

Digital learning technologies usage during Covid-19 lockdowns

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Funding information

Economic and Social Research Council

Abstract

The global impact of the Covid-19 pandemic on school education has been unprecedented, with widespread school closures and the need for education to be delivered remotely. By providing an overview of the continuity of learning and teaching during the 2019–2021 academic years, this study aims to contribute to a better understanding of the impact of the pandemic on the use of digital learning technologies in Wales. This study links usage data from the Government's National Learning Platform (Hwb) to national administrative school records for all pupils in maintained schools. It employs a quantitative methodology to model the inequalities in digital learning technology usage. Multiple linear regression is used to quantify the factors associated with pupils' use of the national learning platform before and during the pandemic, with a particular emphasis on school closures. The study's findings show notable differences in the level of learning platform usage across school sectors, with primary school pupils using the platform the most. Furthermore, school-level teacher usage of the platform and household socioeconomic status are key factors influencing pupil usage. The analysis also reveals that levels of learning platform usage prior to the first school closure were associated with learning platform usage in the first school closure period, and usage in the second school closure period was also associated with usage in the first school closure period.

KEYWORDS

access, Covid-19 pandemic, digital learning disparities, remote learning platform

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Key insights

What is the main issue that the paper addresses?

This paper examines the patterns and determinants of digital learning platform logins in Wales before and during the Covid-19 pandemic, focusing on how factors such as socioeconomic status, school characteristics and prior engagement influenced pupils' access to digital learning technologies during school closures.

What are the main insights that the paper provides?

The paper provides insights into digital learning platform logins patterns across school sectors before and during Covid-19 school closures. It reveals associations between platform usage and school-level factors, highlights the relationship between prior and current usage, and identifies differences in logins related to school characteristics and pupil demographics.

INTRODUCTION

The Covid-19 pandemic has had an unprecedented impact on school education worldwide, with many countries imposing lockdowns that resulted in widespread school closures and the need for education to be delivered remotely. In more than 190 countries, schools closed their doors for many weeks or months, affecting over 1.5 billion learners (Maldonado & De Witte, 2021; United Nations, 2020). The paradigm shift towards digital learning became the norm, with no other options considered suitable during a global pandemic. However, concerns were raised about the digital readiness of the educational community, in terms of both learning and teaching, as well as access by learners. Although regarded as a necessary first response to the fast-spreading virus, continued school closures led to concerns about potential learning losses and how these may exacerbate existing educational inequalities (Armitage & Nellums, 2020; Azevedo et al., 2020; Engzell et al., 2021; Maldonado & De Witte, 2021). As a result, the challenges and ramifications of this digital transition in education have been questioned in terms of a 'digital divide' that could lead to educational inequalities by socioeconomic status (SES), ethnicity, special educational needs (SEN), disability and geography (Coleman, 2021; Cullinane & Montacute, 2020; van de Werfhorst et al., 2020; Van Lancker & Parolin, 2020; Ziauddeen et al., 2020).

Digital exclusion has been a long-standing concern in many countries around the world, with the UK being no exception. However, the Covid-19 pandemic has highlighted the extent of this issue and its potential to lead to educational exclusion. The digital divide can exacerbate existing inequalities and negatively impact the well-being of pupils, especially those from disadvantaged socioeconomic backgrounds who are already at risk of learning losses and low academic attainment (Anders et al., 2021; Andrew et al., 2020a, 2020c; Cullinane & Montacute, 2020; Green, 2020; Holmes & Burgess, 2020; Pensiero et al., 2020; Thorn & Vincent-Lancrin, 2022). These pupils may lack the resources and support necessary to adapt to a home learning environment that significantly differs from the classroom setting (González-Betancor et al., 2021; Thorn & Vincent-Lancrin, 2022; Warschauer & Matuchniak, 2010).

Nevertheless, access to technology alone does not guarantee improved learning outcomes. Research suggests that it can also have a negative impact on pupil's well-being and

thus on their learning outcomes if not accompanied by appropriate guidance and digital literacy skills (Cowie & Myers, 2021; Hu et al., 2018; Rasheed et al., 2020). Factors such as the quality of digital resources, particularly a good internet connection, the level of engagement and the ability to effectively use technology for learning play a crucial role in determining the impact of digital access on pupils' well-being and, inherently, on their academic outcomes (Coleman, 2021; Rodríguez-Pose et al., 2024; Warschauer & Matuchniak, 2010).

Thus, the Covid-19 pandemic has also highlighted the need for understanding the factors that influence digital learning platform usage, as this knowledge can inform policy decisions and interventions aimed at promoting educational equity and resilience. While there is a growing body of research on the impact of the pandemic on education and the resulting exacerbation of existing educational inequalities (Blanden et al., 2023; Blaskó et al., 2022; Murat & Bonacini, 2020), few studies have focused specifically on the patterns and determinants of digital learning engagement (Andrew et al., 2020a; Bayrakdar & Guveli, 2023; Green, 2020; Pensiero et al., 2020; Reimers, 2022a, 2022b).

In the UK, the closure of all schools in March 2020 owing to the Covid-19 pandemic prompted the four nations to shift their education delivery online¹ and cancel national examinations (Coleman, 2021). As a constituent nation of the UK, Wales mirrored these sudden educational shifts. However, the Welsh Government maintains devolved authority to make independent decisions regarding health and education policies specific to its schools and population, while often aligning with the broader UK approach. This autonomy allowed Wales to establish its own national online learning platform, Hwb, which was already in place and available for remote education delivery before the Covid-19 pandemic.

Wales's unique position makes it an ideal case study for investigating digital learning usage, as the Hwb Platform was quickly adopted as one of the main forms of learning provision during the pandemic. In this study, we leverage our unique access to the monthly usage metrics by school, which track both the pupils' logins and the total number of logins into the Hwb Platform. These data allow us to address the knowledge gap regarding the patterns and determinants of digital learning usage. Although not exhaustive, these data provide valuable insights into the usage patterns of the platform and by linking these data to other administrative data, we can examine differential access and use by factors such as free school meal (FSM) eligibility.

