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Article

Mixed-Methods Inquiry of Socially Inclusive e-Learning: A Policy Document Analysis and Rapid Survey Study

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Abstract

The Covid-19 pandemic has catalyzed irreversible structural changes in education systems worldwide. One key development is the broad utility of remote digital e-learning modalities for learning and instruction that could jeopardize social inclusion if digital in(ex)clusion is left unaddressed. This study assembles a two-step mixed method research design and conducts a case inquiry of Shaanxi Province in China by leveraging policy document analysis and rapid survey methodology in examining how transitions to remote digital e-learning may introduce learning barriers to children from vulnerable backgrounds. Findings reveal that children's access to remote digital e-learning devices during the rapid transition to e-learning has a close association with their backgrounds. Key policy implications include utilizing multimodal hybrid technology in diversifying content delivery and maximizing e-learning coverage, developing open learning platforms, expanding access to e-learning resources, and collaborating with industry partners to bring tangible support to families and realize meaningful e-learning at home.

Keywords

China; Covid-19; digital e-learning; rapid survey; remote e-learning

Issue

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1. Introduction

The novel coronavirus epidemic caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) began in December 2019 and spread rapidly around the world (Zhang et al., 2020). According to the World Health Organization (2020), more than a hundred countries, territories, and regions were affected to varying degrees. As a collateral consequence, education systems were faced with an imminent challenge of more than three-in-five children at academic risk in the wake of system-wide school closures, as public health mandates and social distancing measures were enforced to contain local disease transmission (UNESCO, 2020a). To this end, recent studies estimate that school closures are

expected to result in a quality-adjusted loss of 0.6 years of schooling, reducing the effective years of basic education achieved by children in their schooling from 7.9 years to 7.3 years (Azevedo et al., 2021). In light of new societal realities imposed as consequence of the Covid-19 pandemic, unintended adversities inevitably add to an already widening learning crisis around the world that impedes children from reaching their full potential (Liu, 2021).

In light of broad-spectrum learning interruptions, designing and implementing digital remote e-learning strategies at scale have become a near unitary response to mitigate adverse learning loss in the wake of broad-base school closures globally (Liu et al., 2021). Digital remote e-learning is commonly a manifest of the

teacher–learner separation in both time and space, by leveraging media and technology devices to activate meaningful learning and communication tools and social media channels for web-based information exchange (UNESCO, 2020b). Undoubtedly, digital remote e-learning has alleviated the adverse consequences caused by the inaccessibility of schools in the wake of the ongoing pandemic, but emerging research suggests that the problem of household digital inequality is significantly exacerbated and dearly threatens social inclusiveness in education (van Deursen, 2020). To that end, UNICEF identifies digital inequality as a key obstacle to educational service delivery during the Covid-19 pandemic and recommends adopting alternative low-tech teaching methods in areas where digital remote e-learning devices are not readily available, including alternatives such as television and radio broadcasting of instructional content (World Bank, 2020c).

In many countries, social exclusion in the form of disparate access to the internet and unequal ownership of digital devices has become a pressing challenge, limiting the full potential of digital remote e-learning to an emergency form of learning mitigation. Particularly, there is an elevated social inequality risk in channeling learning opportunities through pre-existing forms of home digital disparities (Goudeau et al., 2021). Household digital inequality exists in various forms, including connectivity, devices, and supportive environments for e-learning that collectively transcend into a vast digital divide reproducing new inequalities online (World Bank, 2020a). Against the backdrop of a pandemic-led “new normal,” household digital inequality emerges as a significant contributor to educational achievement gaps among children. On the one hand, home digital device availability and internet connectivity have become vital in light of the transition to e-learning amidst school closures. Studies show that, as of 2020, only 14.9% of households in low-income countries have broadband access, and only 9.5% of these households are frequent users of digital devices at home (International Telecommunication Union, 2020). These less visible social inequalities at home leave an influential vacuum for children from disadvantaged backgrounds, who are not only losing learning opportunities at present but also risk future access to further and higher education levels (Li & Ranieri, 2013). On the other hand, parental and caregiver socioeconomic status influences the quality of children’s engagement with digital devices and reflects how home environments support digital remote e-learning. Prior research has indicated that children’s learning conditions outside of school settings highly mirror that of their family socioeconomic conditions and can lead to consequential heterogeneity that varies sharply from context to context (Liu & Steiner-Khamisi, 2020). To illustrate, parents with higher levels of educational attainment are more likely to participate and provide learning scaffolding for children’s engagement with e-learning devices, whereas parents from disadvantaged backgrounds rarely have the oppor-

tunity to offer the same kind of guidance since they are often preoccupied with unfavorable life circumstances, exacerbating the already large gaps in children’s home learning environment (Stewart et al., 2018).

