Experiencing London's Digital Divide: An analysis of online learning among different socio-economic groups during the pandemic

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The COVID-19 pandemic school closures forced students to adapt to remote learning, raising the issue of the digital divide in education. Online learning has become the 'new normal' since the pandemic, with almost every educational institute applying certain aspects of it in their curriculum. Though research has identified many ways in which a digital divide may result from disparities in socioeconomic backgrounds, little is known about the comparative significance of the various factors mediating the two. This paper thus compares the perceived importance of five different factors pertaining to the digital divide amongst secondary students. To this end, we conducted both a bivariate regression and a thematic analysis based on an online survey sent to students in London. We find that 1) for students from disadvantaged socioeconomic backgrounds, access to digital devices remains the most significant obstacle; 2) for students from more affluent backgrounds, online support from schools appears more significant. Our paper thus agrees with the government's policy response to provide digital devices to students in need during the pandemic.

Key words:
Inequalities, digital divide, online learning, COVID-19, digitalisation, education

INTRODUCTION

During the pandemic, students across London had to adapt to online learning following school closures between March 2020 and March 2021. This forced acceleration in digitalization increased the prominence of the digital divide in secondary school education, including social inequalities. A digital divide is the difference between groups regarding their access to digital devices, digital literacy (i.e. one's ability to competently study online), and the outcomes of technology use (Van Dijk, 2002). This report focuses on secondary school students from different socioeconomic backgrounds. A sample of X students was asked to fill an online survey. We then conducted qualitative and quantitative analyses based on the responses to the survey. We intended to identify aspects of the digital divide which are most profoundly affected by the socioeconomic status of the students. These aspects are their access to devices, internet connection, digital skills, the quality of their workspace and the online support provided by schools.

Recent studies highlight the ways in which socioeconomic status affects online learning experience due to mediations by each of the aforementioned factors. However, few have investigated the significance of these factors compared to each other. In conducting such a comparison, we help policymakers identify aspects to prioritize when levelling the playing field for students.

As the government has provided digital devices to students during school closures, we expected to find that access to digital devices was the most significant factor among the five in terms of impacting online learning from the students' perspective. Otherwise, it might suggest that the government's intervention may not be the most effective, which would mean that the government should focus on other aspects of narrowing the digital divide.

LITERATURE REVIEW

I. Definition of digital divide

The term "digital divide" first appeared in the article of the Los Angeles Times journalists Webber and Harmon on 29th July 1995, describing the difference in the involvement of information technology which is the first level of the digital divide (Gunkel, 2003). Drawing from that article, Pippa Norris extended the concept to describe the divide in the physical access to computers and the Internet from global, social, and democratic perspectives to provide a broader picture (Norris, 2001). Considering the increasing adoption rate of IT devices during the second half of the 1990s due to Internet hype, researchers proposed the second level of the digital divide which focused on unequal online skills and featured the digital divide was not primarily a technological issue (Hargittai, 2002). As the diffusion of computers and the Internet saturated in the Global North since 2012 (van Deursen & van Dijk, 2019), researchers were more concerned about the outcomes of the use of digital devices in all domains (economic, social, political, cultural, educational, and personal development) which featured the third level of the digital divide (Dijk, 2012).

II. Five factors affecting the digital divide

Recent research shows that students' socioeconomic backgrounds have impacted their online learning experience during the COVID-19 pandemic in five respects, namely access to devices, internet connection, digital skills, quality of workspace and online support from schools. According to Green (2020), 20% of free school meal recipients had limited access to adequate digital devices for online learning, compared with 7% of students who were not receiving free school meals (Green, 2021). Montacute and Cullinane echoed this, by arguing that the percentage of private schools with all students having access to digital devices is higher than that of state schools, with 54% compared with 5% respectively (Montacute & Cullinane, 2021). Similarly, Cullinan et al. (2021) suggested that education divisions with the lowest median household income are less likely to have quality broadband connectivity (Cullinan et al., 2021). Hence, socioeconomically disadvantaged students lack the digital tools and high-speed internet connectivity, which constrains disadvantaged students from engaging in remote learning. Furthermore, students from upper/middle-class families show better proficiency in digital skills