Building on this foundation, this study aims to contribute to a better understanding of the impact of the pandemic on the access to digital learning technologies in Wales, a nation with unique socioeconomic and educational challenges (Davies et al., 2011), by exploring the factors contributing to disparities in accessing digital learning before and during the Covid-19 pandemic at a school level. Thus, three research questions are addressed:

1. How does digital learning platform usage trajectories (before and during Covid-19 school closures) differ by school sector?
2. What factors are associated with digital learning platform usage before the pandemic?
3. How does the relationship between the above factors (including prior logins) change during the two school closures?

The paper is divided into four sections. The first section provides a theoretical framework for comprehending what were the determinants of inequalities in accessing digital learning technologies during the Covid-19 pandemic in the UK and Wales. The second section describes the study's methodology, including the data sources and analytical methods used to understand the trends and inequalities in access to digital learning before and during the Covid-19 pandemic. The third section presents the findings of the analysis on pupils' logins to Hwb Platform, focusing on their trend by school sector, geography and socioeconomic characteristics at the school level over time. It also explores the association between pupils'

logins and the school's socioeconomic characteristics, as well as other school factors such as geography, language medium, sector and area level of deprivation, in addition to prior pupils' logins to the platform. This section also discusses the implications of the findings, while considering existing literature and theoretical frameworks. Finally, the conclusion summarises the main findings, while also acknowledging the limitations of the data.

CONTEXTUAL FRAMEWORK: INEQUALITIES IN ACCESSING DIGITAL LEARNING DURING THE COVID-19 PANDEMIC IN THE UK

Inequality in access to digital technology has been a longstanding issue in many parts of the world, including the UK. But since the beginning of the Covid-19 pandemic, the consequences have been more apparent, with the shift to remote learning creating new challenges for pupils who lack access to the internet and digital tools. The Covid-19 pandemic exacerbated the digital divide, as schools around the world were forced to close and rely on remote learning to maintain learning and teaching continuity. Worldwide this has resulted in disparities in access to online learning technologies, which have important consequences for educational attainment and future academic progress (Engzell et al., 2021; Major et al., 2021).

Prior to the Covid-19 pandemic, research has shown that disparities in access to digital learning technologies were already present and were often linked to socioeconomic factors, such as demographics and geographical location (Hasebrink et al., 2009; Riggins et al., 2005).

In the UK, digital exclusion has been a central issue for those who are already vulnerable or disadvantaged owing to socioeconomic, geographic or demographic factors (Ofcom, 2022b). The Covid-19 pandemic has further exacerbated this issue, highlighting the fact that digital exclusion can lead to educational exclusion, particularly for pupils who lack access to internet and digital tools (Coleman, 2021). Studies have highlighted the challenges faced by disadvantaged families in supporting their children's home learning during school closures (Bayrakdar & Guveli, 2023; Major et al., 2021; Pensiero et al., 2020; Thorn & Vincent-Lancrin, 2022). These findings underscore the need to investigate the specific experiences and challenges faced by pupils in different parts of the UK, given the distinct socioeconomic and educational contexts of each nation.

This is particularly relevant for Wales, a country with a high level of deprivation when compared with England and Scotland (Abel et al., 2016; Coleman, 2021). Wales faces unique socioeconomic challenges, with a higher proportion of children living in poverty compared with other UK nations (Equality and Social Justice Committee, 2023; Royal College of Paediatrics and Child Health, 2022; The Social Mobility Commission, 2021). This context may exacerbate the impact of digital exclusion on educational outcomes for disadvantaged pupils in Wales. Additionally, data from Ofcom, 2022a indicate that rural areas in Wales often experience slower broadband speeds and poorer internet connectivity, posing challenges for remote learning.

Nevertheless, research in the UK into the impact of the Covid-19 pandemic on inequalities in accessing digital learning technologies has primarily focused on England, with fewer studies on the other nations. There is a paucity of research focusing specifically on Wales, which underscores the need for a focused study to understand the factors contributing to disparities in access to digital learning technologies in this nation.

Studies focusing on England have highlighted the impact of digital exclusion on educational outcomes, as well as the factors that contribute to disparities in access to digital learning technologies (Andrew et al., 2020b; Bayrakdar & Guveli, 2023; Cattan et al., 2021a;

Cullinane & Montacute, 2020; Eivers et al., 2020; Parkin et al., 2020). They have highlighted the importance of factors such as insufficient access to devices and internet connectivity, as well as the lack of digital literacy skills among pupils (Coleman, 2021). In addition, sharing devices and limited data allowances have further hindered pupils' ability to participate in remote learning (Ofcom, 2021). Indeed, a survey of parents in England determined that the primary challenges associated with remote learning are a lack of access to suitable devices, technology compatibility issues or poor internet connection or no internet at all (Ofsted, 2021). This lack of access to reliable internet connectivity can also affect the quality of the learning experience, with pupils from low-income households more likely to experience buffering, slow internet speeds and difficulty accessing online resources (Cattan et al., 2021b; Lucas et al., 2020; Montacute & Cullinane, 2021; Pensiero et al., 2020). Lucas et al. (2020) found that schools in the most deprived areas had twice as many pupils with limited or no IT access, compared with those in the least deprived areas, while Green (2020) found that pupils eligible for free school meals were three times more likely to have no access to a computer at home, compared with the other children. This is in line with findings from a report by Sibieta and Cottell (2020), which revealed insufficient support for disadvantaged and vulnerable children across all four nations.

Studies have also highlighted the disproportionate impact of Covid-19 on ethnic minority groups. For example Goudeau et al. (2021) show differences for pupils from ethnic minority backgrounds in terms of both health and educational outcomes, findings further confirmed by Bayrakdar and Guveli (2023) and Anders et al. (2021). Although there is a lack of extensive research on the relationship between ethnicity and educational impact in the UK during the Covid-19 pandemic, available studies have indicated that schools with a higher proportion of pupils from ethnic minorities are more likely to have lower attendance rates and a higher proportion of pupils requiring intensive catch-up support (Sharp et al., 2020).

Research in Scotland has shown that a considerable number of pupils, particularly those from underprivileged backgrounds and with additional learning needs and disabilities, encounter significant difficulties accessing reliable internet for remote learning purposes (Couper-Kenney & Riddell, 2021). This challenge was especially relevant for pupils from remote rural areas, who faced increasing barriers in accessing remote learning resources owing to both slow internet speeds and a lack of digital devices, further widening the achievement gaps and contributing to learning losses (Crummey, 2022; McCluskey et al., 2023).