To determine how new forms of digital inequality may introduce less-visible learning barriers to children from vulnerable backgrounds, there is not only a strong need to understand how disparate family socioeconomic conditions affect children’s e-learning under the Covid-19 pandemic, but there are also clear social inclusion imperatives in exploring potentially viable policy measures that can alleviate such adverse effects of digital inequality. To achieve these dual research objectives, this study takes advantage of a two-step mixed-method research design to unpack the intertwined relationship between digital learning inequality, policy intervention, and digital social inclusion.

2. Mixed-Methods Inquiry of Digital Social In(ex)clusion

Family socioeconomic status has traditionally been identified as one of the most influential factors associated with children’s health, cognitive, and socioemotional outcomes, beginning as early as the prenatal stage and lasting well into late adulthood (Bradley & Corwyn, 2002). Dating as far back as the Coleman Report, variation in academic achievement has been found to be significantly influenced by family environment and educational resources (Coleman et al., 1966). Globally, children raised in disadvantaged families with low parental educational support are more likely to suffer from prolonged “learning poverty,” which results in a substantial delay in early childhood cognitive development and unfavorable outcomes in adulthood (World Bank, 2020b).

More recently, interdisciplinary studies have begun utilizing a mixed-methods approach in documenting the more nuanced mechanisms of how inequality in family socioeconomics act as a critical factor affecting child development in the digital age (Ragnedda et al., 2020). A primary premise of scholars advocating for adopting a mixed-methods approach in unpacking intricacies of digital exclusion is because integration of both qualitative and quantitative inquiry provides a more layered and in-depth picture than any singular methodological approach alone (Creswell, 2014). On the one hand, emerging evidence indicates that disparate family wealth circumstances highly correlate with the unequal distribution of material capital that serves as prerequisite for ownership and access to digital devices that may be utilized as information acquisition tools for children (Istemic, 2021). On the other hand, scholars argue that heterogeneity in how families use the internet and how parents interact with children in household environments with digital devices creates another key area where family conditions may predetermine quality of digital learning and determinedly a fundamental human rights issue in the digital age (Sanders & Scanlon, 2021).

In light of the rapid digitization of social life and increasing immersion of educational interaction in technology-enhanced environments, the once less visible social inequality existing in the form of an at-home digital divide is becoming increasingly salient, and digital exclusion has become a serious threat to families from disadvantaged backgrounds (Bonfadelli, 2002). Having access to digitally-rich learning environments is in itself a reflection of how familial pecuniary and non-pecuniary capital affect the unequal distribution of digitally meaningful educational interaction across households that persists in the form of disparate digital literacy, parental guidance, and learning support (Lythreath et al., 2021). Against this backdrop, the saliency of digital divide, which is characterized as the social inequality that persists between those who have access to digital devices and digitally-enriched learning opportunities and those who do not, in limiting children from reaching their full potential is more pronounced than ever before and is observed to be drastically reshaping the landscape of social stratification in the digital era (Bernard, 2011).

During the Covid-19 pandemic, pre-existing forms of digital divide at home were further amplified by the rapid transition to remote e-learning arrangements adopted in many education systems (Barron et al., 2021). Emerging evidence has indicated that the digital divide within households during the pandemic mainly manifested in unequal access to information and communication technology, disparate skills proficiency in digital competency, and differential engagement with digital resources (Goudeau et al., 2021). For digital connectivity, emerging studies have found that about one-fifth of working-class families in France are unable to access information and communication technology; in England, about the same proportion of children who are eligible for free school meals did not have a computer at home; in the United States, more than two-fifths of working-class families do not own a laptop or desktop computer, nor have reliable broadband access (Cheshmehzangi et al., 2022). In terms of digital skills, there exists a substantial gap in respect to the number of working-class children who are proficient in using a computer as compared to that of upper-middle-class children (OECD, 2015). Recent studies have shown that families with higher socioeconomic status are more proficient in web-based tools and resources, and are more likely to be already familiar with digital devices necessary for remote e-learning, and that the associated pandemic learning loss is higher for those families lagging in such digital competency (Engzell et al., 2021; van Deursen & van Dijk, 2010). As for e-engagement, existing evidence suggests that families with higher socioeconomic status are more likely to use digital resources for productive activities such as work and education, whereas families from disadvantaged families lack such e-engagement, and when they do, they are more likely to use e-resources solely for entertainment (Harris et al., 2017). Additionally, studies have found that children who study alone tend to

