 1, 2020. Survey by the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT) found that 33% of all elementary and junior high schools and 35% of high schools reopened at the beginning of the school year, with schools in the most impacted urban areas[2] staying closed (MEXT 2020a).

On April 7, 2020, a state of emergency was declared for 7 out of the 47 Japanese prefectures, which on April 16 was extended nationwide, leading to reopened schools closing again. As of April 22, 95% of elementary and junior high schools and 97% of high schools were closed (MEXT 2020b). The state of emergency was partially lifted on May 14 and fully lifted on May 25. By June 1, 99% of elementary and junior high schools and 96% of high schools were open (MEXT 2020c). Based on the data collected by MEXT from boards of education about public schools nationwide, in the period from

[2] Chiba, Fukuoka, Hyogo, Kanagawa, Osaka, Saitama prefectures, and Tokyo metropolis.

April 1 to June 23, on an average, public elementary schools were closed for 24.6 school days; public junior high schools, for 24.5 school days; and public high schools, for 26.7 school days.[3]

As of the time of drafting this paper in June 2021, the central government had not requested schools to close again, even during subsequent waves of the pandemic. However, schools might have closed for short periods of time independently of the central government to contain local outbreaks. Fig. 1 shows the timeline of the COVID-19 spread in Japan, the state of emergency and the data collection points, from January 16 to December 31, 2020.

4. Data

We use data from the first and the second round of "Survey on Lifestyle Attitudes and Behavioral Changes during the COVID-19 Pandemic" collected by the Cabinet Office of the Japanese government. Both rounds were implemented online targeting a national representative sample of respondents, stratified by age and region, over the age of 15 across Japan. The first round was conducted between May 25 and June 5, 2020, which we call "May survey," following the end of the state of emergency on May 25, and collected data from 10,128 respondents. The second round, which we call "December survey," took place between December 11 and December 17, 2020, with 10,128 respondents of which 5,212 also participated in the first round. Both rounds of this survey included questions about the respondent's background, work styles, family and social life, personal well-being, and the youngest school-aged child's education. The survey also asked about plans and wishes for the future.

To observe and understand the impact of the pandemic on children's education more precisely, we limited our sample to respondents who participated in both rounds of the survey, have children with their youngest child in elementary, junior high, or high school, and have provided consistent answers about their child's and their own level of schooling in both rounds of the survey, arriving at a sample of 566 respondents. We then excluded respondents who did not produce a definitive answer about the type of education their child had been receiving (answer "do not know") in either wave to finalize our sample at 530 respondents.

In the final sample, 46% of respondents were female, 62% of respondents had a child in elementary school, 21% in junior high school, and 17% in high school. Of all children, 11% attended private schools. By school level, 2% of elementary, 12% of junior high, and 39% of high school students in the sample attended private schools, with these numbers in the general population for the academic year 2020 standing at 1%, 8%, and 33%, respectively (School Basic Survey, MEXT). On an average, our sample is more educated than the general population, with 75% of respondents having attained a post-secondary education. The data on the educational attainment of respondent's spouse were not available. Based on the 2010 national census, 44% of those in the 25–49-year age category, which is most likely to be represented in our sample, attained post-secondary education. The sample is also composed of respondents who are relatively well-off; 58% of the respondents live in households with annual household income over 6 million yen, which is the highest income bracket common to both rounds of the survey. In 2018, the average annual household income stood at 5.52 million yen for all households and at 7.46 million yen for households with children under the age of 18 years according to the governmental statistics (MHLW, 2020). Other properties of the sample are described in Table 1. Ages of both parents and children were collected in the survey but not disclosed.

The questionnaires of our survey in May and December enquire the type of online education the youngest school-aged child experienced at school and outside school. The responding parent chose all applicable answers from a given selection of "online classes," "online instruction," and "online materials" both at school and outside school (cram school, after-school activities), "other," and "no online education received."

[3] "Survey of School Instructions (Gakushuu Shidou ni Kansuru Joukyou Chousa)." This survey did not cover private schools; however, the guidelines regarding school closures and reopening applied to both public and private schools.

In May, 34% of the children in our sample received some type of online education at school, defined as at least one of "online classes," "online instructions," and "online materials," with this number dropping to 13% in December. In May, 51% of parents responded that their child had received no online education whatsoever and in December this percentage increased to 76%. As May data cover the period of mandated school closures, it is possible that during the closures, two thirds of school children received little to no education.

Figs 2 and 3 descriptively show the type of online education experienced by level and type of school the child attended. In both May and December, the higher the level of school attended, the more online education the child received at school. The opposite trend can be seen for outside-school online education, defined as at least one of "online classes," "online instruction," and "online materials" outside school. Furthermore, children attending private schools had at both time points received more at-school online education than children in public schools, and more outside-school online education in December.

The questionnaire also asks parents about their preferred future school format as it relates to at-school online education, but not outside-school online education. The respondents selected a single answer from the options "100% in person," "in principle in person," "over 50% in person," "over 50% online" and "do not know." The phrasing of this question is identical in both rounds of the survey. As our goal was to examine the determinants of parents' preferences for online education, we excluded the response "do not know" in either wave from our sample and for the purposes of this analysis, worked with a limited sample of 421 respondents. The descriptive statistics for this limited sample are presented in Appendix Table A1.[4]

Figs 4 and 5 show the distribution of parental preferences towards at school education in May and December broken down by level and type of school. Comparing parents' stated preferences in May and December, parents' views shifted in the direction of in-person learning. In May, 11% of parents wanted school to be held mainly online and 69% of parents wanted education to return to in-person schooling in principle or completely. In December, these proportions shifted to 5% and 86%, respectively. Generally, in both surveys the younger the child, the more the parent preferred in-person learning. Moreover, parents with children in public schools preferred in-person learning over parents of children in private schools.

To assess the impact of COVID-19 pandemic in Japan, we utilize the officially published data summarized by the COVID-19 Japan Anti-Coronavirus Dashboard (https://www.stopcovid19.jp/) as they can be accessed through the software Stata. The Japanese government announces the number of newly confirmed cases on a prefectural basis. Some municipalities independently share their numbers; however, these do not cover all our sample, and therefore, we used the prefecture-based data. Measures against the pandemic, such as the state of emergency or school closures, are generally taken at a prefectural or nationwide level; and thus, we consider prefecture-based COVID-19 numbers as appropriate for our study. We construct two measures of the COVID-19 spread: one covering the period of 30 days prior to the beginning of each survey round, the other covering 7 days. Both were adjusted to show the number of newly confirmed cases in the given prefecture during the given time frame weighted by population of the prefecture.

[4] To check the consistency of the two samples utilised as it relates to our variables of interest, we run a probit regression of whether a respondent declared a preference about future school format. We find that respondents with a child who had received online education at school and respondents whose child attended private school tended to express a specific preference. Respondents from high income households as well as single mothers—defined as mothers not living with a spouse—were also more likely to state a preference. On the contrary, respondents living in multigenerational households (with respondent's or respondent's spouse's parents or grandparents) were more likely to answer "do not know" in December and thus, to be omitted from our sample. The regression results for the consistency check can be found in Appendix Table A5.

In the first part of the analysis, examining differences in access to online education, we use the 30-day measure which corresponds with the period the questionnaire asks about in December.[5] Then, to analyze parents' preferences, we turn to the 7-day measure, which we deem more relevant to personal views. Over the 30 days prior to the May survey, the number of newly confirmed COVID-19 cases increased in 38 out of 47 prefectures of Japan and was 0 in the rest. For the weekly measure, the number of newly confirmed cases per capita stood at 0 for 31 prefectures and increased in 16. In December, all prefectures saw an increase during both periods.