In Wales specifically, studies have also detailed similar issues, highlighting that accessing digital learning technologies is highly affected by socioeconomic status (Sandu & Hampton, 2022) and level of digital literacy (Children's Commissioner for Wales, 2021a, 2021b). The lack of digital literacy skills can lead to difficulties in navigating online learning platforms, using digital tools for assignments, and effectively communicating with teachers and peers. This can further widen the existing educational inequalities and negatively impact academic progress and attainment (Coleman, 2021; Equality, Local Government and Communities Committee, 2020).

The Hwb Learning Platform in Wales directly addresses the challenges outlined earlier, offering educators and learners access to a wide range of digital tools and resources. The Platform's creation was a direct response to the main recommendation of the 2012 report titled 'Find it, make it, use it, share it: learning in digital Wales' (Hayward, 2012). This strategic review of digital learning in Wales emphasised the importance of incorporating digital technologies and resources on a broader scale in education. The report advocated for a shift from sporadic to ubiquitous use of digital tools and proposed the establishment of a National Digital Content Repository.

Created in 2012, the Hwb Learning Platform has since become the central digital platform for learning and teaching in Wales. Designed to support and enhance teaching and learning for learners aged 3–19, the platform provides a coordinated approach to digital teaching

and learning. It grants users access to various educational tools and resources including Microsoft Office and Google G Suite for Education, through a single sign-on feature. This allows users to access all the services made available through Hwb using their Hwb username and password, without necessarily visiting the Hwb website itself. This streamlined access proved essential during the Covid-19 pandemic as it enabled educators to provide ongoing learning through virtual classrooms.

Since its establishment in 2012, the Hwb Learning Platform has been freely available to every pupil and teacher in Wales. However, it is important to acknowledge that while Hwb logins provide some insight, they offer only a partial indication of overall Hwb usage, as users can access third-party services offered through Hwb directly without logging in through the Hwb website. These logins are not included in the data analysed in this study, as they were not available. Thus, a low number of Hwb Platform logins does not necessarily imply low usage of Hwb services overall. Additionally, the aggregated nature of the data at the school level introduces biases, as it does not capture individual-level information, masking individual variations and patterns.

Thus, given the nationwide accessibility of the Hwb Learning Platform, it is worth exploring its role in education prior to the pandemic and the subsequent changes in usage patterns. How did educators and learners engage with the platform before the pandemic, and how have these patterns evolved over time? With the unprecedented shift to remote and online learning during the pandemic, it is important to evaluate the trends in platform usage of the Hwb Platform. How has the frequency and pattern of logins changed as educators and learners adapted to the new learning environment? Assessing these usage trends can provide valuable insights into the evolving role and usage of the Hwb Platform in facilitating remote and online education. Moreover, the findings of our study will be adding to the growing body of research on digital equity and literacies across UK nations and similar Global North contexts. This aligns with the broader narrative of social innovation, where enhancing digital skills is a key policy instrument for addressing inequalities and promoting inclusiveness across education, but also across broader socioeconomic contexts (Trofymenko et al., 2023).

DATA AND METHODOLOGY

Data

The present study uses a dataset comprising information on pupil accounts and their direct logins to the Hwb Platform in maintained schools in Wales for the academic years of 2019/2020 and 2020/2021, spanning specifically from September 2019 to February 2021. The data were provided by the Welsh Government for 1432 schools, including 1210 primary schools, 182 secondary schools and 40 special schools. The data were accessed through a secure data sharing agreement with the Welsh Government that ensured proper data governance protocols were followed. The dataset did not include any personally identifiable information on individual pupils or teachers. The data only include monthly aggregate information by school for: (1) number of accounts (total and pupil) and (2) number of logins into Hwb (total and pupil). The number of staff accounts and staff logins per month, for each school, could then be calculated by taking the total accounts/logins and subtracting the pupil accounts/logins.

To account for variations in the number of school days in each month during the study period, the number of logins was first weighted by the number of school days for that month. This step ensures that the login data are comparable across months with different numbers of school days. The weighted login variable was then further adjusted to account for the number of user accounts (pupils or staff) in each school, allowing for comparability across

schools of different sizes. This adjustment was done by dividing the weighted number of logins by the number of accounts and then multiplying by 100 to obtain a measure of access ratio. It needs to be acknowledged that a 100% access rate does not imply that each user logs in once per day, as users may log in and out multiple times, especially when sharing devices or having data restrictions. The access rate reflects the overall direct platform logins relative to the number of user accounts, rather than accurately measuring individual login behaviour.

Moreover, it is important to keep in mind that not every school used the Hwb Platform consistently or at all, and that users could directly access certain learning resources without logging into Hwb itself. Consequently, these data serve as a partial representation rather than a comprehensive measure of Hwb usage or digital learning as a whole during that period. Nevertheless, by analysing trends over time and making comparisons across schools based on their characteristics, the Hwb data can offer valuable insights into remote learning in response to the pandemic in Wales.

The Hwb Platform data were supplemented by data from the Pupil Level Annual School Census, which were collected in January 2020. This additional data encompassed several variables including pupils' eligibility for free school meals (eFSM), special education needs (SEN), ethnicity and school size, as well as the decile of deprivation based on the Welsh Index of Multiple Deprivation (WIMD) for the most recent available year, specifically 2019. These were retrieved from StatsWales, at school level. Data on school location (urban/rural) were also incorporated, which were retrieved from DataMapWales.

Finally, the timeframes of the two nationwide school closures established in Wales served as the framework for these analyses, as follows: (1) before school closure (September 2019 to February 2020); (2) first school closure (April to June 2020); and (3) second school closure (December 2020 to February 2021). Importantly for all the analysis, the month of August is not considered, as it being the summer holidays, the usage was minimal and it would have skewed interpretations if included.

Methodology

The study uses descriptive statistics to examine patterns of usage across maintained schools in Wales. Specifically, we examine differences in the mean weighted number of logins to the digital learning platform across different school sectors (primary, secondary and special schools), but we also consider the socioeconomic status (as indicated by eFSM), SEN and ethnicity.

To derive insights into usage patterns related to these three indicators, the schools are grouped into two categories—above and below the national (Wales) median percentage. This grouping allows for a comparative analysis of mean weighted number of logins to the digital learning platform between these two categories and allows for the identification of any variations or trends that may exist at the level of Wales when examining the overall usage of the Hwb Platform.