underperform than when they are well supported by their parents at home, since self-regulation skills and digital self-efficacy tend to develop under adult supervision (Jackson et al., 2006; Størksen et al., 2015). Emerging programmatic evidence also suggests that one-on-one digital literacy tutoring sessions targeting parents of children in middle school can reap potentially large benefits for children lacking parental educational support at home (Angrist et al., 2021).

3. Data and Methodology

In this study, a two-stage interrelated mixed-method approach is adopted, with the first step being qualitative in nature and attempting to understand how educational policies were utilized to address social inclusion issues during the implementation of digital remote e-learning during the outbreak of Covid-19. The second step adopts a more quantitative lens, focusing on how children's background characteristics are related to their remote digital learning experiences.

Mixed-methods research is a promising productive approach in social, behavioral, and health sciences that enables the researcher in gathering and integrating both quantitative and qualitative data to better answer a set of given research questions (Creswell & Plano, 2017). The mixed-methods analytic lens empowers researchers with the utility of both quantitative and qualitative methodological traditions and allows for careful triangulation of intricately intertwined observations at varying observational levels (Cohen et al., 2018).

Both stages of the analysis in this study anchor on the case of Shaanxi Province in China, which is a large well-populated administrative region covering a total of 17 municipalities and population size of 39 million people. At the onset of the Covid-19 pandemic, schools in Shaanxi Province were closed from 26 January to 29 April 2020, during the first wave of the outbreak. The main rationale for focusing on one provincial administrative region, instead of expanding the analysis to include larger cross-provincial geographic variation, is twofold. Firstly, the analytic objective is to unpack the intertwined complexities underlying family socioeconomics, remote e-learning experiences, and public policy response during the Covid-19 pandemic. Therefore, the empirical analysis benefits from an in-depth case-oriented inquiry on the "life-world," rather than broadly focusing on inter-variable relationships that could be confounded by contextual factors across inquiry sites (Maxwell, 2012). Secondly, the research design is analytically positioned to uncover and understand educational processes, interactions, and contexts that persistently shape the experiences of children that engaged in remote e-learning during a unique period, characterized by a rapid transition to digital learning and instruction.

In the qualitative analysis stage, this study leverages policy document analysis to produce a detailed systematic review of all published policies by the

Shaanxi Provincial Department of Education and the Xian Municipal Bureau of Education, between 26 January to 29 April 2020. In qualitative research, policy document analysis can help researchers identify the role of policy intent, discourse, and actions in intervening in educational affairs (Liu, 2019). Policy documents analyzed in this study were retrieved directly from the provincial and municipal educational policy document depository, utilizing a combination of the following keywords: COVID* (*xinguan**), delayed school start (*yanchikaixue**), school closure* (*tingke**), learning disruption* (*tingxue**), emergency* (*jinji**), and crisis* (*yingji**). The 14 policy documents are identified and listed in chronological order in Table 1.

In the quantitative analysis stage, this study employs an original large-scale rapid roll-out survey study, which was distributed between 12 to 18 May 2020, just before schools in Shaanxi Province began reopening after three months of unexpected school closures following January 2020. The survey inquiry was designed as informed by rapid survey methodology, which is an established survey data collection approach commonly operationalized in developing contexts to maximize sample size within a relatively abbreviated timeframe. The questionnaire was directly distributed to respondents and collected information about children's background demographics such as sex, grade level, urban–rural status, as well as information on their experience engaging in remote e-learning during the pandemic-induced school closures. The sam-

ple inclusion criteria for valid survey respondents are as follows: (a) can comprehend and respond to the questionnaire; (b) currently enrolled in middle or high school; (c) volunteered to participate; (d) respondents whose guardians have completed the informed consent form. A total of 1,171 respondents from 7th to 12th grade satisfied the inclusion criteria.