5. Empirical strategy

5.1 Access to online education

We first examine the online education experiences at the two data points, May and December, by the type of school attended and family backgrounds. We estimate the following probit model to measure the likelihood of a child experiencing online education at and outside school by their backgrounds:

$$OnlineEducationAccess_{t=1,2} = \beta_0 + \beta_1 * School + \beta_2 * Family_{t=1,2} + \beta_3 * Covid_{t=1,2} + \varepsilon \quad (1)$$

where $OnlineEducationAccess$ is a dummy variable taking two forms, one for at-school online education and the other for outside-school online education. As for at-school online experience, $OnlineEducationAccess$ is equal to 1 in case the child had received at least one of the three types of online education, "online classes," "online instructions," or "online materials," from school, and takes 0 otherwise. For outside-school online education, $OnlineEducationAccess$ takes 1 if the child had received at least one of the same three types of online education outside school, such as at an after-school program or private tutoring and takes 0, otherwise. $Covid$ measures newly confirmed COVID-19 cases over the period of 30 days prior to the survey in each prefecture and is weighted by population of the prefecture. Term ε represents an error term, which is for all models assumed to be clustered on a prefectural level.

We also estimate the changes in online educational experience from May to December survey using the following value-added probit model to see, given the online education experience in May, how the access in December was influenced by observed school and family factors:

$$\begin{aligned} OnlineEducationAccess_{t_2} \\ = \beta_0 + \beta_1 * School_{t_2} + \beta_2 * Family_{t_2} + \beta_3 * Covid_{t_2} + \beta_4 \\ * OnlineEducationAccess_{t_1} + \varepsilon \end{aligned} \quad (2)$$

Next, to examine whether a faster increase of regional COVID-19 cases was associated with changes in online educational experiences, we combine May and December data and estimate the following difference-in-difference (DID) linear probability model treating rapid increase in COVID-19 cases as an unexpected exogenous shock:

$$OnlineEducationAccess = \beta_0 + \beta_1 * D_{Covid} * December + \beta_2 * D_{Covid} + \beta_3 * December + \varepsilon \quad (3)$$

where the definition of $OnlineEducationAccess$ is identical to that in Equations (1) and (2). D_{Covid} in Equation (3) is a dummy variable equal to 1 in case respondent's prefecture of residence saw an increase in new COVID-19 cases above sample average, based on the difference between $Covid_{t_1}$ and $Covid_{t_2}$.

[5] In the May survey, the period in question is not specified besides "during the pandemic." We understand this as the period since the beginning of the new school year on April 1. Therefore, we assume that parents described the online learning experience at the type of school stated on the day of the survey. In the December survey, the same question was asked again, this time specifying the period of the previous 30 days.

For our data, the average difference is 0.49 cases per 1,000 inhabitants. $December$ is a dummy variable identifying December survey.

To further evaluate the effect of the faster increase of COVID-19 cases and the role of family background factors, we extend the difference-in-difference estimation to a triple difference linear probability model. We estimate the following model:

$$\begin{aligned} &OnlineEducationAccess \\ &\quad = \beta_0 + \beta_1 * D_{Covid} + \beta_2 * December + \beta_3 * D_{Covid} * December + \beta_4 \\ &\quad * D_{Background} + \beta_5 * D_{Covid} * D_{Background} + \beta_6 * December * D_{Background} + \beta_7 \\ &\quad * D_{Covid} * December * D_{Background} + \varepsilon \end{aligned} \tag{4}$$

where $D_{Background}$ is a dummy variable which identifies children's family backgrounds along 3 dimensions: household income, responding parent's education and the type of school attended (public or private). A child is considered to come from a high-income family when annual household income is above 6 million yen. Parental education is taken as high in case the responding parent has attained post-secondary education. With this model, we expect to evaluate how an exogenous increase of Covid-19 cases had heterogenous impacts on children's online learning experiences both at school and outside school by family background and school types.

5.2 Parental demand for online education

To examine parental preferences towards at-school online education both in May and in December, we estimate the following ordered logit model separately for both surveys:

$$\begin{aligned} OnlineEducationDemand_{t=1,2} = \beta_0 + \beta_1 * OnlineEducationAccessSchool_{t=1,2} + \beta_2 * \\ School + \beta_3 * Family_{t=1,2} + \beta_4 * Covid_{t=1,2} + \varepsilon \end{aligned} \tag{5}$$

Outcome variable $OnlineEducationDemand_{t=1,2}$ shows parental preference towards at-school online education over in-person education measured on a four-point scale, with greater numbers indicating stronger preference for online education. $OnlineEducationAccessSchool$ is a dummy variable equal to 1 if respondent's child had received some form of online education at school lately[6], and 0, otherwise. $School$ and $Family$ are vectors of school characteristics and family backgrounds, respectively. In addition to household income and parental education, to get insights into potential constraints on the demand side of online school education, $Family$ variables include parents' work status or changes in parents' work styles due to the pandemic. $Covid$ is a control for the number of newly confirmed COVID-19 cases in respondent's prefecture of residence over 7 days prior to the beginning of the respective survey.

Next, to analyze how parents' preferences changed from May to December, we employ the following value-added model:

$$\begin{aligned} OnlineEducationDemand_{t_2} = \beta_0 + \beta_1 * OnlineEducationAccess_{t_2} + \beta_2 * School_{t_2} + \beta_3 * \\ Family_{t_2} + \beta_4 * Covid_{t_2} + \gamma * OnlineEducationDemand_{t_1} + \varepsilon \end{aligned} \tag{6}$$

where we expand Equation (5) by including the lag of the outcome variable $OnlineEducationDemand$. Equivalently to the preceding models, the error term ε is assumed to be clustered on a prefectural level.

[6] The period in question is from April 1 to the survey date for the May survey, and previous 30 days for the December survey. We do not include outside-school online education access variable in the model, as child's after-school activities are related to family backgrounds and thus, likely to be endogenous.

6. Results and discussion

6.1 Equality of access to online education

In this section, we describe the differences in access to online education by the type of school the child attended, and family background factors based on Equations (1) and (2). Table 2 reports the determinants of online education as experienced in May (Columns (1) and (4)) and in December (Columns (2) and (5)) and provides a closer look at the changes between May and December (Columns (3) and (6)).

First, we discuss the results for at-school online education shown in Columns (1) to (3). In Column (1) we observe that, in the May survey, children from high-income families and those attending private schools were highly statistically more likely to have experienced online education at school than their corresponding counterparts by 17% and 23%, respectively. In Column (2), the December survey, the sign and significance on the coefficient of the private school dummy variable is unchanged, yet high-income household coefficient, remaining positive, retains significance only at the 10% threshold, despite a lower effect size. However, in Column (3), which reports the results from a value-added model specification (Equation (2)), while we did not confirm any statistically significant difference between high and low-income households, the effect of the child attending private school remained significant at a 10% level and positive in sign, albeit with a lower effect size. This result suggests that the online education access gap between public schools and private schools further widened even after schools reopened.