The study also examines the impact of several factors on pupils' average usage across three distinct periods through econometric models:

- before first school closure—Model 1;
- first school closure—Model 2; and
- second school closure—Model 3.

Disparities in patterns of Hwb access owing to socioeconomic status were investigated using indicators of disadvantage and vulnerability, such as eFSM, SEN and

ethnicity—simplified to percentage of White British pupils, owing to low numbers of non-White British pupils in Wales—all aggregated at the school level. We consider the language medium of learning and teaching to account for the context of Wales, where both English and Welsh are official languages. We also use school location data to categorise the school into an urban/rural classification, and include a measure of the school neighbourhood deprivation—WIMD. Employing both the eFSM data and the WIMD data allowed us to account for situations where pupils live outside the Lower Layer Super Output Area (LSOA) of their school. To assess the potential multicollinearity among the independent variables, the variance inflation factor (VIF) was computed for each of the three models. As the values for the two variables ranged from 1.26 to 2.27, below the commonly used threshold of 5 and even the more conservative threshold of 2.5, it suggests no considerable multicollinearity among the independent variables (Johnston et al., 2018; Shrestha, 2020).

Furthermore, we include staff average logins and prior pupils' average logins in our analysis to examine the relationship between current and past Hwb average logins (see Table 1).

RESULTS AND DISCUSSIONS

This section provides an indication of Hwb logins patterns and trends in Wales, before and during the Covid-19 pandemic, with a particular focus on the two school closure periods. Our study will then discuss estimates of the associations between pupils' Hwb usage (aggregated at the school level and to each month) and pupil socioeconomic status, also aggregated at the school level, and school characteristics including school location data (urban/rural), socioeconomic characteristics of the areas schools are located in (WIMD) and staff login data. Models for the two school lockdown periods include prior measures of the outcome (pupils' logins). By examining the correlations between these factors and Hwb logins, we aim to gain a deeper understanding of the digital learning disparities present in Wales and to identify key predictors of higher use of the Hwb Platform.

Hwb learning platform: Trends in the access before and during the Covid-19 pandemic—Descriptive overview

Figure 1 provides clear evidence of the impact of school closures on Hwb Platform usage among pupils. Specifically, there was a significant increase in the pupils' login into Hwb Platform starting from March 2020, peaking in April 2020 and subsequently declining until July 2020, which corresponds to the first school closure. During the second school closure (December 2020 to February 2021), Hwb Platform usage further increased, reaching a peak in January 2021. However, it is important to note that despite similar increasing trends over time, there were substantial variations in the levels of use across different school sectors, with secondary and special schools accessing the Hwb Platform far less than primary schools. Indeed, in primary schools during the first school closure, there were an average of 47 logins per 100 pupil accounts, whereas secondary schools had only 20 logins per 100 pupil accounts and special schools had only 12 logins per 100 pupil accounts. Moreover, during the second school closure, while the ranking of sectors in terms of Hwb usage remained the same, the gap between primary schools and the other two sectors doubled in value.

Figure 2 shows the mean logins by school type for different socioeconomic status groups (Figure 2a), ethnicity (Figure 2b) and special education needs (Figure 2c)—above and below Welsh median. When considering socioeconomic status, one could note there is a link between Hwb usage and the school's proportion of pupils eligible for free school meals (Figure 2a). Pupils are eligible for free school meals if their families receive certain benefits

TABLE 1 Variables for the econometric models.

Variable	Description	Model 1 inclusion	Model 2 inclusion	Model 3 inclusion
Pupils' logins before first school closure	Proportion of pupils' logins from September 2019 to February 2020	Dependent variable	Independent variable	Independent variable
Pupils' logins during the first school closure	Proportion of pupils' logins from April 2020 to June 2020	—	Dependent variable	Independent variable
Pupils' logins during the second school closure	Proportion of pupils' logins from December 2020 to February 2021	—	—	Dependent variable
Staff Hwb logins before the first school closure	Proportion of staff logins on the Hwb Platform	Independent variable	—	—
Staff Hwb logins during the first school closure	Proportion of staff logins on the Hwb Platform	—	Independent variable	—
Staff Hwb logins during the second school closure	Proportion of staff logins on the Hwb Platform	—	—	Independent variable
%eFSM	The percentage of pupils in each school eligible for free school meals	Independent variable	Independent variable	Independent variable
%SEN	The percentage of pupils in each school with special educational needs	Independent variable	Independent variable	Independent variable
Ethnicity	The percentage of pupils in each school who are White British	Independent variable	Independent variable	Independent variable
WIMD 10%	Categorical variables representing the school location based on the WIMD, respectively WIMD—10% most deprived, WIMD—20% most deprived, WIMD—30% most deprived and WIMD—50% most deprived, WIMD—50% Least deprived being the reference category	Independent variable	Independent variable	Independent variable
WIMD 20%		Independent variable	Independent variable	Independent variable
WIMD 30%		Independent variable	Independent variable	Independent variable
WIMD 50%		Independent variable	Independent variable	Independent variable
Welsh medium	Categorical variables representing the language medium used in the school, with <i>English medium</i> as the reference category	Independent variable	Independent variable	Independent variable
Other than Welsh/English medium ^a		Independent variable	Independent variable	Independent variable
Secondary school	Categorical variables representing the school sector, with <i>Primary school</i> as the reference category	Independent variable	Independent variable	Independent variable
Special school		Independent variable	Independent variable	Independent variable

^aIncludes: bilingual, dual stream and English with significant Welsh.

WIMD, Welsh Index of Multiple Deprivation.