4. Results

4.1. Qualitative Findings From the Policy Document Analysis

Announced in early February of 2020 at the dawn of the epidemic crisis caused by the initial outbreak of Covid-19, the Chinese Ministry of Education detailed the Disrupted Classes, Undisrupted Learning (DCUL) initiative as a pandemic-response policy aimed at providing flexible learning opportunities to children who were quarantined at home or unable to attend in-person classes due to system-wide school closures (Huang et al., 2020a). In epistemology terms, flexible learning has a long theoretical history in academic research and has been developed to encompass both flexibility and resilience in the design of learning environments, delivery of learning and instructional pedagogical content, and execution of learning outcomes assessment (Ryan & Tilbury, 2013). In the present study, the policy document analysis focuses on how flexible learning was

Table 1. List of provincial policy documents analyzed.

ID	Date	Translated title	Level
1	2020/1/26	Municipal Notice on Delaying Start of Spring 2020 Semester	Municipal
2	2020/1/26	Municipal Notice on Preparing for Delaying Spring 2020 Semester Start	Municipal
3	2020/2/2	Provincial Notice on Preparing for Disrupted Classes, Undisrupted Learning (DCUL) Initiative	Provincial
4	2020/2/5	Provincial Announcement on Disrupted Classes, Undisrupted Learning (DCUL) Special Column	Provincial
5	2020/2/7	Municipal Notice on Implementing Disrupted Classes, Undisrupted Learning (DCUL) Online Professional Development	Municipal
6	2020/2/10	Provincial Notice on Delaying School Start Beyond March 2nd 2020	Provincial
7	2020/2/11	Municipal Notice on Control and Protection of Novel Coronavirus Pneumonia for School Health Safety	Municipal
8	2020/2/14	Provincial Notice on Implementing Disrupted Classes, Undisrupted Learning (DCUL) Initiative during School Closure	Provincial
9	2020/2/26	Provincial Notice on Teacher-Related Policy Arrangements	Provincial
10	2020/3/9	Municipal Announcement of Online Training for School Administrators and Homeroom Teachers	Municipal
11	2020/3/13	Provincial Announcement of Partnership With Firms to Support Disrupted Classes, Undisrupted Learning (DCUL) Initiative	Provincial
12	2020/3/19	Municipal Announcement of Professional Development Program for All Teachers	Municipal
13	2020/4/10	Municipal Notice on Preparing for Spring 2020 Semester Start	Municipal
14	2020/4/29	Municipal Notice on Official Spring 2020 Semester Start	Municipal

crafted as a policy and operationally realized in execution and attempts to bring clarity to this process by zooming in on DCUL implementation, tracking provincial- and municipal-policy guidance, and identifying four key thematic takeaway lessons, as organized and synthesized in the following.

First, there existed an instantaneous national–local link and provincial–municipal policy coupling in the early stages of the Covid-19 response, such that within a couple of days of the announcement of delayed school start by the Chinese Ministry of Education, the Shaanxi Provincial Department of Education began instructing and supporting schools in preparation for implementing DCUL-related online instruction and designing remote e-learning activities, particularly highlighting the importance for ensuring learning opportunities for children from disadvantaged backgrounds (Policy ID#1 in Table 1). The DCUL initiative was regarded as highly unconventional, since policy decision chains are shortened and implementation preparation abbreviated, with key instructional features designed, piloted, and scaled swiftly at the local level. To a large extent, locally designed and context-adapted DCUL plans carefully catered to local learning conditions, since local education authorities were instructed to partner directly with schools to personalize flexible learning arrangements (Liu, 2020). Particularly, DCUL plans were designed to be highly practice-driven with hands-on protocol, resource contact, and FAQ information to aid local implementation on the ground.

Second, during the spring school-postponement period, both provincial and municipal education authorities actively provided free and open access to remote digital e-learning materials for all children online. On the one hand, to facilitate a successful implementation of the DCUL, the Shaanxi Provincial Department of Education created a thematic column that curated comprehensive integration of national, provincial, and school-based units of high-quality instructional resources, providing everything free-of-charge to children and families. In addition, the thematic column regularly featured live-streamed courses on pandemic-related instructional content, such as pandemic-related mental health guidance and at-home physical activity remedy workshops (Policy ID#2). To address learning inclusivity, provincial DCUL plans instructed municipalities to independently choose the mode of remote e-learning delivery, in consideration of substantial intra-province variability in providing flexible learning opportunities. In addition, provincial authorities widely mobilized teacher training resources to ensure that all teachers felt prepared to implement synchronous and asynchronous instruction via remote e-learning platforms. At the municipality level, the Xian Municipal Bureau of Education initiated live-streamed teaching on 10 February 2020: This involved 270 well-known teachers from 28 schools. This DCUL initiative in Xian covers a wide range of disciplines and instructional

grades, and leverages multimedia platforms in the integration of high-quality and freely-accessible educational content. Concurrently, radio and television broadcasting resources are mobilized to reach children who lack access to remote digital e-learning medium at home, particularly those families residing in rural and hard-to-reach areas (Policy ID#3).