Second, in Columns (4) to (6) in Table 2, we examine the factors associated with access to online education outside school. Results from the May survey in Column (4) indicate that children from high-income households and those with a responding parent with a post-secondary education had a higher likelihood of experiencing online education outside school during the first wave of the pandemic by 16%. A similar trend was observed in the December survey in Column (5), where, in addition to household income and parent's educational level, the positive effect of a child attending a private school becomes significant. Further, a value-added model in Column (6) shows significant and positive coefficients on all three variables, high-income household, highly educated responding parent and private school. This evidence collectively suggests that there is a clear association between children's family backgrounds and their likelihood of receiving outside-school online education, and that the gap in access to outside-school online education increased over the course of the pandemic.

Finally, utilizing the interaction terms, we investigate the heterogeneous effect of family backgrounds on the access to online education by the level of school. The results are reported in Table 3. In Columns (1) to (3), we do not confirm any difference in access to at-school online education based on the level of school the child attended, with the baseline set to elementary school, for households in the high-income category, at either survey point. Regarding outside-school online education in Columns (4) to (6), in addition to the above discussion, we find that the effect of coming from high-income family is especially pronounced for high school students. High schoolers from high-income households were nearly 70% more likely to have experienced outside-school online education than high school students from low-income households in December, as seen in Column (5), and as a change from May to December in Column (6). Comparing the effect of having a highly educated parent between school levels, we observe a similar trend in December, and seen as a change from May to December, high school students with a highly educated parent were significantly 64% more likely to have access to outside-school online education than high school students with a parent without post-secondary education. These findings are not unexpected, as part of 3rd year high school students would be facing university entrance exams in January and February, possibly creating additional demand for outside-school online education.

To summarize, during the first wave of the COVID-19 pandemic in Japan, when schools were ordered to close, there was a clear divide in terms of access to online education both at school and outside school based on family backgrounds, especially household income, and the type of school

attended. The online educational access gap persisted into December, when Japan was experiencing a third wave of the pandemic and possibly further widened, indicating increasing inequality during the pandemic, especially in terms of online educational opportunity outside school.

6.2 Heterogeneity of impact of COVID-19 on online education

To assess whether a greater impact of COVID-19 was associated with higher likelihood of online educational experience, we employ a difference-in-difference model treating a rapid increase in COVID-19 cases as an unexpected exogenous shock to education in each region. The results are shown in Table 4. "COVID-19 rapid increase" variable corresponds to D_{Covid} in Equation (3) and identifies prefectures that saw above sample average increase in newly confirmed cases from May to December.

We do not find a statistically significant effect of the interaction term of "COVID-19 rapid increase" and "December" for either at-school or outside-school online education. Therefore, we further estimate triple difference models, as described in Equation (4), to examine the heterogenous impact of COVID-19 on online educational access by various measures of family backgrounds.

First, we analyze the effect of a greater impact of COVID-19 on online educational experience by household income level and report our findings in Columns (1) and (4) of Table 5. Coefficients of the interaction term "COVID-19 rapid increase," "December" and "High income household" in either column are not statistically significant. These results indicate that a greater impact of COVID-19 does not create heterogeneous effect on access to online education, both at school and outside school, by household income.

Next, we investigate the heterogenous effect of COVID-19 by parent's educational level, presenting the results in Columns (2) and (5) of Table 5. The coefficient of the interaction term of "COVID-19 rapid increase," "December," and "highly educated parent" is positive and significant at a 5% level for outside-school online educational experience in Column (5). This result suggests that, with a greater impact of COVID-19, children with a highly educated parent had a 12% higher likelihood of experiencing online education outside school than children with a parent without post-secondary education.

Finally, we examine the effect of a greater impact of COVID-19 by the type of school attended, public or private, and report the results in Columns (3) and (6) of Table 5. The coefficient of the interaction term of "COVID-19 rapid increase," "December," and "Private school" is not statistically significant for at-school online education experience in Column (3), but it is significant at a 5% level and positive for outside-school online educational experience in Column (6). This result indicates that as almost all schools had resumed face-to-face education in December 2020, the more pronounced impact of COVID-19 was not associated with difference in access to at-school online education in both public and private schools. However, in prefectures that saw a greater impact of COVID-19, children attending private schools had a 17% higher likelihood of receiving online education outside school than children attending public schools.

In sum, the heterogeneous impact of COVID-19 on children's online educational experience is only observed outside school by children's school type and parental education, but not by household income. These results imply that the greater impact of COVID-19 did not create differences in online educational experience at school, but it did outside school, where parents have discretion over what education their children receive. Parents who do not necessarily have higher income but are highly educated or willing to send their children to private schools, might have higher expectations for their children's educational achievement. The stronger influence of COVID-19 promoted these parents who were more highly concerned about their children's learning during the COVID-19 pandemic to seek out more online education outside school.

6.3 Family backgrounds and demand for at-school online education

Turning our attention to the demand side, we investigate parents' views regarding the type of education they want their children to receive at school with a focus on the effects of family backgrounds. Estimates from an ordered logit regression of parental preference for online education are reported in Table 6 (1), with cross-sectional results (Equation (5)) from the May survey and from the December survey in Columns (1) and (2), respectively. Column (3) show results of the December survey from a value-added model (Equation (6)), revealing changes from May to December.

In all instances, the strongest determinant of favorable views of at-school online education is the recent experience of at-school online education. Estimating the impact of the type and level of school the child attended on responding parent's preferences, we do not find any consistently significant effect in either May or December. While the results discussed in Section 6.1 reveal that children in private schools had, at both time points, greater access to at-school online education, there is no difference in parents' views based on the type of school attended when the actual experience of at-school online education is controlled for.[7]

Focusing on family backgrounds, we find that highly educated responding parents were more likely to hold stronger preference for online education than parents without post-secondary education in the May survey, but not in the December survey. Highly educated parents might hold jobs more conducive to remote-work than less educated parents, allowing them to better accommodate at-home education of their children. While we discuss the role of the shift in work styles thoroughly in the following section, in short, we find only a very limited association, suggesting that the significance of the responding parent's attained education is not caused by varying work styles, provided that telework or other types of flexible work were not a wide-spread practice in Japan prior to the COVID-19 pandemic (Okubo 2020). Combined with the results from Section 6.2, our interpretation of these findings is that highly educated parents or parents who send their children to private schools in Japan do not necessarily prefer online education to face-to-face education at school; however, they seek additional online education outside school as a supplement especially when the concerns regarding the pandemic increase.

The opposite trend can be seen for the role of household income, which was not statistically significant in the May survey. Yet in the December survey, respondents from high income families were at a 1% level of significance more likely to hold positive views of online education. While the survey did not inquire about the number of Internet-connected devices in the household, which are crucial to access online education, if they were the driving factor behind different views based on household income, the effect would likely already be evident in May. It is possible that children from high-income families have access to better schools than less fortunate children. Schools with more resources might direct them towards building knowledge and infrastructure needed to provide high quality online education even after schools reopen which would consequently lead to more favorable parental views in December.

Next, we analyze the role of parents' work status, setting the baseline to the parent being present at home, as either stay at home parent, unemployed parent looking for work or parent engaging in pay-by-volume work from home. In general, we find that in the May survey, parents who might not be in a position to adapt to new circumstances easily were more likely to want their children to return to the classroom, while in the December survey, parents likely adjusted to the situation overall and their employment status was no longer statistically significant. Specifically, mothers employed on indefinite full-time contracts (regular employment) and fathers in non-regular employment showed higher preference for in-person education in the May survey. Besides the possible difference in job content between employment contract types, mothers in other than regular contracts might choose these types

[7] The full results of Table 6 (1), with and without family background controls, are available in Appendix Table A4. In the December survey, parents of high schoolers were more likely to be open to online education in comparison to the baseline of parents of elementary school students; however, the significance of the effect disappeared with the inclusion of family background covariates in Columns (4) and (6). Parents' views on the type of education their child receives, therefore, do not seem to be related to child's age.

of jobs for the level of flexibility they provide. On the contrary, fathers who are more likely to be the breadwinners, face lower job security and earnings in non-regular employment than regular employees, which might make it difficult to support child learning from home.