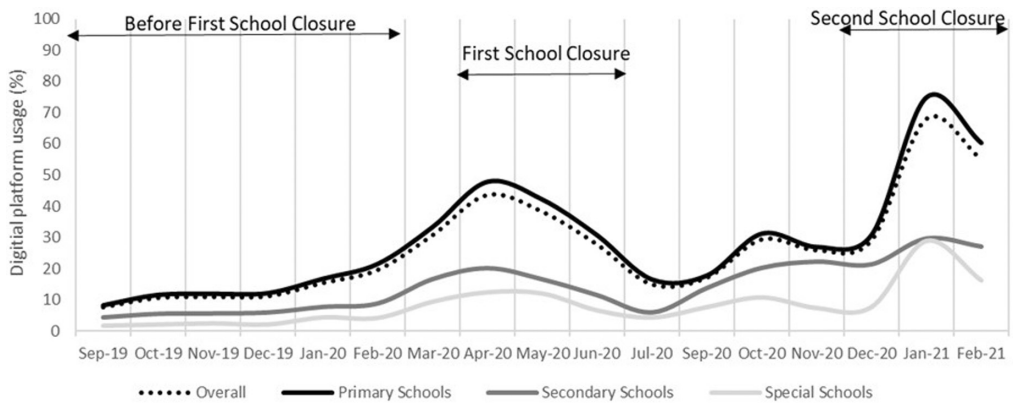


FIGURE 1 Hwb Learning Platform mean logins for pupils by school sectors—Wales level.

or fall below a specified income threshold.² Schools with lower Hwb usage have a higher percentage of pupils who are eligible for free school meals. Moreover, throughout the entire period, the data indicate that the gap between pupils' logins in the two school groups remains relatively constant. This suggests that the differences in Hwb Platform usage is a persistent and enduring pattern.

In the case of ethnicity (see Figure 2b), little to no difference could be observed throughout the whole period of analysis. The data suggest that ethnicity does not appear to impact Hwb usage, as the levels of engagement remain relatively similar across two groups. However, when taking into account a below median vs. above median Wales proportion of pupils with a special education needs (Figure 2c), one could note that schools with a lower proportion of pupils with special education needs demonstrate higher levels of Hwb usage, particularly during the two school closures. Nevertheless, it is important to keep in mind that these figures provide a simplified overview of the trends in Hwb Platform logins for these two groups of schools. As a result, the trends observed may be affected by confounding factors that are not accounted for, but will however be considered in the next section when regression analysis is employed.

Determinants of access to digital learning disparities before and during the Covid-19 pandemic

In this section, we present the key findings obtained from the three econometric models, as outlined in the methodological section. Specifically, we examine the factors that are significantly associated with pupils' login rates into the Hwb Learning platform across three distinct periods: before first school closure—Model 1 (see Table 2); first school closure—Model 2 (see Table 3); and second school closure—Model 3 (see Table 4).

Our first model (see Table 2) provides a baseline understanding of the factors that positively or negatively seem to influence Hwb Platform logins. Specifically, our results indicate that schools that have a language medium other than English (Welsh medium, bilingual, dual stream and English with significant Welsh) have reported higher levels of logins compared with those that teach in English. Our results also suggest that the wider socioeconomic characteristics of the areas schools are located in, as measured by the WIMD, seem to have an influence on pupil logins, with schools located in the most deprived LSOAs demonstrating lower levels of platform usage compared with those located in the 50% least deprived LSOAs. Indeed, schools in deprived areas may face challenges such as limited funding,

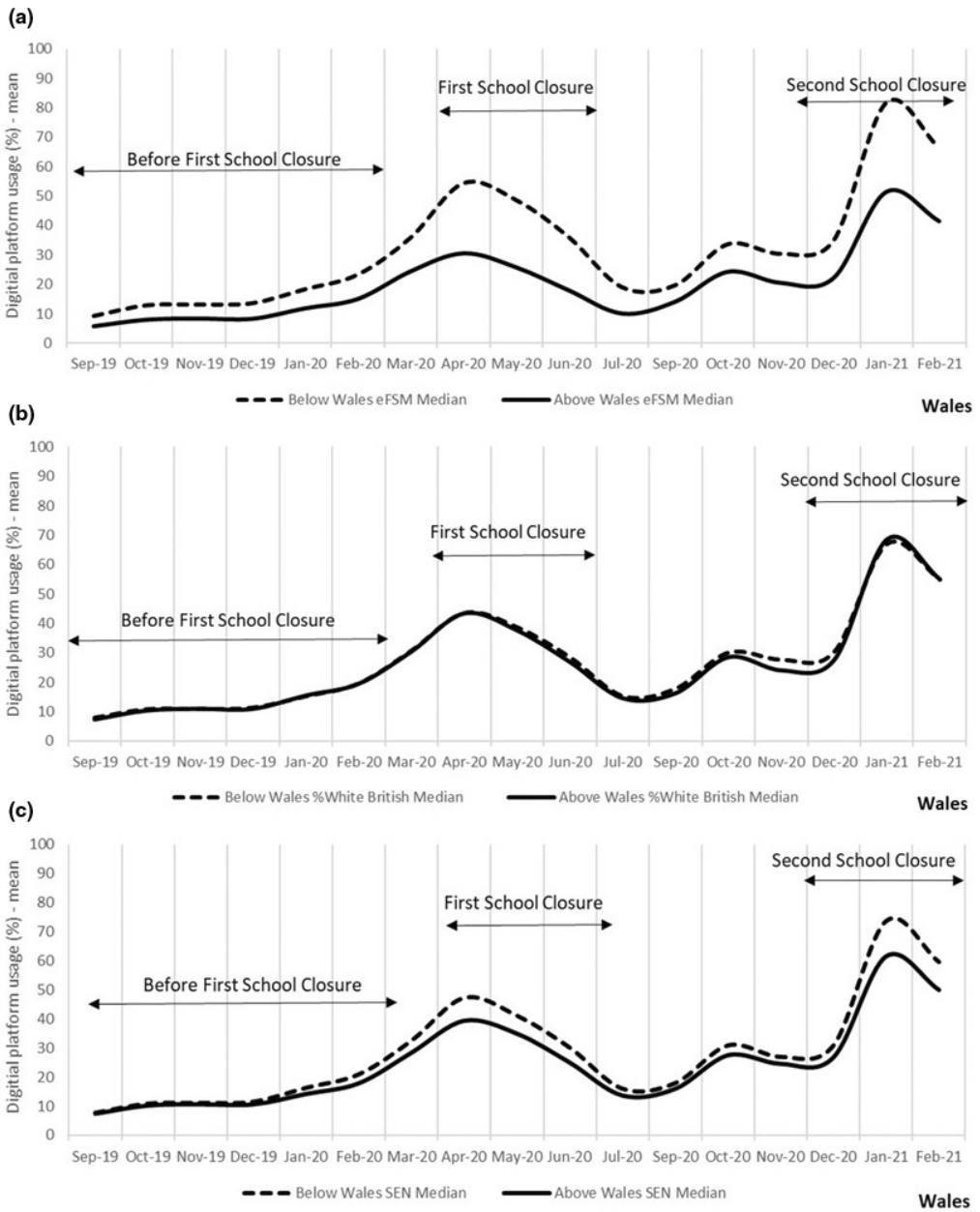


FIGURE 2 Hwb Learning Platform average logins for pupils in Wales by eligibility for free school meals (%) (a), ethnicity (%) (b) and special education needs (%) (c).