than students from working-class families (Goudeau et al., 2021). Moreover, a YouGov questionnaire shows that 12% of parents saw the quality of space to learn as the main challenge[1]. In the same vein, Baltà-Salvador et al. argued that the quality of the learning space is positively correlated with academic development (Baltà-Salvador et al., 2021). Thus, the gap in access to quality workspace widens educational inequalities between students from affluent and disadvantaged families. Socioeconomic backgrounds also affect the digital divide mediated by school online support. Lucas et al. pointed out that deprived schools rely more on physical resources during the COVID-19 pandemic, and 15% of senior leaders in affluent schools reported that their teachers were providing live online lessons for students, compared with 7% of senior leaders in disadvantaged schools (Coleman, 2021, p. 17). Although schools gained experience from the first lockdown and the percentage of state schools using online lessons increased from 4% to 54% since March 2020, the digital gap between private and state schools widen, compared with 86% in private schools (Montacute & Cullinane, 2021). Thus, unequal school online support may consequently result in learning loss for students from disadvantaged backgrounds.

III. Significance of research

During the pandemic, the government has provided digital devices as well as skill training to students in need to facilitate their online learning[2]. However, it is not clear whether digital devices are what is most needed by students from disadvantaged socioeconomic backgrounds, as they face both first-level and second-level digital divides. With the pandemic and the subsequent government intervention being a recent development, few studies have been conducted to explore this question. Our paper contributes by highlighting which factors students from such backgrounds value the most, to evaluate if the government has tackled the most significant issue when it comes to accessing online learning.

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[1] *Remote education research.* (2021, May 4). GOV.UK.
https://www.gov.uk/government/publications/remote-education-research/remote-education-research

[2] *Get help with technology for remote education.* (2022, April 4) GOV.UK.
https://www.gov.uk/guidance/get-help-with-technology-for-remote-education

METHODOLOGY

To answer this question, we conducted a survey on students in London who were in years seven to thirteen during the lockdowns, and we aimed to gain data on their experience in education during the pandemic. We chose to study students in years seven to thirteen to keep our analysis focused and precise – expanding our research to younger students would have included further ethical concerns, as well as a separate set of questions related to the learning experience and studying university students would have complicated our variables considering the large sample of international students. The survey was conducted with full respect to research ethics, by asking for explicit consent from our respondents. We have attached the questions on consent in the Appendix.

We received 94 responses over a period of three days. The survey was broken down into two main sections. The first section concerned the background and demographic of the participants; the questions in this section were about their respective boroughs, the type of school attended, the sector of employment of the highest income earner in the family. The questions from this section were used to create our model to measure each individual's socioeconomic status. We assigned different values to different responses (see appendix) to calculate a common socioeconomic index. For example, we used the sector of employment as a proxy for income, as it would be difficult to ask individuals to accurately provide this data in the timeframe given. The six components of the index are weighted equally, as is frequent practice[3]. The formula for the socioeconomic index for an individual is below (further details in the appendix):

$$socioeconomic\ index = \log(10000 * \alpha * \beta * \gamma * \delta * \theta * \mu)$$

The second section asked participants to express the extent to which their education was impacted in general, and the following questioned aimed to determine which factors affected their education by ranking them in the order of most to least significant. The answers from this section were weighted where the option ranked 1 was the factor that impacted education the least, whereas the ranking of 5 indicated the factor that impacted their education more

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[3] *Guidelines on producing leading, composite and sentiment indicators.* (2019, November) UNECE.ORG. https://unece.org/info/publications/pub/21941

significantly (further details are in the appendix). With this data, we ran bivariate regression calculations on STATA to assess whether any of the aspects are significantly correlated with the socioeconomic index.

To contextualize/complement our quantitative research, we also collected qualitative data by including an open-ended question in our survey. The aim of this was to further understand the underlying reasons that determined the significance of each factor in the ranking. To analyse this data, we employed thematic analysis to convert the survey answers into codes and themes. We chose this method because we believe that it was the best way to sieve through and analyse the substantial number of responses in a timely manner that helped gauge a better and more detailed analysis of the subjective experience of education.