6.4 Parents' work styles and demand for at-school online education

In this section, we investigate the association between parents' preferences for online education and change in their work styles while controlling for other family backgrounds and employment type. We expand the family background variables in the model detailed in Section 6.3 to include variables indicating change in work styles. This analysis remains purely observational, as we are unable to confirm whether it is parents' work styles that impact their views regarding online education or whether parents adjusted their work styles in response to children's educational experience.

For this analysis, we limit the sample to parents who, in the corresponding survey, were reported as working, either as regular employees, non-regular employees, or were company executives or self-employed. The survey in both its rounds asked respondents how had theirs and their spouses' work styles changed, since the beginning of the pandemic for the May survey and since May for the December survey. The questionnaire inquired specifically about the change in total hours worked and about the use of telework and other flexible work styles such as flextime and staggered working hours and days. Respondents were asked to mark all applicable answers. We divide the answers by respondent's sex to assess the effect of mother's and father's work styles separately.

As seen in Appendix Table A1, in the May survey, 38% of working mothers and 41% of working fathers experienced a decrease in total hours worked, while 8% and 7%, respectively, saw an increase. In December survey, 18% of both mothers and fathers worked fewer hours, and 8% of mothers and 12% of fathers reported more working hours. Regarding teleworking, in the May survey, 17% of mothers and 42% of fathers utilized telework more than they did before the pandemic and in the December survey, 12% of mothers and 30% of fathers teleworked more than they did in May. Besides teleworking, work styles became more flexible for 18% of mothers and 22% of fathers in the May survey and 12% of both mothers and fathers in the December survey.

For this analysis, we first look at working mothers and fathers separately regardless of their spouse's employment status, and then at households with both parents working, resulting in a different sample size for each estimation. The results of ordered logit regression are presented in Table 6 (2) with Columns (1) to (3) displaying results from the May survey and Columns (4) through (6) results from the December survey. Identical to the preceding analysis on parental preference, models reported in Columns (7) to (9) include a lag of the outcome variable to showcase changes in attitudes between survey rounds. The baseline the results refer to is set to no change in work styles as the survey asked about them.

Overall, we observe limited association between changes in work styles and parental views regarding online education. In the May survey, examining parents' changes in work styles separately, decrease in mothers' working hours is associated with a higher likelihood of positive views of online education. However, this effect was no longer statistically significant in the sample of both parents working. In a sample of households with both parents working, we observe that respondents from households with mothers whose working hours increased, were at a 1% level of significance more likely to prefer in-person education. We do not find any significant effect of fathers' work style changes.

Using the December survey, in the cross-sectional analysis, no difference in parental views is observed based on the change in work styles. From the results of a value-added model, in Column (8), controlling for previous preference, we observe that respondents from households where fathers teleworked more in December than they did in May were at a 10% level of significance more open to online education than respondents from households where fathers saw no change in work styles. However, we observe this effect in the sample of working fathers only, not in the sample of both parents working in Column (9).

Although the association between work styles and parental preference for online education we identify is weak, it is consistent with the results from Section 6.3 regarding parents' employment status. Our findings suggest that in the short term, parents in less flexible or more demanding work-related circumstances had a more negative stance on online education, while in the long term the difference based on employment type or changes in work styles virtually disappeared. Our results are also in line with Yamamura-Tsutsui (2021), who found that it was mainly working mothers who bore the brunt of school closures in Japan. However, more research is needed into the topic, especially to determine whether parents adjust their employment status or work style to accommodate the children's online learning, which could have vast policy implications.

7. Conclusion

In this study, by utilizing data from two rounds of a government survey carried out in May 2020 and December 2020 to the same households, we analyze the impact of the COVID-19 pandemic on online education in Japan, as experienced by children in public and private elementary, junior high, and high schools at school as well as outside school, and focus on the heterogeneity brought about by family socioeconomic status and regional differences. We also analyze parental preferences towards online education as opposed to in-person learning at school, which is essential in understanding why Japan is lagging behind other OECD countries in introducing online learning at school, and how these preferences are shaped by the actual experience of online education, family backgrounds and parents' work styles. Our paper presents not only the first evidence on online educational access at school during the COVID-19 pandemic in Japan, covering both public and private schools, but also provides broad perspectives to understand the status of online education in Japan by including both at-school and outside-school learning experiences and family backgrounds, while also examining the key factor on the demand side for online education, parents' wishes.

Overall, we find that during the COVID-19 pandemic children from high-income households and children with a highly educated parent had better access to online education, especially outside school. One possible reason for this result is that due to the limited access to at-school online education, parents with high socioeconomic status felt the need to seek online educational opportunities elsewhere, outside schools, which was especially the case for high school students, who spent years preparing for university entrance exams. A rapid growth in COVID-19 cases was associated with increased access to online education outside school, particularly for children in private schools, who already enjoyed more access to online education at school than children in public schools, and for children with a highly educated parent. We do not observe a difference in access to at-school online education based on regional differences in the spread of the COVID-19 infection. Therefore, it is evident that ignoring the socioeconomic differences in the access to online education outside school would lead to a substantial bias in the estimates of the inequality of the amount of online education the children received.

We also show that the parents of children who had an experience of online education at school consistently tended to express more positive views about at-school online education. Further, we find that, in general, highly educated parents and parents in high-income households were more likely to welcome online education at school, even after controlling for the actual experience, which appeared to contribute to the search for additional online learning opportunities outside school. However, parental work status and work styles seemed to be potential factors creating heterogeneity in the preferences for at-school online education. Survey respondents from households with mother in regular employment and those in families with father in non-regular employment, preferred face-to-face education at school in May 2020, immediately after schools reopened after mandated closures, but not in December 2020. These results suggest that parents who initially had conflict in having children at home with their work, adjusted to accommodate the new remote learning style.

Overall, the results indicate an inequality in the access to online education and in preferences for online education at school across socioeconomic status and, to a lesser degree, work status of parents. The limited access to online education at school may create a new learning gap among children due to

the differences in access to online education outside school. This, over the course of the pandemic, may develop into a serious educational inequality as the baseline learning time has become much shorter than usual. Parents' understanding and acceptance of the new remote learning style may be the key to levelling up the access to online education at school. Our results suggest that parents are more open to at-school online education once their children experience it.

The Japanese government was quick to adopt a supplementary budget in June 2020 to provide remote learning devices to all students in public elementary and junior high schools, but the actual execution of this policy has been very slow and would have minimal, if any, impact during the period covered by the data used in this study.[8] While supply side policies are important and merit further research, remote learning devices might be of limited benefit if parents find it difficult to have children learn from home. Clearly, carefully designed policies targeting both demand and supply sides are essential for effectively achieving equity in high quality online education for children. Our study suggests that, on the demand side, we need to focus on building online learning environment accessible to all children, supporting children whose parents feel difficulties in staying home with them while considering the hidden inequality in the online educational access outside school.