which may impact their ability to support the effective use of digital resources like the Hwb Learning Platform. Moreover, it is possible that pupils from those schools face other challenges that may have also contributed to the lower levels of usage, such as food insecurity or poor living conditions, which could impact their ability to engage in learning and making use of digital resources like the Hwb Learning Platform (Children's Commissioner for Wales, 2021b; Coleman, 2021). This brings into question the role of household conditions in determining learning inequality during school closures and remote learning (Azevedo et al., 2020). Indeed, Reimers (2022a) highlights how the pandemic exacerbated various

TABLE 2 Model 1: before first school closure (T1)—results.

Variables	Coefficient	Robust standard error
Staff Hwb logins	0.0099	-0.008
% eFSM	-0.1611***	-0.041
% SEN	0.1601***	-0.040
Ethnicity (%) White British	-0.0143	-0.024
School location: WIMD 0–10% most deprived	-2.3724*	1.265
School location: WIMD 10–20% most deprived	-2.1727*	1.234
School location: WIMD 20–30% most deprived	-1.5977	1.089
School location: WIMD 30–50% most deprived	-1.9925**	1.011
Language medium: Welsh medium	4.0980**	1.659
Language medium: other than Welsh/English medium	3.9309***	1.037
School location—urban areas	-1.7189*	0.889
School sector—secondary school	-7.6620***	0.975
Constant	14.0494***	1.343
Observations	1222	
R^2	0.1237	
Adjusted R^2	0.115	

*** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

eFSM, eligibility for free school meals; SEN, special educational needs; WIMD, Welsh Index of Multiple Deprivation.

challenges, including poverty, social inequality, limited resources and constrained space at home, all of which hindered children's ability to study effectively.

The school sector has a statistically significant influence on the level of Hwb Learning Platform logins, with secondary schools demonstrating lower levels of platform usage compared with primary schools. This could be attributed to a range of factors, including differences in the types of learning activities and resources offered to pupils in primary vs. secondary schools. For example, primary school pupils may require more interactive learning activities that can be facilitated through online platforms, while secondary school pupils may require more advanced and specialised resources that are not as readily available through online learning platforms (Coleman, 2021).

Moreover, the school location, with respect to urban or rural areas, seems to have a statistically significant influence on the level of Hwb Learning Platform logins, with schools located in urban areas demonstrating lower levels of platform usage compared with those in rural areas. This finding is interesting, as urban areas typically have better access to high-speed internet and digital resources compared with rural areas (Lai & Widmar, 2021; Ofcom, 2022a). One potential explanation for this finding is the presence of competing digital entertainment options in urban areas. As mentioned in the Ofcom (2020) report, children and adolescents in the UK have increasingly been using digital media for entertainment purposes. This trend may have been more pronounced in urban areas, where pupils generally have better internet connectivity and access to a wider range of digital entertainment options, such as video streaming, gaming and social media (Mesce et al., 2022). However, further research is needed to identify the specific factors contributing to the observed differences in the Hwb Platform logins between urban and rural schools.

In terms of aggregated socioeconomic characteristics of the pupils within schools, schools that have a higher percentage of pupils eligible for free school meals tend to demonstrate lower levels of logins into the Hwb Platform. Ethnicity, however seems to have no significant

TABLE 3 Model 2: first school closure (T2)—results.

Variables	Coefficient	Robust standard error
Constant	18.1753***	2.781
Staff Hwb logins	0.2557***	0.016
% eFSM	-0.5603***	0.071
% SEN	0.0589	0.072
Ethnicity (%) White British	-0.0121	0.046
School location: WIMD 0–10% most deprived	0.9951	1.971
School location: WIMD 10–20% most deprived	0.2223	2.172
School location: WIMD 20–30% most deprived	-8.4587***	1.688
School location: WIMD 30–50% most deprived	-3.0793*	1.799
Language medium: Welsh medium	3.0249	3.475
Language medium: Other than Welsh/English medium	-1.1830	2.002
School location—urban areas	-4.4103**	1.755
School sector—secondary school	-8.0847***	1.771
Pupil logins—before first school closure	0.7410***	0.088
Observations	1218	
R^2	0.5664	
Adjusted R^2	0.562	

*** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

eFSM, eligibility for free school meals; SEN, special educational needs; WIMD, Welsh Index of Multiple Deprivation.

influence. In contrast, schools with a higher percentage of pupils with special education needs seem to have higher levels of logins into the Hwb Platform. These findings may appear to contradict the trends observed in Figure 2c, which shows that schools with an above-median proportion of pupils with SEN in Wales have lower levels of Hwb usage compared with those with a below-median proportion. Nevertheless, the regression model considers the values for each school, controlling for other variables such as school sector, language medium and socioeconomic deprivation. This allows for a more precise estimation of the relationship between the percentage of pupils with SEN and Hwb Platform logins while accounting for the influence of other factors.

Model 2 examines factors associated with changes in login rates during the first school closure, controlling for pupils' logins before first school closure. Importantly, as a model of change, these coefficients represent the effects on the change in logins.

When analysing the average number of pupil logins during the first school closure (see Table 3) our results indicate that prior levels of pupil engagement demonstrate a statistically significant influence, as do the staff logins, both having a positive influence. This suggests that schools with higher pupil logins before the first school closure and higher staff engagement during the school closure tended to maintain higher pupil login rates during the first lockdown. Thus, the Covid-19 pandemic can be viewed both as a path accelerator and as a path change concerning digital learning (Baxter et al., 2023; Zancajo et al., 2022).

Indeed, the inclusion of previous pupils' logins as a control variable substantially increases the model's R^2 value, indicating that prior logins levels are a strong predictor of current engagement. This high R^2 value, however, may also raise concerns about potential multicollinearity among the independent variables. To address this issue, we conducted a VIF analysis, which revealed that all of the variables have VIF values below the commonly

TABLE 4 Model 3: first school closure (T3)—results.