ANALYSIS OF RESULTS

We ran bivariate regression between various aspects of the digital divide (dependent variable) and socioeconomic index (independent variable) respectively to identify the extent of correlation between the two and adopt hypothesis testing to figure out whether the relationships are reliable considering sampling fluctuations. ($y = \alpha + \beta x + \varepsilon$). Our null hypothesis is the correlation (β_0) between each aspect of the digital divide and the socioeconomic index is 0. We then test whether our β falls within a certain range of normal distribution around the null ($-2 \leq t \leq 2$ given confidence level = 0.05, t = $\frac{\beta_1 - \beta_0}{estimated\ standard\ error}$).

Regarding the results, the t-values for internet connection, a quiet workspace, and digital skills are not big enough to reject the null and the p-values are larger than the confidence level, which shows the values for β are the results of sampling fluctuation instead of a real correlation. For access to devices and school online support, the t-values are big enough to reject the null and show there is correlation between access to digital devices or online support and socioeconomic index.

For the value of β between access to devices and socioeconomic index, the figure is 0.008 which means these two are positively correlated. While for the β between school online support and socioeconomic index, the figure is -0.00956 which demonstrates there is an inverse relationship

between these two. Apart from the direction of β, the correlation between school online support and socioeconomic index is stronger compared to the figure for access to devices. Nevertheless, we must note that the β are extremely small; this could be linked back to the small sample size we collected.

The t-values indicate that two of the five factors that are statistically significantly correlated with the socioeconomic index. Access to devices is the first level of the digital divide (Coleman,2021), and thus our data shows that during the pandemic this aspect of the divide was still an issue; its positive correlation suggests that the poorer you are, the more you felt that it was a concern.

However, this does not mean that access to devices is necessarily the most common and significant barrier that is subjectively faced by our respondents. The qualitative data gathered highlighted that the statistically significant result of access to devices may be because people answered objectively to the question instead of speaking from their own experiences. For example, one respondent claimed, "If one didn't have access to devices there would be no possible way to enhance your learning." Nevertheless, we reference this viewpoint later.

We found a negative correlation regarding the aspect of school online support: the richer you are, the more you felt that it was a concern. This may be as students from more disadvantaged backgrounds may have had access to more support during the lockdowns as they were entitled to support such as government programs. However, students from more affluent backgrounds felt abandoned and stranded with respect to their school supporting them throughout online learning.
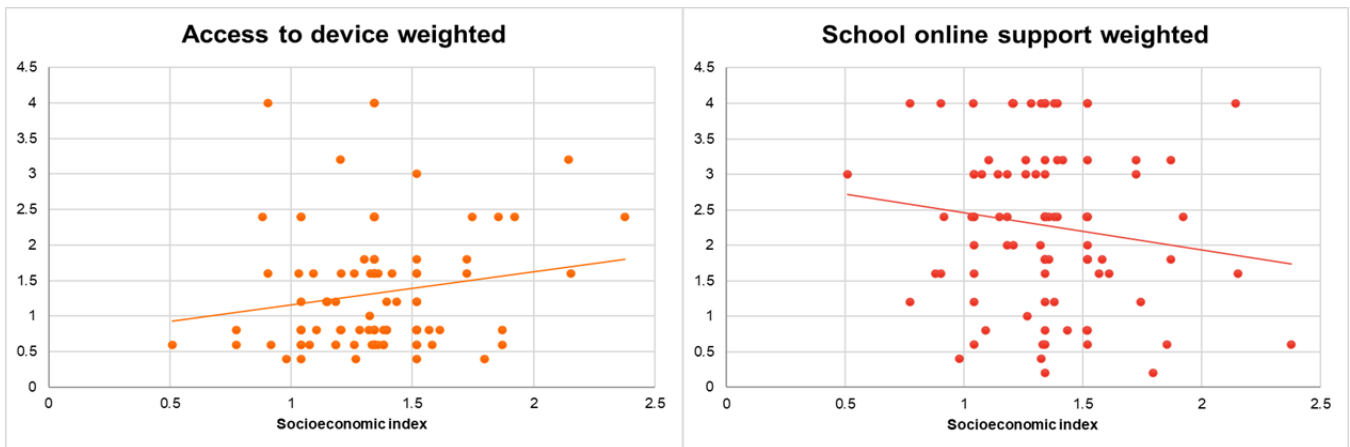
Figure 1: Scatter plot of aspect of digital divide on y-axis and socioeconomic index on the x-axis.