Declarations

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Availability of data and material: The individual data of "Survey on Lifestyle Attitudes and Behavioral Changes during the COVID-19 Pandemic (Shingata Koronauirusu Kansenshou no Eikyouka ni Okeru Seikatsu Ishiki-Koudou no Henka ni Kansuru Chousa)" collected by the Cabinet Office of the Japanese government can be obtained by applying through the website, https://www5.cao.go.jp/keizai2/manzoku/index.html. The other data and materials can be provided upon request to the corresponding author.

Code availability: The Stata code used in this research can be provided upon request to the corresponding author.

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[8] According to a governmental announcement in March 2021, by the end of November 2020, 11.2% of municipalities completed purchasing computer devices for remote education for all public elementary and junior high school students.

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Table 1 Descriptive statistics

	May 2020 Survey					December 2020 Survey				
	obs.	**mean**	**s.d.**	**min**	**max**	**obs.**	**mean**	**s.d.**	**min**	**max**
School type										
Elementary school - public	530	0.602	0.490	0	1	530	0.602	0.490	0	1
Elementary school - private	530	0.015	0.122	0	1	530	0.015	0.122	0	1
Junior high school - public	530	0.185	0.389	0	1	530	0.185	0.389	0	1
Junior high school - private	530	0.025	0.155	0	1	530	0.025	0.155	0	1
High school - public	530	0.106	0.308	0	1	530	0.106	0.308	0	1
High school - private	530	0.068	0.252	0	1	530	0.068	0.252	0	1
Online learning experience in past month (multiple answer)										
At school	530	0.336	0.473	0	1	530	0.130	0.337	0	1
Online classes	530	0.140	0.347	0	1	530	0.058	0.235	0	1
Online instruction	530	0.155	0.362	0	1	530	0.057	0.231	0	1
Online materials	530	0.168	0.374	0	1	530	0.060	0.238	0	1
Outside school	530	0.228	0.420	0	1	530	0.119	0.324	0	1
Online classes	530	0.166	0.372	0	1	530	0.077	0.267	0	1
Online instruction	530	0.058	0.235	0	1	530	0.038	0.191	0	1
Online materials	530	0.089	0.285	0	1	530	0.036	0.186	0	1
Other online education	530	0.053	0.224	0	1	530	0.028	0.166	0	1
No online education	530	0.506	0.500	0	1	530	0.758	0.428	0	1
Preferred school format										
Over 50% online	530	0.102	0.303	0	1	530	0.040	0.195	0	1
Over 50% in person	530	0.166	0.372	0	1	530	0.074	0.261	0	1
In principle in person	530	0.332	0.471	0	1	530	0.289	0.454	0	1
100% in person	530	0.281	0.450	0	1	530	0.479	0.500	0	1
Do not know	530	0.119	0.324	0	1	530	0.119	0.324	0	1
Respondent's highest attained education										
Highly educated (post-secondary)	530	0.747	0.435	0	1	530	0.747	0.435	0	1
Household annual income										
High income (over 6 million yen)	530	0.583	0.494	0	1	530	0.589	0.493	0	1
Household type										
Working mother	530	0.698	0.460	0	1	530	0.709	0.454	0	1
Regular employee	530	0.247	0.432	0	1	530	0.258	0.438	0	1
Non-regular employee	530	0.415	0.493	0	1	530	0.413	0.493	0	1
Executive	530	0.008	0.087	0	1	530	0.008	0.087	0	1
Self-employed	530	0.028	0.166	0	1	530	0.030	0.171	0	1
Working father	530	0.906	0.293	0	1	530	0.904	0.295	0	1
Regular employee	530	0.791	0.407	0	1	530	0.798	0.402	0	1
Non-regular employee	530	0.042	0.200	0	1	530	0.036	0.186	0	1
Executive	530	0.034	0.181	0	1	530	0.036	0.186	0	1
Self-employed	530	0.040	0.195	0	1	530	0.034	0.181	0	1
Single mother	530	0.081	0.273	0	1	530	0.083	0.276	0	1
Single father	530	0.015	0.122	0	1	530	0.011	0.106	0	1
Multigenerational household	530	0.104	0.305	0	1	530	0.100	0.300	0	1
Number of children under 18	530	1.457	0.605	1	3	530	1.440	0.597	1	3
Female respondent	530	0.462	0.499	0	1	530	0.462	0.499	0	1
Area										
Rural area	530	0.051	0.220	0	1	530	0.051	0.220	0	1
COVID-19 spread (week prior; per 1000 inhabitants)	530	0.002	0.002	0	0.007	530	0.153	0.091	0.002	0.320
COVID-19 spread (month prior; per 1000 inhabitants)	530	0.026	0.030	0	0.095	530	0.511	0.347	0.023	1.240
COVID-19 rapid increase	530	0.483	0.500	0	1	530	0.483	0.500	0	1

Note: This table shows the descriptive statistics for the sample used in the analyses in Tables 2-4. The descriptive statistics for the analyses in Tables 5 and 6 is in Appendix Table A1.

Table 2 Determinants of access to online education at school and outside school

Dependent variable	**At school**			**Outside school**		
Access to Online Education:	**May**	**December**	**December (with lag)**	**May**	**December**	**December (with lag)**
	(1)	(2)	(3)	(4)	(5)	(6)
Private school	0.228***	0.109***	0.079**	0.004	0.102*	0.095**
	(0.061)	(0.038)	(0.038)	(0.081)	(0.055)	(0.039)
Junior high school	0.065*	-0.008	-0.019	0.052	0.013	0.005
	(0.038)	(0.028)	(0.027)	(0.043)	(0.030)	(0.030)
High school	0.238***	0.095**	0.060	-0.114**	-0.105**	-0.079*
	(0.054)	(0.041)	(0.039)	(0.050)	(0.047)	(0.042)
High-income household	0.166***	0.038*	0.016	0.156***	0.101***	0.068**
	(0.044)	(0.020)	(0.018)	(0.037)	(0.031)	(0.028)
Highly educated parent	0.021	0.027	0.022	0.058*	0.097***	0.081**
	(0.040)	(0.030)	(0.027)	(0.031)	(0.034)	(0.032)
COVID-19 spread (1 month, per 1,000 inhabitants)	0.446	0.050	0.041	1.178***	0.053**	0.040
	(0.475)	(0.042)	(0.041)	(0.306)	(0.024)	(0.026)
Pseudo R^2	0.122	0.081	0.119	0.057	0.078	0.182
Observations	530	530	530	530	530	530

Notes: Average marginal effect estimates from probit model regression. The dependent variable is a dummy variable indicating whether the youngest school-aged child had experienced any form of online education at school (Columns (1) to (3)) or outside school (Columns (4) to (6)) since the beginning of the school year in April (May) or in the past month (December). Private school, Junior high school, High school (with Elementary school as a baseline), High-income household (household annual income over 6 million yen), Highly educated parent (responding parent attained post-secondary education) are dummy variables. COVID-19 spread variable shows newly confirmed COVID-19 cases over 1 month prior to the survey starting date per 1,000 inhabitants in the prefecture of residence. Other controls are Rural area, Respondent's gender. Columns (3) and (6) include lagged dependent variable from May survey. Full results are available in the Appendix Table A2. Robust standard errors clustered at prefectural level are shown in parentheses. Levels of significance: *** p<0.01, ** p<0.05, * p<0.1.