Variables	Coefficient	Robust standard error
Constant	-1.7491	3.007
Staff Hwb logins	0.2768***	0.019
% eFSM	-0.1585*	0.091
% SEN	-0.0149	0.091
Ethnicity % White British	0.1467***	0.055
School location: WIMD 0–10% most deprived	-5.0535*	2.958
School location: WIMD 10–20% most deprived	-1.7419	2.529
School location: WIMD 20–30% most deprived	0.2417	2.753
School location: WIMD 30–50% most deprived	0.2797	2.133
Language medium: Welsh medium	2.4098	3.622
Language medium: other than Welsh/English medium	5.5413**	2.213
School location—urban areas	-0.4287	1.988
School sector—secondary school	-2.1639	2.366
Pupil logins—before the first school closure	0.8052***	0.040
Pupil logins—during the first school closure	0.2838***	0.090
Observations	1215	
R^2	0.7340	
Adjusted R^2	0.731	

*** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$.

eFSM, eligibility for free school meals; SEN, special educational needs; WIMD, Welsh Index of Multiple Deprivation.

used thresholds of 2.5 or 5, with a mean VIF of 1.46. This indicates that multicollinearity is not a significant problem in our model. Furthermore, the substantial decrease in the R^2 value to 0.20 if staff and previous pupil login variables are removed from the model underscores the important role of these factors in explaining pupil logins into the Hwb Learning Platform during the first school closure. The inclusion of these variables is supported by previous studies that underscore the significance of prior experience and familiarity with digital technologies in shaping the adaptation to remote learning (Bubb & Jones, 2020; Huber & Helm, 2020; Ivari et al., 2020; Inan & Lowther, 2010; König et al., 2020; Lucas et al., 2020; van Braak et al., 2004).

Similar to our previous model, but while controlling for before the first school closure logins, we found that schools that had a higher percentage of eFSM pupils continued to demonstrate a negative influence on Hwb Platform logins. However, for this model ethnicity and the school's percentage of pupils with SEN did not seem to have any statistically significant influence, nor did the language medium. With respect to the socioeconomic characteristics of the areas schools are located in, as measured by WIMD, our findings suggest a negative influence on Hwb Platform logins among schools located within the 20–30% and 30–50% most deprived LSOAs, compared with pupils' logins from schools located within the 50% least deprived LSOAs.

Interestingly, the results suggests that pupils studying at schools located in urban areas displayed lower levels of platform usage compared with pupils from rural areas during the initial pandemic lockdown period, holding previous login rates constant. While as mentioned earlier, one could speculate that pupils from urban areas tend to have more distractions and alternative options for spending time offline, decreasing engagement with remote learning

platforms, these hypotheses require a more systematic analysis in order to better understand the factors behind this difference.

The final model (see Table 4) examines factors associated with pupils' logins during the second school closure, controlling for pupils' logins before and during the first school closure. As a model of change, these coefficients represent the effects on login rates during the second closure period, after accounting for previous login levels.

As such, similar to Model 2, the R^2 for this model is high, even higher than for Model 2. As in the case of Model 2, when staff and pupil previous logins variables are removed, the R^2 value decreases substantially to 0.19. This important decrease in explanatory power underscores the important role of these factors in explaining pupil logins into the Hwb Learning Platform during the second school closure, as also observed in Model 2.

Similar to the concerns raised in Model 2, the high explanatory power of Model 3 may raise questions about potential multicollinearity among the independent variables. To address this issue, a VIF analysis was also conducted, revealing that all of the variables have VIF values below the commonly used thresholds of 2.5 and 5, with a mean VIF of 1.52, providing confidence in the estimated coefficients, as was the case in Model 2.

The results seem to indicate that both staff logins and prior pupils' logins positively influence pupils' usage. This suggests that schools with higher logins in the two previous periods tended to have higher rates during the second school closure, even after accounting for prior logins, possibly suggesting that familiarity with the Hwb Learning Platform led to more consistent use.

Again, after accounting for pupils' logins before and during the first school closure, schools having a higher percentage of eFSM pupils seems to have a negative influence on pupils' logins. Indeed, the school's percentage of pupils eligible for free school meals (eFSM) appears to have a significant negative influence across all three models. This is concerning as eligibility for free school meals is often used as a proxy measure for disadvantage and vulnerability in the UK (Hobbs & Vignoles, 2007; Ilie et al., 2017; Taylor, 2017), and pupils from disadvantaged backgrounds are already more likely to face barriers to academic achievement (Connolly, 2006; Cook et al., 2014; Crawford et al., 2014; Humphrey et al., 2013; Shaw et al., 2017). Therefore, the lower levels of Hwb Platform logins among schools with a high percentage of pupils eligible for free school meals could exacerbate existing inequalities in education, leading to learning opportunities loss, attainment issues and falling behind, which are already a problem in Wales (Connolly, 2006).

The school's percentage of pupils with SEN did not show any significant influence on Platform logins. Additionally, the logins did not vary significantly based on school location (urban/rural), nor based on the wider socioeconomic characteristics of the areas where schools are located, as measured by the WIMD, or the school sector. However, for this model, ethnicity seems to influence the level of logins into the Hwb Platform, with schools having a higher percentage of White British pupils demonstrating significant higher usage rates. Moreover, in terms of the language medium, schools with language mediums other than English/Welsh (bilingual, dual stream and English with significant Welsh) have higher levels of logins into the Hwb Learning Platform. These associations are observed while controlling for pupils' login rates from previous periods, allowing us to examine relationships during the second school closure beyond the influence of prior usage levels.

Finally, the strong association between pupils' logins before and during the second school closure could raise some questions about the underlying factors driving digital engagement. It is possible that unobserved characteristics, particularly household factors, have interacted with school-level factors in shaping pupils' participation during this extended period of remote learning. The answers to these questions could provide valuable insights into the complex dynamics at play during this unprecedented period of educational disruption. Further

research is needed to explore these questions and to better understand how different factors influenced pupils' engagement with digital learning platforms throughout the pandemic.

CONCLUSIONS

Even though digitalisation is widespread in our daily lives, the Covid-19 pandemic shows that the educational system is not yet able to provide equitable access to digital learning technologies. While first viewed as a viable method of reducing the speed of virus spread, legitimate concerns have been expressed regarding digital exclusion and the exacerbation of existing educational disparities owing to a lack of remote-learning opportunities for some pupils.