Third, both provincial and municipal education authorities actively sourced infrastructure support from network providers and ensured stable operation of internet connectivity as the foundation for a successful implementation of DCUL. The Shaanxi Provincial Department of Education emphasized that schools in all administrative regions should take into full consideration of the local network connectivity and instructional support conditions in reasonably selecting an online instruction platform fit for the local scale of learning and instructional need (Policy ID#4). For example, in safeguard measures issued by the Shaanxi Provincial Department of Education, some municipalities actively consulted with major network operators and requested data and speed boosts to network connection for families with school-age children up to 500 megabytes free of charge, effectively alleviating network congestion and network burden for families. In other municipalities, there was a stark focus on supporting rural “left-behind” children in remote, hard-to-reach areas, providing service guarantees to families with financial difficulties, establishing a working mechanism of “one-to-one” support systems, and guiding the use of low-tech media such as radio and television to carry out autonomous learning at home (Policy ID#5).

Fourth, both provincial and municipal education authorities prioritized the implementation of teacher training during early-stage mobilization and preparation, which is not only conducive to preparing teachers to more flexibly carry out teaching tasks during digital instruction but is considered especially useful for families from disadvantaged socio-economic backgrounds. Relatedly, the Shaanxi Provincial Department of Education emphasizes that local education authorities and school administrators should pay particular attention to guiding teachers in making full use of digital e-learning resources. Both the National Training Program for Primary and Secondary School Teachers and the Shaanxi Provincial Teacher Training Network provided teachers with extensive resources to support the instructional transition to technology-rich environments (Policy ID#6). At the local level, the Xian Municipal Bureau of Education also actively provided teacher support network services for teachers and commissioned Xian Radio Station and the China Teacher Training network to jointly broadcast over-the-air training for teachers and school staff in aiding their transition to remote e-learning (Policy ID#7).

Fifth, in addition to fully utilizing the existing educational digital resources, both provincial and municipal education authorities partnered with local enterprises

quickly and formed cooperative partnerships to better support remote e-learning and e-instruction. For instance, strengthening the cooperation with major telecommunication can effectively cover a wider range of demographic groups, through timely technical support services. In addition, both provincial and municipal education authorities collaborated with Shaanxi Telecom to make available free synchronized and asynchronized lessons and to complement existing online instructional resources. Importantly, these partnered initiatives provided improved online learning opportunities and experiences for families in remote areas through installation free of charge of high-speed broadband internet connection and providing heavily subsidized 4G-enabled smartphones. As a result, a total of 415 schools have initiated synchronous online classes, with more than 230,600 registered students, 9,800 teachers and 2,521 classroom broadcast rooms, with an average of 820,000 online viewers and an average of 63,000 hours of viewing documented (Policy ID#8). Consequently, to promote DCUL, diverse forms of online learning are mobilized to ensure programmatic support to those children needing additional support the most, especially for families in rural remote areas, left-behind children, and families with financial difficulties.

4.2. Quantitative Findings From the Rapid Survey

In the following quantitative analysis segment, we first report information on descriptive statistics of respondents to the rapid survey and conduct three pairs of bivariate analyses to identify patterns of how children's remote digital e-learning experiences are shaped by their background characteristics during the Covid-19 pan-

dem. In Column 2 of Table 2, respondent breakdown is reported by sex, education level, and residential location. More specifically, there are 577 female respondents (49.27%) and 494 male respondents (50.13%), among whom 269 respondents (22.97%) are currently attending middle school while the remaining 902 respondents (77.03%) are in high school. In terms of residential location, 151 respondents (12.89%) are in rural areas and 1020 respondents (87.11%) are in urban areas.