Table 3 Heterogeneity in determinants of access to online education at school and outside school

Dependent variable	**At school**			**Outside school**		
Access to Online Education:	**May**	**December**	**December (with lag)**	**May**	**December**	**December (with lag)**
	(1)	(2)	(3)	(4)	(5)	(6)
Junior high school	-0.007	0.123*	0.132*	-0.055	-0.041	-0.009
	(0.100)	(0.071)	(0.071)	(0.096)	(0.062)	(0.063)
High school	0.068	0.027	0.024	-0.141	-1.472***	-1.377***
	(0.108)	(0.085)	(0.084)	(0.137)	(0.130)	(0.116)
High-income household	0.154***	0.061*	0.042	0.184***	0.096**	0.063*
	(0.050)	(0.034)	(0.029)	(0.039)	(0.038)	(0.037)
Junior high school * High-income household	0.018	-0.092	-0.103	-0.134	-0.026	-0.022
	(0.086)	(0.068)	(0.068)	(0.083)	(0.070)	(0.068)
High school * High-income household	0.039	-0.035	-0.034	-0.017	0.704***	0.690***
	(0.108)	(0.070)	(0.065)	(0.107)	(0.072)	(0.077)
Highly educated parent	-0.046	0.033	0.0432	-0.018	0.056	0.058
	(0.055)	(0.041)	(0.039)	(0.046)	(0.047)	(0.046)
Junior high school * Highly educated parent	0.080	-0.123	-0.144*	0.261***	0.089	0.036
	(0.135)	(0.080)	(0.081)	(0.099)	(0.089)	(0.095)
High school * Highly educated parent	0.205*	0.112	0.071	0.045	0.702***	0.642***
	(0.108)	(0.091)	(0.091)	(0.137)	(0.082)	(0.078)
Pseudo R^2	0.128	0.102	0.141	0.071	0.090	0.192
Observations	530	530	530	530	530	530

Notes: Average marginal effect estimates from probit model regression. The dependent variable is a dummy variable indicating whether the youngest school-aged child had experienced any form of online education at school (Columns (1) to (3)) or outside school (Columns (4) to (6)) since the beginning of the school year in April (May) or in the past month (December). Junior high school, High school (with Elementary school as a baseline), High-income household (household annual income over 6 million yen), Highly educated parent (responding parent attained post-secondary education) are dummy variables. Other controls are Private school, Rural area, Respondent's gender, COVID-19 spread in the prefecture of residence over past month. Columns (3) and (6) include lagged dependent variable from May survey. Full results are available in the Appendix Table A3. Robust standard errors clustered at prefectural level are shown in parentheses. Levels of significance: *** p<0.01, ** p<0.05, * p<0.1.

Table 4 Response to COVID-19 increase in access to online education at school and outside school

Dependent variable		
Access to Online Education:	**At school**	**Outside school**
	(1)	(2)
COVID-19 rapid increase	0.076**	0.042
	(0.035)	(0.031)
December	-0.193***	-0.120***
	(0.027)	(0.021)
COVID-19 rapid increase * December	-0.025	0.023
	(0.033)	(0.033)
Constant	0.299***	0.208***
	(0.028)	(0.020)
Pseudo R^2	0.065	0.026
Observations	1,060	1,060

Notes: Coefficient estimates from linear probability model regression. The dependent variable is a dummy variable indicating whether the youngest school-aged child had experienced any form of online education at school (Column (1)) or outside school (Column (2)) since the beginning of the school year in April (May) or in the past month (December). COVID-19 rapid increase is a dummy variable equal to 1 in prefectures where the difference in newly confirmed cases per capita over 1 month prior to the survey between December and May is higher than the sample average. December is a dummy variable identifying December survey. Robust standard errors clustered at prefectural level are shown in parentheses. Levels of significance: *** p<0.01, ** p<0.05, * p<0.1.

Table 5 Heterogeneous response to COVID-19 increase in access to online education

Dependent variable						
Access to Online Education:	**At school**			**Outside school**		
	(1)	(2)	(3)	(4)	(5)	(6)
COVID-19 rapid increase	0.007	-0.041	0.055	-0.019	0.055	0.076**
	(0.068)	(0.073)	(0.039)	(0.039)	(0.046)	(0.034)
December	-0.125***	-0.217***	-0.188***	-0.102***	-0.087**	-0.122***
	(0.037)	(0.047)	(0.030)	(0.032)	(0.033)	(0.024)
COVID-19 rapid increase * December	0.007	0.017	0.004	0.037	-0.067	0.004
	(0.047)	(0.070)	(0.041)	(0.052)	(0.056)	(0.035)
Heterogeneity in parental income						
High-income household	0.151***			0.112**		
	(0.043)			(0.050)		
COVID-19 rapid increase * High-income household	0.083			0.078		
	(0.092)			(0.060)		
December * High-income household	-0.128***			-0.035		
	(0.043)			(0.044)		
COVID-19 rapid increase * December	-0.029			-0.017		
* High-income household	(0.074)			(0.087)		
Heterogeneity in parental education						
Highly educated parent		-0.046			0.084**	
		(0.048)			(0.039)	
COVID-19 rapid increase * Highly educated parent		0.156**			-0.017	
		(0.077)			(0.046)	
December * Highly educated parent		0.032			-0.045	
		(0.046)			(0.039)	
COVID-19 rapid increase * December		-0.057			0.120**	
* Highly educated parent		(0.074)			(0.058)	
Heterogeneity in private-public difference						
Private school			0.321***			0.114
			(0.101)			(0.120)
COVID-19 rapid increase * Private school			0.180			-0.315**
			(0.111)			(0.127)
December * Private school			-0.054			0.019
			(0.091)			(0.055)
COVID-19 rapid increase * December			-0.262			0.171**
* Private school			(0.162)			(0.074)
Pseudo R^2	0.092	0.071	0.126	0.056	0.037	0.038
Observations	1,060	1,060	1,060	1,060	1,060	1,060

Notes: Coefficient estimates from linear probability model regression. The dependent variable is a dummy variable indicating whether the youngest school-aged child had experienced any form of online education at school (Columns (1) to (3)) or outside school (Columns (4) to (6)) since the beginning of the school year in April (May) or in the past month (December). COVID-19 rapid increase is a dummy variable equal to 1 in prefectures where the difference in newly confirmed cases per capita over 1 month prior to survey between December and May is higher than the sample average. December is a dummy variable identifying December survey. High-income household (household annual income over 6 million yen), Highly educated parent (responding parent attained post-secondary education), Private school are dummy variables. Robust standard errors clustered at prefectural level are shown in parentheses. Levels of significance: *** p<0.01, ** p<0.05, * p<0.1.

