Bridging Digital Divide Amidst Educational Change for Socially Inclusive Learning During the COVID-19 Pandemic

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Abstract
During the coronavirus disease-19 (COVID-19) outbreak, many education systems were forced to shut down and move learning and instruction online. The future of learning is here before we know it. While the combination of distance learning and educational technology presents a timely solution combating adverse consequences of school disruptions, there is a real risk of channeling learning opportunities through already-existing forms of digital disparity, especially for marginalized populations. China, as one of the first education systems to experience system-wide school closures due to COVID-19, faces critical challenges of digital divide. To examine pandemic ramifications and effective policy strategies taken to mitigate its unintended consequences, this study leverages an original student learning experience survey collected during the pandemic, and documents national and provincial-level COVID-19 education policy responses in China since the initial outbreak. The study uncovers saliency of access to distance learning and educational technology in shaping student learning experiences, and identifies three compelling policy takeaways from the “Disrupted Classes, Undisrupted Learning” initiative, and discuss emerging lessons drawn for crafting an undivided future for remote distance learning.

Keywords
COVID-19, digital divide, online learning, distance learning, social justice

Introduction
The world is experiencing an unprecedented global school closure crisis as result of social distancing measures to halt the coronavirus disease (COVID-19) pandemic. The threat of the disease has led to more than 190 education systems to shut down instructional facilities and mandate school closures, and the lives of more than 1.5 billion students have been affected globally (UNESCO, 2020). Undoubtedly, many education systems have entered uncharted policy territory while coping with the ongoing COVID-19 outbreak. Education disruption due to the pandemic is posing a major challenge for the global community, and the adverse effects of school closures will likely be compounded by the preexisting global learning crisis (World Bank, 2019). It is estimated that school closures have generated global learning loses that are presently valued at more than US$10 trillion (Azevedo et al., 2020). Furthermore, the COVID-19 pandemic has not only brought a complex array of psychological stress factors influencing children’s learning, but the uncertainty of social isolation and loneliness is also impacting their physical and mental health (Phelps & Sperry, 2020; Liu, Chen, et al., 2021), which will unequivocally shape their emotion, behavior, and world-view (Wang et al., 2020; Liu, Li, et al., 2021).

In consideration of the inimical implications of school interruption on student learning, safety, health, and well-being, a clear policy imperative has been centered around finding new ways to promptly resume learning and simulate classroom interaction. To this end, while many countries continue to brave the impact of the pandemic and grapple with the uncertainty of re-opening schools, more than 60 countries have elected to partially re-open schools by offering remote and online instruction (CGDEV, 2020). While a combination of remote distance learning and educational technology presents a timely solution to mitigate adverse consequences of
learning disruptions due to school closures, emerging research suggests that large inequality in access to information and communication technology (ICT) can obstruct continuity of learning in many countries (Bonal & González, 2020; Livari et al., 2020; van Lancker & Parolin, 2020).

Importantly, having access to ICT, in and of itself, not only reflects the unequal social status and uneven distribution of material capital that persists within societies, but is also a vivid indication of the broader digital imbalance between high- and low-income communities (Istenič, 2021). For one, there is substantial global disparity in internet coverage and bandwidth, in addition to unequal access to computers among households. While approximately nine-in-ten individuals (86.6%) in developed economies report to using the internet in 2019, this number is less than one-in-five (19.1%) in low-income countries (International Telecommunication Union [ITU], 2020). At the household-level, ITU (2020) estimates that only 14.9% in low-income countries are connected via broadband and merely 9.5% of households have access to a computer at home. In other respects, countries’ swift transition to remote learning can exacerbate current learning gaps due to existing disparities in parental literacy and family endowment. Research has shown that children’s learning conditions at home highly mimic that of their family socioeconomic conditions, and these differences explain significant portions of educational achievement gaps among children (Hartas, 2015; Liu & Steiner-Khamsi, 2020; Martins & Veiga, 2010). Critically, the lack of family support and educational resources is often compounded by inadequate digital connectivity. While this challenge can be partially mitigated by supporting teachers and students with more educational resources, limited digital access at home can compromise such efforts. As more countries prepare to move instruction online, digital deficits will inevitably hit the most vulnerable the hardest in these times of crisis (UNESCO, 2020). For many education systems, there is a real risk of channeling learning opportunities through already-existing forms of digital disparity at home.

In light of this global challenge, this case study aims to spotlight the unintended yet critical repercussions of social and digital exclusion through distance learning arising concurrently as result of the COVID-19 pandemic. This study warns that if unequal access to instructional and learning technology is left unaddressed, the impact on a whole generation of students will be devastating. As scholars have rightfully illuminated, education is not only a matter of social justice, but a fundamental human right through which other rights are fulfilled (Chaney, 2011). In this regard, this study argues that education policy-makers have a critical role to play in addressing the digital divide, especially during pandemic-led school closures. Using the case of China’s successful early intervention experience, this study utilizes a two-step analysis to synthesize key policy takeaways in tackling digital divide amidst the pandemic, and identify what it might take to craft an undivided future of learning for all. Ultimately, this study seeks to shed light on the less-visible social inequality that will amplify adverse effects of pandemic-led school closures, and highlight caution against its consequential social justice costs on marginalized populations if left unaddressed globally.