Here, Figure 1 shows the two graphs of the statistically significant factors. Clearly the trendline indicates the significant positive and negative correlation we see regarding these two aspects and socioeconomic index.

Regarding the values for the R^2 of our regression, the values for quality of workspace, Internet connection, and digital skills are 0.18%, 1.39%, and 0.04% respectively which means most of the variations in the figure could not be explained by our model. Although the figures for access to digital devices and school online learning are 5.09% and 4.7%, they are still not very explanatory, and this is again mainly due to the limited sample size we collected. However, with a greater sample size, we may see the same trends, and this paves way for future research.

For the qualitative data we analysed the common phrases and keywords that were frequently mentioned in the open-ended response section. The open-ended question asked our participants to briefly explain the reasoning behind their ranking for the five different factors that potentially affected their education during the pandemic. The aim of analysing this data was to account for the subjectivism that would complement and contextualise our quantitative analysis. From the wide range of the 94 responses received, the frequently used terms and phrases create codes for our model of analysis. Example of such codes can be seen in Figure 2, such as "old computer", "difficulty in contacting teachers", and "nowhere to work". When we compared different codes to each other we started observing patterns that helped cluster common codes together into collective themes. For instance, not having a "quiet place," working in an "informal setting," or having one's "own room" to study in were grouped together under the same theme. Following this model of analysis gave us three significant themes: 'Quality and accessibility of learning device', 'Level of engagement', and 'Nature of learning environment.'

Figure 2: Codes and Themes used in analysing open-ended survey question

In addition to interpreting and grouping these codes, we also observed a correlation between the themes highlighted above with our socio-economic index. Once we had received all our responses, we organised the answers in the descending order of the socio-economic index calculated. So, respondent 1 had the highest calculated value, 2.3758 which meant that they were the most disadvantaged according to our index, whereas respondent 94 was attributed a value of 0.5109 which meant that they were comparatively advantaged and were placed on the other end of the socio-economic spectrum. When we started highlighting the codes for our research, we observed that most respondents who faced challenges with their devices, whether it be quality or accessibility, were from a poorer socio-economic background. Figure 3 shows how respondent 4, 9, 10, 11 were the ones that faced such issues. When we move on to analysing respondents from the bracket of 63 to 84, we observed that the dominant factor for them was their level of engagement with their school (Figure 3). The observed pattern thus supports our quantitative analysis by demonstrating that most respondents have ranked the factors according to their

subjective experience, even though some had interpreted the question as one asking for their opinion as an indifferent onlooker.

However, whilst our quantitative analysis only found two significant factors in affecting student's educational experience, i.e., access to device and school online support, the qualitative analysis revealed another factor to be significant: the nature of one's learning environment was a common challenge faced by those in the middle socio-economic bracket. Figure 3 shows how respondents 26 to 43 often complained about the lack of a "proper" workspace that affected their quality of education.
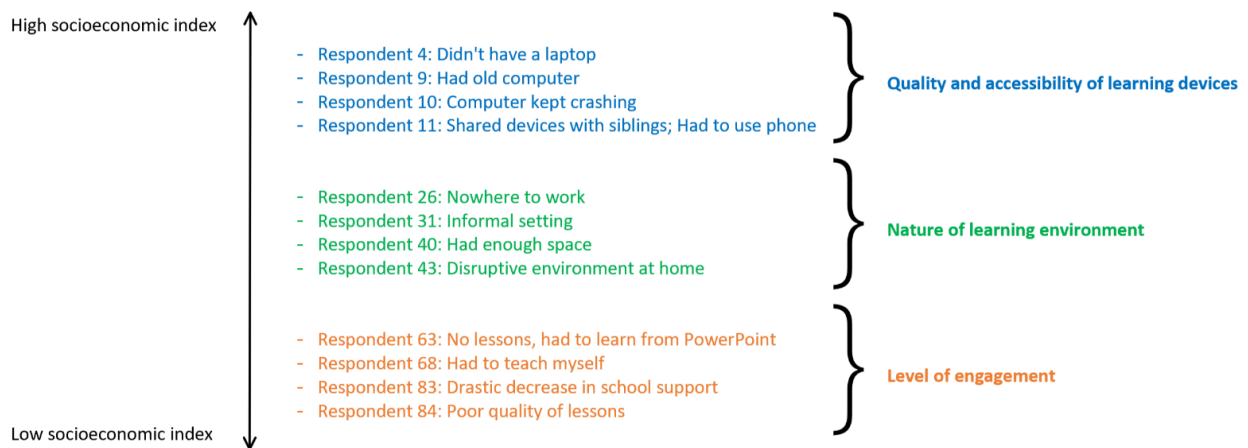
Figure 3: Graph showing respondents in socioeconomic order and their qualitative answers and themes