In Wales, digital learning platform login trajectories showed variations not only based on the school sector but also based on the socioeconomic status. Eligibility for free school meals emerged as a significant factor that contributed to lower Hwb Learning Platform usage both before and during the school closures. This highlights that the pandemic exacerbated existing disparities rather than being the sole cause.

Furthermore, the models of change show a strong association between prior pupils' login and subsequent logins during school closures. While this is common when including lagged variables, it highlights potential consistency in engagement patterns over time. By including these lagged variables, our models account for the potential path dependency in the adoption and use of digital learning tools. However, one should interpret these associations cautiously, recognising that they represent the relationship between prior and current usage patterns, rather than direct causal effects. These findings suggest that efforts to encourage engagement with the platform might have ongoing effects on usage patterns, but further research would be needed to establish a strong causal relationship. Additionally, the statistically significant association of staff usage and pupils' logins highlights the key role of staff engagement with digital technologies and their ability to encourage and facilitate the use of these technologies among pupils. It also underscores the importance of providing support to staff to effectively use digital platforms and enhance pupils' learning experiences.

Moreover, the socioeconomic characteristics of the areas where schools are located, as measured by the WIMD, also had an impact on the usage of the Hwb Platform. Pupils attending schools in more deprived areas had lower logins into the Hwb Platform than those in less deprived areas, both before and during the school closures. This underscores the necessity of providing additional support to schools in deprived areas, assisting them in overcoming the challenges they face while implementing digital technologies. Additionally, there is a pressing need to address pre-existing inequalities that were present even before the Covid-19 pandemic emerged.

Indeed, in response to these issues, policymakers and educational institutions have implemented various strategies and interventions to address the digital divide during the pandemic. These included providing devices and internet connectivity, while also aiming to develop digital literacy skills. However, the effectiveness of these strategies remains unclear, and further research is needed to understand their impact on narrowing the gap in access to digital learning technologies and improving educational outcomes for disadvantaged pupils (Sibieta & Cottell, 2020).

Finally, while our study provides valuable insights into the usage of the Hwb Learning Platform during school closures in Wales, it is important to acknowledge several limitations that may impact the interpretation and generalisability of our findings. First, it is important to acknowledge the limitations of Hwb data logins as a measure of Hwb usage and online learning. While these logins provide some insight, they offer only a partial indication of overall Hwb usage, as it is possible to access Hwb resources without logging on

via Hwb. Moreover, the login data used do not have information on which specific pupils are logging in, their individual backgrounds, or whether they logged in multiple times. This lack of individual data at the pupil level limits our ability to analyse the logins patterns of different pupils' subgroups, such as those from disadvantaged backgrounds or with special educational needs.

Additionally, the Hwb data logins may not capture the full extent of online learning activities, as there are other digital platforms or tools used for educational purposes that are not integrated with Hwb or do not require Hwb logins. For example, pupils and teachers may use Google Classroom, Microsoft Teams or other integrated educational tools (single sign-on) without necessarily logging into the Hwb Platform itself. However, these logins to third-party services are not included in the data. Consequently, low levels of Hwb website logins do not necessarily imply low usage of Hwb services overall. It is possible that schools and pupils were actively using the various resources and tools provided by Hwb, even if they were not logging in through the main Hwb website. Thus, relying solely on Hwb data may provide an incomplete picture of the overall online learning landscape, as the data solely reflect logins to the Hwb Platform and do not provide information on the actual usage or engagement with the available resources and thus does not capture the quality or effectiveness of the learning experiences.

Lastly, the aggregated nature of the data at the school level introduces biases, as it does not capture individual-level information, masking individual variations and patterns. Indeed, while data aggregated at the school level give some insight into pupils' circumstances as a whole in a specific school, it may not account for variations in access to technology or personal circumstances such as household socioeconomic characteristics. Taking into account individual circumstances is important for designing targeted interventions and ensuring equitable access to online learning resources.

In conclusion, while recognising the limitations of the Hwb data, this study remains a good starting point for understanding the patterns and trends in digital platform usage during school closures in Wales and one should consider the results within the context of the broader picture they aim to provide. Overall, this research contributes new insights to the growing body of research on the impact of the Covid-19 pandemic on education by focusing specifically on the determinants of digital learning platform usage in Wales. Our findings underscore the importance of considering the unique socioeconomic and educational contexts of different nations when examining the factors influencing pupils' engagement with digital learning technologies. By leveraging linked administrative data, we were able to identify the persistent influence of socioeconomic disparities, such as eligibility for free school meals, on platform logins, both before and during the pandemic. Furthermore, our study highlights the important role of staff engagement and prior pupil usage in driving platform logins during school closures, providing valuable insights for educators and policymakers seeking to support the effective implementation of digital learning strategies. All in all, these findings can guide the development of targeted interventions and policies that aim to mitigate the long-term impacts of the pandemic on educational outcomes and build resilience in the face of future crises in Wales and beyond.

ACKNOWLEDGEMENTS

This research was undertaken with funding from the Economic and Social Research Council (awards ES/S012435/1 and ES/W012227/1), for which we are very grateful. We would also like to thank the Welsh Government, for providing the Hwb Learning Platform data used in this analysis. The authors are also grateful to Dr Robert French, Dr Katy Huxley and Dr Jennifer Keating for reviewing several versions of the manuscript.

FUNDING INFORMATION

This research was undertaken with funding from the Economic and Social Research Council (awards ES/S012435/1 and ES/W012227/1).

CONFLICT OF INTEREST STATEMENT

No potential conflict of interest was reported by the authors.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the Welsh Government. Restrictions apply to the availability of these data, which were used under a secure data-sharing agreement.

ETHICS STATEMENT

The study did not require individual consent or ethical review board approval.

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ENDNOTES

¹ We recognise that schools remained opened for pupils whose parents were essential workers and specific groups of vulnerable children (Coleman, 2021).

² It is important to note that as of September 2022, the Welsh Government has begun rolling out the Universal Primary Free School Meals programme, which aims to provide free school meals to all primary school children in Wales by 2024. However, at the time of this study, the changes had not been implemented.

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How to cite this article: Sandu, A. & Taylor, C. (2024). Digital learning technologies usage during Covid-19 lockdowns. *British Educational Research Journal*, 00, 1–22. <https://doi.org/10.1002/berj.4092>