Table 6 Determinants of demand for online education at school
(1) Heterogeneity over parents' work status

Dependent variable **Preference for Online Education at School**		**May**	**December**	**December (with lag)**
		(1)	(2)	(3)
Online education at school		0.989***	1.363***	1.273***
		(0.220)	(0.215)	(0.211)
Private school		0.642	-0.273	-0.560
		(0.404)	(0.311)	(0.344)
Junior high school		0.377*	0.142	0.014
		(0.213)	(0.257)	(0.244)
High school		-0.274	0.246	0.268
		(0.355)	(0.256)	(0.247)
High-income household		0.325	0.601***	0.503**
		(0.211)	(0.226)	(0.242)
Highly educated parent		0.561***	0.296	0.184
		(0.140)	(0.239)	(0.245)
Working mother				
	Regular employee	-0.511*	-0.330	-0.280
		(0.291)	(0.256)	(0.225)
	Non-regular employee	-0.219	-0.089	-0.058
		(0.227)	(0.215)	(0.200)
	Executive	1.297	0.779	0.430
		(0.817)	(1.392)	(1.551)
	Self-employed	-0.672	-0.728	-0.899
		(0.651)	(0.907)	(0.994)
Working father				
	Regular employee	-0.502	-0.945	-1.007
		(0.449)	(0.707)	(0.739)
	Non-regular employee	-1.528*	-1.729	-1.604
		(0.834)	(1.064)	(1.090)
	Executive	-0.433	-0.126	-0.376
		(0.513)	(0.946)	(0.996)
	Self-employed	-0.413	-0.475	-0.457
		(0.902)	(0.869)	(0.849)
Lag (May survey)				✓
Pseudo R^2		0.058	0.071	0.103
Observations		421	421	421

Notes: Coefficient estimates from ordered logit model regression. The dependent variable is the preference for online education at school ranging from 1 (100% in person) to 4 (over 50% online). Respondents who answered "Do not know" are dropped. The descriptive statistics of this sample is shown in Appendix Table A1. Online education at school, Private school, Junior high school, High school (with Elementary school as a baseline), High-income household (household annual income over 6 million yen), Highly educated parent (responding parent attained post-secondary education), Regular employee, Non-regular employee, Executive, and Self-employed for mother and father are dummy variables. Baseline for working parents is set to the parent being present at home. Other controls are Rural area, Respondent's gender, Multigenerational household, Single mother household and Single father household dummy variables, Number of children and COVID-19 spread (week prior) variables. Column (3) includes lagged dependent variable from May survey. Full results are available in the Appendix Table A4 (1). Robust standard errors clustered at prefectural level are shown in parentheses. Levels of significance: *** p<0.01, ** p<0.05, * p<0.1.

(2) Heterogeneity over changes in parents' work styles

Dependent variable Preference for Online Education at School		May			December			December (with lag)		
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Working styles - mother										
	More teleworking	0.302		0.323	0.0343		0.00817	0.192		0.133
		(0.284)		(0.294)	(0.471)		(0.521)	(0.476)		(0.510)
	More flexible work	-0.208		-0.062	0.017		-0.052	0.025		-0.050
		(0.261)		(0.288)	(0.340)		(0.460)	(0.302)		(0.411)
	Fewer working hours	0.420**		0.332	-0.065		0.122	-0.121		0.028
		(0.193)		(0.252)	(0.267)		(0.395)	(0.251)		(0.357)
	More working hours	-0.464		-0.972***	0.312		0.384	0.228		0.338
		(0.359)		(0.353)	(0.423)		(0.546)	(0.384)		(0.479)
Working styles - father										
	More teleworking		0.169	-0.236		0.241	0.195		0.293*	0.262
			(0.188)	(0.205)		(0.176)	(0.335)		(0.173)	(0.354)
	More flexible work		0.172	0.250		0.362	0.494		0.198	0.298
			(0.223)	(0.351)		(0.308)	(0.344)		(0.353)	(0.403)
	Fewer working hours		0.341	0.100		-0.108	-0.588		-0.223	-0.668
			(0.212)	(0.278)		(0.399)	(0.437)		(0.406)	(0.408)
	More working hours		0.343	0.661		0.243	0.398		0.318	0.468
			(0.425)	(0.476)		(0.298)	(0.374)		(0.275)	(0.348)
Working spouse		✓	✓		✓	✓		✓	✓	
Single parent household		✓	✓		✓	✓		✓	✓	
Lag (May survey)								✓	✓	✓
Pseudo R^2		0.067	0.055	0.079	0.083	0.074	0.100	0.113	0.105	0.124
Observations		296	378	261	305	377	265	305	377	265

Notes: Coefficient estimates from ordered logit model regression. The dependent variable is the preference for online education at school ranging from 1 (100% in person) to 4 (over 50% online). Respondents who answered "Do not know" are dropped. Sample is limited to parents who were reported as working (regular employees, non-regular employees, company executives, self-employed) in corresponding surveys. More teleworking, More flexible work, Fewer working hours, More working hours are dummy variables equal to 1 in case respondent chose corresponding options in questions about their own and spouse's changes in work styles since the beginning of the COVID-19 pandemic in May survey and since May in December survey. Other controls are Online learning at school, School type and level, Highly educated parent, High-income household, Employment type, Multigenerational household, Rural area and Respondent's gender dummy variables, Number of children and COVID-19 spread (week prior) variables. Columns (7) to (9) include lagged dependent variable from May survey. Full results are available in the Appendix Table A4 (2). Robust standard errors clustered at prefectural level are shown in parentheses. Levels of significance: *** p<0.01, ** p<0.05, * p<0.1.