Between columns 3 and 7 of Table 2, detailed frequency count and percentage share of respondents are reported by access to remote digital e-learning devices, as categorized as "smartphone," "computer," "multiple e-devices," and "television." Across all respondent background categories, generalized patterns indicate that approximately half of all respondents report using smartphones as their main mode of remote digital e-learning medium, while about one-fifth report using computers and one-third report relying on multiple e-devices for e-learning engagement. Very few respondents, or between 1 to 3% of the total sample report using television as the main medium. Results from the bivariate χ^2 statistical test in the final column of Table 2 identify statistically meaningful differences in access to remote digital e-learning by sex ($\chi^2(3) = 8.19$, p-value = 0.04), but not for education level ($\chi^2(3) = 5.46$, p-value = 0.14) or by residential location ($\chi^2(3) = 2.41$, p-value = 0.49). Observed patterns seem to indicate that there is a markedly higher percentage of male respondents (34.92%) having access to multiple devices than do female respondents (21.49%).

For the remainder of the analysis, we leverage multinomial regression analysis in examining how respondents' background characteristics are related to

Table 2. Descriptive statistics and bivariate analysis results (N = 1,171).

	N (Col %)	Smartphone (row %)	Computer (row %)	Multiple e-devices (row %)	Television (row %)	N (row %)
Sex						
Female	577 (49.27)	324 (56.14)	121 (20.97)	124 (21.49)	8 (1.39)	577 (100%)
Male	594 (50.13)	295 (49.66)	132 (22.22)	148 (34.92)	19 (3.20)	594 (100%)
Education level						
Middle school (7th–9th)	269 (22.97)	134 (49.81)	71 (26.39)	60 (22.30)	4 (1.49)	269 (100%)
High school (10th–12th)	902 (77.03)	485 (53.77)	182 (20.18)	212 (23.50)	23 (2.55)	902 (100%)
Residential location						
Rural	151 (12.89)	86 (56.95)	27 (17.88)	36 (23.84)	2 (1.32)	151 (100%)
Urban	1020 (87.11)	533 (52.25)	226 (22.16)	236 (23.14)	25 (2.45)	1020 (100%)

their access to different modalities of remote digital e-learning devices. In detail, the outcome comparison is made between respondents' access to smartphones (defined as base outcome), as opposed to computers, television, or multiple devices. The predictor variables are modeled as a set of background characteristics including sex, grade level, and residence location. For results interpretation, relative risk ratios (RRR) illustrate the probability of having access to computers, television, and multiple devices as opposed to owning smartphones (base outcome). Results in Column 2 of Table 3 show that respondents in high school are less likely to use computers than smartphones, when compared to similar respondents in middle school (RRR = 0.70, p-value <0.05). Results in Column 3 of Table 3 indicate a lower probability of male respondents having less access to television rather than smartphones when compared to similar female respondents (RRR = 0.39, p-value <0.05). There is no discernible statistical difference regarding the influence of background characteristics on access to smartphones or multiple devices. In more conclusive terms, multinomial regression model findings seem to jointly suggest that there exists a certain degree of influence of respondent background on access to remote digital e-learning devices, particularly between smartphones, computers, and television, but less so between smartphones and multiple e-devices.

5. Discussion

Under rapid transition to remote digital e-learning as catalyzed by the Covid-19 pandemic, the global pace of digital transformation in education is increasing exponentially, aggravating the emergence and saliency of an expanding broad-based digital divide across the entire social spectrum. Given the growing uncertain prospects of the pandemic, remote digital e-learning is likely to become integrated as part of an inevitable global trend in digitally transforming how teachers and students interact. In light of such broad-scoped transformation, it becomes more important than ever before to consider the social in(ex)clusion implications of relying more heavily on remote digital e-learning media as channels of learning and instructional interaction. While a combina-

tion of remote instruction and digital e-learning presents a timely solution to mitigate the adverse impacts of pandemic-induced school closures, the risk of digital exclusion is greater than ever before. In this regard, a large body of prior studies has shown that family socioeconomic level is a primary determinant of children's access, participation, and outcome in engaging in remote digital e-learning opportunities (Claro et al., 2015). Pandemic-induced school closures have created new and uncharted environments in which education systems are forced to deal with new forms of systemic inequality in the wake of the broad transition to remote digital e-learning.