**Review of the Literature on Digital Divide and Unequal Learning**

Digital divide, which is commonly defined as the social inequality that exists in the form of unequal access to ICT, is a concept that has quickly gravitated global attention since the dawn of the digital age in the early 1980s (van Dijk, 2006; Warschauer, 2003). Scholarly interests have been ample on the causes and consequences of digital exclusion, particularly on the implications for children from different social groups (DiMaggio et al., 2004; Zhong, 2011). To this end, considerable gaps in access to digital devices, content, and networks have been found to align with unequal income, geography, gender, social status, and age (Bonfadelli, 2002; Warschauer & Tate, 2012). As the world is rapidly becoming immersed in technology-enhanced environments, the less visible digital gulf poses a de facto barrier that inhibits individuals from active social participation and signifies the void of upward social mobility particularly for those digitally disenfranchised populations. Empirically, Liu (2020b) finds that having more ICT resources at home can translate into one-third of an academic year learning advantage for Chinese students (B-S-J-Z regions). Such inequality has become a critical policy issue as indicated by the evidence on the progression of digital exclusion on social exclusion, and the ways in which ownership of devices and connectivity can have far-reaching impact on children’s development and life chances (Livingstone & Haddon, 2009; Selwyn & Facer, 2007).

In examining the relationship between digital divide and learning, it is essential to distinguish between formative and substantive forms of digital divide, and disentangle their effect on educational outcomes. On the one hand, formative digital divide is the lack of ICT devices, infrastructure, and connectivity that impedes learning opportunities (van Deursen & van Dijk, 2010). On the other hand, substantive digital divide involves deprivation of meaningful ICT interaction and engagement, which consequently affects learning experience and outcomes (Hawkins & Oblinger, 2006). In many industrialized countries, legal and policy mandates have been enacted to address formative digital divide among schools. For instance, in the United States and United Kingdom, there has been both national and local programing efforts to improve technology infrastructure and internet connectivity for economically disadvantaged schools (Hohlfeld et al., 2008). In developing countries, similar programs have also been implemented to provide access to computers and subsidized internet for students in low-income communities (Severin & Capota, 2011). However, without instructional content and relevant training support, teachers could do little
to integrate ICT in daily classroom teaching. Studies have revealed that beyond initial investment in hardware, schools in these disadvantaged communities rarely receive additional content or instructional support to create synergy that generates meaningful learning interactions (Ertmer & Ottenbreit-Leftwich, 2010; Warschauer et al., 2004).

In addition, another important but often overlooked dimension of digital disparity remains at home, and represent both a quantitative and qualitative difference in terms of families’ experience with ICT. For one, prior research has indicated that family income levels, geography, educational background are key determinants of home ICT availability and connectivity (Claro et al., 2015). Studies have found that children who come from such backgrounds are not only more likely to own computers and use internet at home, they also demonstrate higher levels of self-efficacy and better academic performance than those who do not (Eamon, 2004; Jackson et al., 2006; Li & Ranieri, 2013). For another, home socio-economic factors highly influence the quality of students’ engagement with ICT devices. Researchers find that parental education and home guidance not only critically determines ICT availability, but is also instrumental for supporting learning-relevant ICT use at home (Liu, 2020a; Zhao et al., 2010).

In wealthier households, students are more likely to achieve educational gains from computer use because they engage in learning-enhancing and information-rich ICT activities at a much higher frequency (Zillien & Hargittai, 2009). Additionally, parents with higher educational levels are also more likely to guide, support, and supervise device- and internet-use at home (Hollingworth et al., 2011). Whichever the case, the evidence on the critical role of policy, institution, and family on student learning is clear. To that end, the lack thereof such support systems may risk aggravating social exclusion and education inequality that is inevitably amplified in the rapid transition toward online instruction and learning amidst the COVID-19 pandemic.

Data and Methodology

In this study, a two-step analytic approach is adopted, with the first-step focusing on student learning experiences amidst a nationwide distance learning experiment during the COVID-19 outbreak in China, while the second-step tackles the challenge of digital divide from a policy perspective and attempts at scrutinizing how policy tools were utilized to address the rapid transition to distance learning.

In the first analytic step, this study anchors on an original large-scale rapid survey study, which was distributed between 12th and 18th May of 2020 during the apex of the first-wave of the COVID-19 pandemic, conducted by a nationally-known education press, Teachers Daily (Jiaoshibao). Rapid survey methodology (RSM) is an established data collection approach that has been widely utilized in developing countries, and its operational goal is to maximize sample size within a relatively short and fixed timeframe, in order for quick and timely monitoring of subjects (Frerichs & Tar, 1989). The survey questionnaire collected information about student background demographics such as sex, grade-level, urban-rural status, as well as information on their experience engaging in distance learning during the COVID-19 school closures. The inclusion criteria for valid survey respondents are as follows: (1) can read and understand the questionnaire; (2) currently enrolled in primary, lower-secondary, or upper-secondary schools; (3) voluntary participation in the survey; (4) submitted only one response using the same IP address; and (5) whose guardians have completed the informed consent form. A total of 3,405 respondents from 1st to 12th grade satisfied the inclusion criteria.