LIMITATIONS

As a result of the limited timeframe and resources within which this project was developed, there remain significant gaps within our research methodology and findings.

Due to a two-week time constraint for the process of identifying, researching, and articulating our point of interest, we were only able to obtain a minimal amount of data (94 respondents) for this report. This meant that in the quantitative analysis, the R^2 was relatively small, thus the bivariate regression has a compromised explanatory value. Further on from this, the short amount of time available meant that it was difficult to overcome certain biases in the data collection. Issues like that of selection bias took place as we had to quickly collect data, and

subsequently we could not ensure that the surveys would be equally distributed throughout the London boroughs. Consequently, this resulted in 40.8% of respondents being from a single borough (Enfield).

We also saw a notable disparity between our quantitative and qualitative data in one of our findings, such being how important workspace quality was viewed. While our quantitative analysis finds no significant correlation between our socioeconomic index and the students' perceived significance of having an adequate workspace, the qualitative analysis shows that respondents within the middle range of socioeconomic index values report workspace to be a more significant factor, potentially pointing to a nonlinear relationship instead. This underscores the potential limitation of our assumption that the relationships between socioeconomic backgrounds and the various factors are linear. However, this could also be the result of the questions being interpreted differently by respondents, leading them to have ranked the factors from an objective perspective, instead of from their personal experience.

The report is also limited in relation to how it designates poorer and richer respondents. While basing it on factors like that of their borough, where they went to school, and their parent's profession, broad assumptions are made which may not completely and reliably reflect the socioeconomic background of the respondents.

The limitations of this research have continuously been considered throughout this report, and further research over a longer period is essential to strengthen the reliability of the findings within this report. With the long-term consequences of the impact of the digital divide during the pandemic still yet to be seen, it is imperative that these oversights are amended if future research on this topic is to take place is to take place.

CONCLUSION

This paper's intention was to identify aspects of the digital divide which are most profoundly affected by the socioeconomic status of the students: we have accomplished that to some extent.

This paper identifies access to digital devices and school online support as the most profoundly affected aspects of the digital divide by students' socioeconomic status, as they are statistically

significantly correlated with the socioeconomic index adopted for the purpose of our research. Meanwhile, internet connection, digital skills, and workspace are not statistically significantly correlated with our index. The correlation between access to digital devices and students' socioeconomic index is positive, whereas that between online support and the index is negative. This demonstrates that the lack of access to digital devices is a more significant issue for students from a disadvantaged background compared to school online support, and vice versa for students from more affluent backgrounds. Besides, the correlation between school online support and socioeconomic index is stronger compared to access to devices.

Our qualitative analysis complements findings from our quantitative analysis and further highlights that different solutions are required for different socioeconomic groups. By conducting a thematic analysis, we identified three main themes of issues regarding online learning, namely, the quality and accessibility of learning devices, the nature of learning environment, and the level of engagement. We also found a trend with respect to students' socioeconomic backgrounds – students from more disadvantaged socioeconomic backgrounds had issues with accessibility and quality of learning devices; students from more affluent backgrounds identified the level of engagement with online teaching as a more prominent problem; meanwhile, students with an average socioeconomic index mostly reported their learning environment as a concern. The observed trend helps confirm that our quantitative analysis is a revelation of students' personal experience with online learning.

Our findings have begun to hint at potential correlations between certain factors and socioeconomic backgrounds, but further data must still be collected. In order to ensure that policymakers are able to accurately develop concrete measures to narrow the digital divide within the UK, more time should be devoted into verifying the findings of our report and ideally identifying more causal relationships.