Fig. 1 Timeline of COVID-19 incidence and state of emergency in Japan

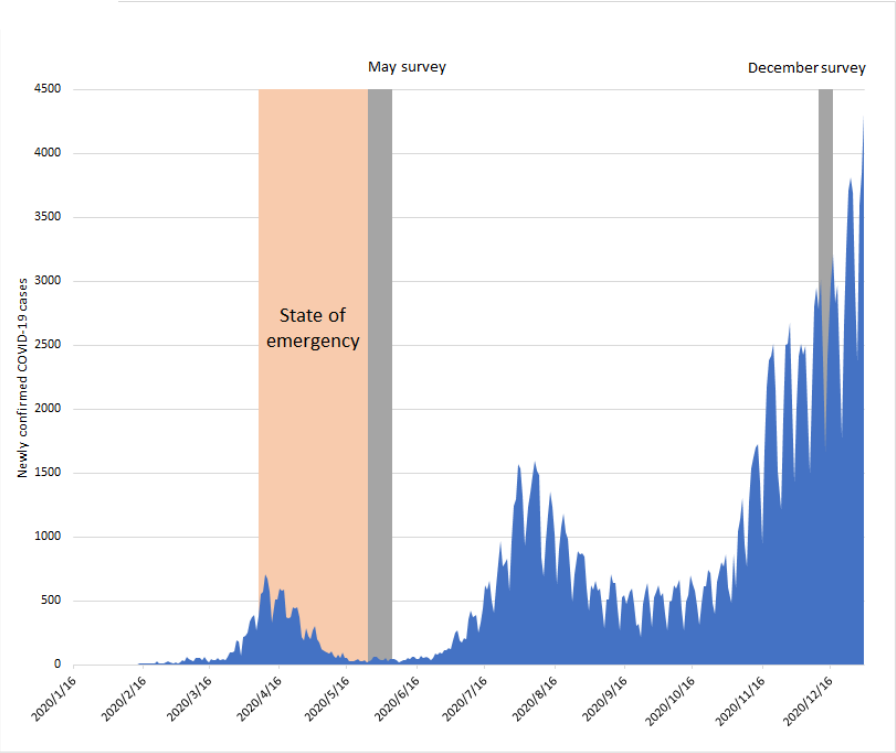

Fig. 2 Online educational experience by school level

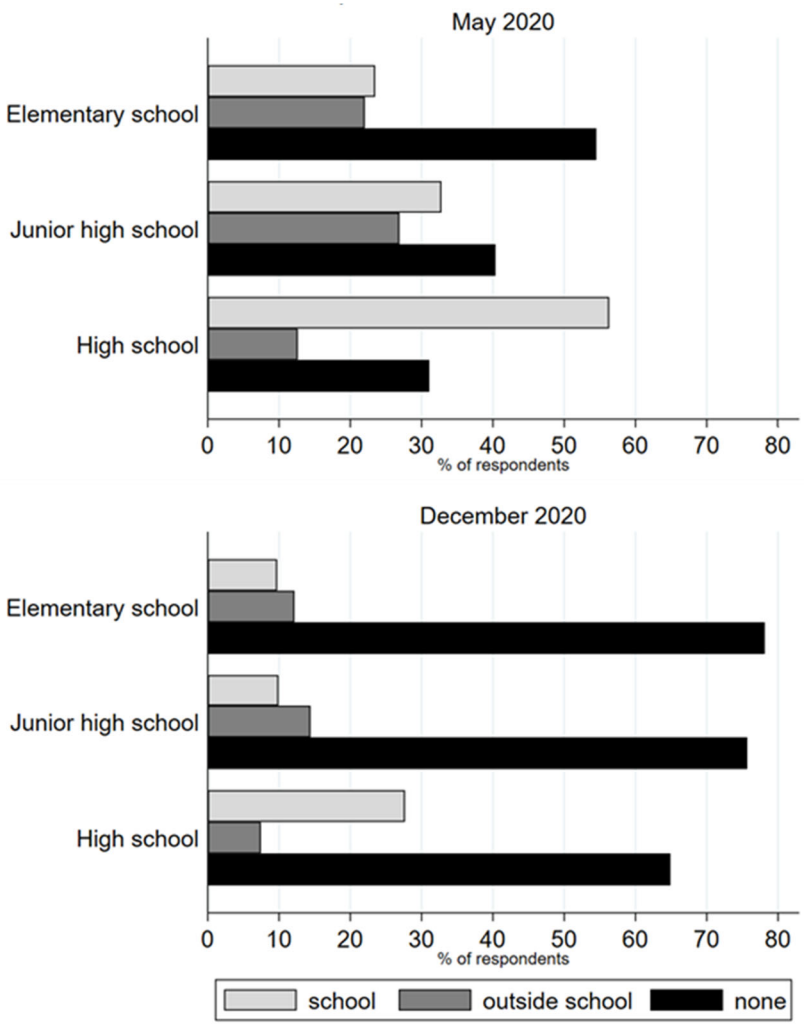

Fig. 3 Online educational experience by school type

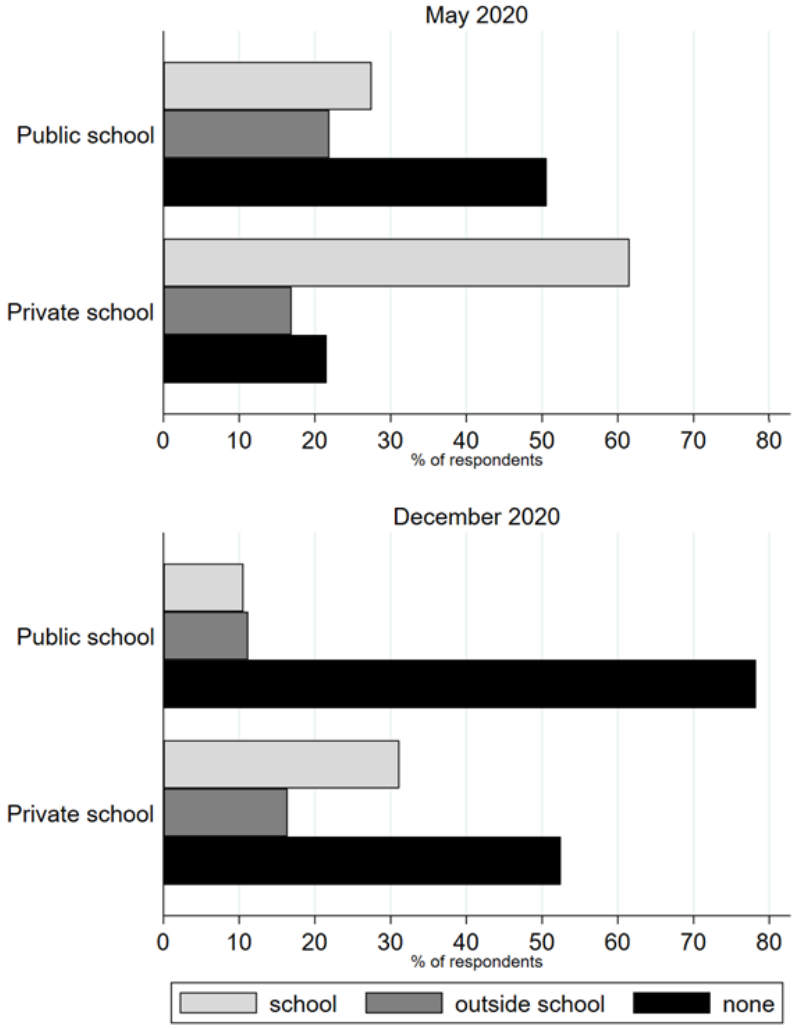

Fig. 4 Preferred school format by school level

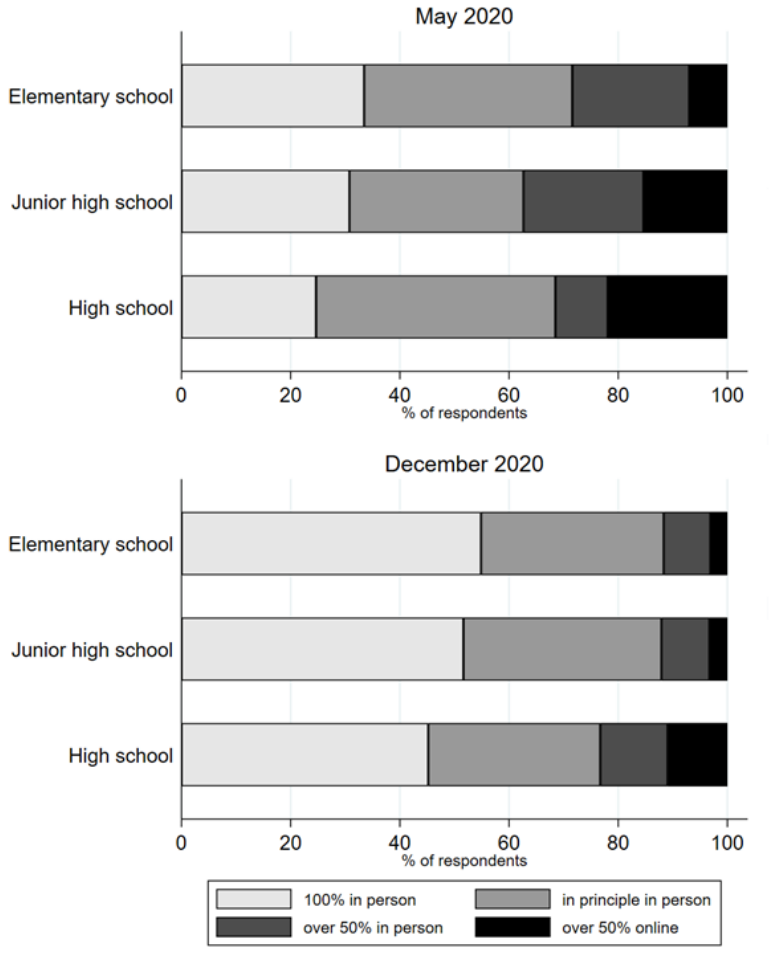

Fig. 5 Preferred school format by school type