In the present study, a key research objective is to deepen understanding of how digital social in(ex)clusion permeates physical boundaries of classroom instruction via channels of remote digital e-learning and attempts to illustrate how these disparate learning experiences are exacerbated by inequalities in family educational resources at home during a unique episode of children's learning amidst the Covid-19 pandemic. By utilizing a two-stage interrelated mixed-method approach, findings uncover the complex and intertwined relationship between digital inequality, policy intervention, and social inclusion. More specifically, we highlight that most respondents in our sample rely on "high-tech" forms of digital media, such as smartphones or computers, while very few use "low-tech" mediums such as television, for which worryingly is the disparate access being reflected in their background characteristics. In response, provincial and municipal education authorities utilized a combination of locally-designed, access-focused, capacity-oriented, and open-resourced policy tools to address the differential consequences of the digital divide on children's learning during the pandemic-led school closures.

Taking stock of these findings, several key implications and potential strategies for re-imagining socially inclusive e-learning could be synthesized. First, utilizing multimodal hybrid technology in diversifying remote digital e-learning opportunity delivery can maximize effective coverage of urban and rural areas. In China, since the DCUL plan was primarily locally designed, it fielded many localized inclusivity solutions by offering a range

Table 3. Multinomial logistic regression results of respondent background characteristics on access to remote digital e-learning devices (N = 1,171).

	Computer v.s. smartphone	Television v.s. smartphone	Multiple e-devices v.s. smartphone
Male (Ref = Female)	0.83 (0.12)	0.39* (0.17)	0.76 (0.11)
High school (Ref = Middle school)	0.70* (0.12)	1.52 (0.84)	0.96 (0.17)
Urban (Ref = Rural)	0.74 (0.17)	0.51 (0.38)	0.95 (0.20)

Note: Cells display exponentiated coefficients in RRR; transformed standard errors in parentheses; * denotes p-value <.05.

of flexible learning alternatives in order to reach children from disadvantaged families who may rely on “low-tech” mediums such as television and radio for remote learning. More recently, such strategies have been echoed in other parts of the world in addressing disparate access to remote digital e-learning resources (Singh et al., 2021). Second, developing open learning platforms and making e-learning resources free of charge can alleviate the learning burden for children from disadvantaged backgrounds. For instance, the National Public Service Platform for Education Resources made a range of learning and instructional materials openly available to the public, which empowers learners, parents, and teachers to access a wide variety of professionally-curated and peer-produced content necessary to facilitate remote digital e-learning at home. The social inclusive value of open educational resources during the pandemic should not and cannot be understated (Huang et al., 2020b). Third, collaborating with diverse stakeholders to expand access to digital devices can bring tangible support to families and realize meaningful e-learning at home. Education authorities in China mobilized public-private partnerships with telecommunication providers in establishing cross-platform solutions that reduce access costs and improve content delivery. To this end, the integration of digital technology in education holds promise not only as a complementary form of remote instruction during times of crisis, but it holds significant value in meeting the diverse individual learning needs of children, by incentivizing and supporting learning that is unrestricted by time and space (World Bank et al., 2021). These cross-sectoral partnerships are anchored on firms’ technology specialization and enhance both the quantity and quality of remote digital e-learning coverage. Furthermore, many schools partnered with telecommunication carriers to text-message parents with information on lesson guidance via a toll-free number to better support learners at home (UNICEF, 2020).

Finally, there are several limitations in this study worth joint consideration in the interpretation of results. Firstly, logistical capacity and social-distancing measures have prompted this current study to adopt a rapid survey approach, which may be improved in the future given the possibility to obtain more representative samples. Secondly, the present study primarily focuses on the case of Shaanxi, China, which requires caution when extrapolating conclusions drawn to other sociocultural and geographical contexts since societal realities are largely unique. Thirdly, given the continuation and uncertainty of the ongoing Covid-19 pandemic, the effectiveness of policy measures requires further monitoring and generates a strong need for future inquiries.

6. Conclusion

The Covid-19 pandemic left influential structural changes in the organization of instruction and delivery of learning and instruction, which could risk amplifying the less-

visible social inequality costs on younger generations from disadvantaged and marginalized backgrounds, particularly if digital exclusion is left unaddressed. As shown in this study, there is a real challenge facing many education systems as digitally empowered forms of e-learning are on the brink of jeopardizing progress in educational equality and are making visible the structural inequalities associated with family background and socioeconomics. Education authorities, at national, provincial, and local levels, have crucial roles to play in redrawing the landscape of the digital divide in remote digital e-learning, and in doing so, the prospects of a truly socially inclusive education arrangement might arise on the approaching horizon.

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Conflict of Interests

The authors declare no conflict of interests.

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