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Your experience of education in London during the COVID-19 pandemic. ⌄

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Thank you for showing interest in our study, which is on individuals' experience of online learning during the COVID-19 pandemic in London, for a London School of Economics and Political Science research paper.

We humbly request your honest and truthful response to the questions below, in order for us to obtain data for analysis in the research paper.

Participation is voluntary. There are no negative consequences for you if you decide not to take part in this study. Most of the questions responses are required, and thus if you feel as if you do not want to answer a question for any reason, you can exit the form whenever you like.

This data will be used in our paper, and presented at a final conference for LSE GROUPS; it will be hosted on the LSE GROUPS website (https://info.lse.ac.uk/staff/divisions/Eden-Centre/Eden-events-and-programmes/LSE-GROUPS) after the 17th of June 2022. Plus there is the possibility of presenting the paper at other UK conferences and blog posts etc.

Your participation will be completely anonymous - we do not require a name or email associated with the responses you give.

If you agree to take part in the research, please answer the following questions below with "Yes". The survey starts as soon as you complete the 3 questions below.

The total time to complete may vary on how you answer certain questions, but it should not take longer than 5 minutes at most. Survey data collection ends at 23:59 on Monday 13th June 2022.

Thank you for your participation.

Do you agree that you have read the aforementioned message above in full? *

◯ Yes

Do you agree to participate in the survey? *

◯ Yes

Do you understand that your responses will be kept confidential and anonymous and that your personal information will be kept securely and destroyed at the end of the study? *

◯ Yes

Question about demographics	Weighting of socioeconomic index factors:
What London borough was your/your family member school in?	α - free school meal % of the specific borough for secondary schools in 2019, e.g. for Enfield, α would be 0.172.
What type of school did you/your family member attend?	β: • 0.6 for selective (grammar) school/state/academy • 0.4 for private
Have you/your family member received free school meals in the last 3 years?	γ: • 0.6 for Yes • 0.4 for No
Have you/your family member received government assistance with respect to their education during the pandemic?	δ: • 0.6 for Yes • 0.4 for No
Does the highest income earner in your household hold a university degree?	θ: • 0.4 for Yes • 0.6 for No
Regarding the highest income earner in your household, what sector is their employment in? [PRIMARY - gathering raw materials from the planet. SECONDARY - manufacturing and producing goods using raw materials. TERTIARY - providing services to others. QUATERNARY - research and development of new ideas]	μ: • $\frac{5}{6}$ for not in employment • $\frac{4}{6}$ for primary • $\frac{3}{6}$ for secondary • $\frac{2}{6}$ for tertiary • $\frac{1}{6}$ for quarternary

To what extent did online learning affect the quality of education received during the pandemic? *

	1	2	3	4	
Not much of an impact	○	○	○	○	A great impact

Weighting of different factors depending on option	0.2	0.4	0.6	0.8

Rank the given factors in order from 1-5, with 1 being the factor that affected the quality of *
education the least and 5 being the factor that affected it the most, during the pandemic.
(NOTE: you CANNOT give two factors the same rank e.g. you cannot rank both internet
connection and school support with 5)

	1	2	3	4	5
Internet connec...	○	○	○	○	○
Access to devic...	○	○	○	○	○
Quality of work...	○	○	○	○	○
School online s...	○	○	○	○	○
Digital skills	○	○	○	○	○

Qualitative questions asked:
Briefly explain why you ranked these factors in the order you chose to do so.
If there was any other factors that you believe affected the quality of education received, please state them below.

Regression table:

Dependent variable (aspect of digital divide)	Internet connection	Access to devices *	Quality of workspace	School online support *	Digital skills
Slope coefficient, β (Standard error)	0.0050733 (0.0044583)	0.0087913 (0.0039568)	0.0017406 (0.004295)	-0.0095604 (0.0044872)	-0.0008128 (0.0040502)
t-value	1.14	2.22	-0.41	-2.13	-0.20
p-value	0.258	0.029	0.686	0.036	0.841
R² value	0.0139	0.0509	0.0018	0.0470	0.0004