In the second analytic step, this study leverages policy document analysis in tracking national and provincial-level COVID-19 education response in China since the initial outbreak. Policy document analysis is a common analytic strategy in understanding the interactions between government behavior and policy movements in education research (Liu, 2019). In chronological order, this study began with an exhaustive and systematic background review of all published policy document relating to keywords: “COVID* (xinguan*),” “school closure* (tingke*),” “learning disruption* (tingxue*),” “crisis* (yijing*)” on the Ministry of Education online document depository, between 1st January and 30th June 2020. From there, this study expands the policy document analysis exercise to cover provincial and municipal education authority policy archives, published in the same time period. In total, the exhaustive policy document chronology resulted in a comprehensive document database which included 178 ministerial, provincial, municipal policy documents that addressed distance learning during the COVID-19 pandemic.

Results

Student Experiences in Distance Learning During COVID-19

To begin, it is crucial to assess the degree of pre-pandemic digital divide in China. In this regard, this study first reports statistics from the most recent student ICT home access information in the pre-pandemic period (see Table 1) using the 2018 wave of Program for International Student Assessment (PISA), which was administered by the Organization for Economic Cooperation and Development. Particularly, of the 12,058 Chinese students (B-S-J-Z regions) surveyed in 2018, more than 80% of students in villages did not own E-book readers, 55.4% reported not having a tablet computer at home, and close to 20% reported not having access to an internet-capable computer at home. Considering that PISA 2018 was administered only in the more affluent B-S-J-Z regions of China, ICT availability is reasonably expected to be even more heterogeneous in China’s less developed regions rural areas.
Next, this section reports findings from both the descriptive statistical analysis as well as two sets of univariate analyses, as means to illustrate how student experiences in distance learning during the COVID-19 pandemic differed by individual traits. More specifically, chi-square test results assessing the degree to which mode of distance learning differs by individual traits are reported in Table 2, whereas in Table 3, differences in length of distance learning engagement are further evaluated by individual trait. In concrete terms, column 2 of Table 2 reports the descriptive statistics of the sample by individual traits, indicating that 51.6% of the sample are male while 48.4% are female, 65.6% are attending primary school while 34.4% are attending secondary school, and that 77.1% reside in urban areas while 22.9% reside in rural areas.

In columns 3 to 7 of Table 2, the sample distribution for mode of distance learning is reported, such that respondents indicated they were using either smartphone, personal computer (PC), television (TV), or multiple modes of engagement. In general terms, there is no statistically meaningful difference in mode of distance learning by gender ($p = .082$), whereas it differed significantly by grade ($p = .000$) and location ($p = .000$). More specifically, a higher percentage of students in primary grades (first to sixth) are using smartphones and television as main mode of engagement than that in secondary grades (7th–12th), whereas the converse is true for personal computer and multiple modes. In addition, respondents in rural areas are overwhelmingly more likely to report using smartphones than those who reside in urban areas, and are less likely to use personal computer, television, or multiple modes.

In Table 3, descriptive statistic information is reported for the length of distance learning that respondents engage every day, which is reported in hours. On average, students in the sample engage in 3.87 hours ($SD = 2.29$) of distance learning per day during the COVID-19 pandemic period. Considering that students commonly have five weekdays of formal learning days each week, this number would approximately translate into 20 hours of distance online learning per week. In columns 2 to 5 of Table 3, information on mean hours of distance learning per day is reported by individual trait, and differences are assessed using univariate T-tests. In broad terms, length of distance learning did not vary significantly by location ($p = .070$), but there are statistically significant differences by gender ($p = .030$) and grade ($p = .000$). Concretely, female respondents on average report 0.17 hours longer engagement each day than males, and respondents in secondary grades report 2.81 hours longer engagement each day as compared to those in primary grades.

### Table 1. Percent of Students Reporting Absence of ICT Device at Home (N=12,058).

|                  | Internet (%) | Cellphone (%) | Desktop computer (%) | Tablet computer (%) | E-Reader (%) | Educational software (%) |
|------------------|--------------|---------------|----------------------|---------------------|--------------|--------------------------|
| Village          | 16.0         | 1.5           | 17.5                 | 55.4                | 80.6         | 39.3                     |
| Small Town       | 9.9          | 0.8           | 15.5                 | 51.6                | 79.5         | 34.5                     |
| Town             | 6.0          | 0.7           | 9.5                  | 47.1                | 78.7         | 28.1                     |
| City             | 6.0          | 0.5           | 8.4                  | 44.2                | 77.7         | 26.2                     |
| Large City       | 2.6          | 0.5           | 3.2                  | 21.7                | 61.7         | 21.1                     |

Source. PISA 2018, Author’s compilation.

### Table 2. Descriptive Statistics and Chi-Square Results (N=3,405).

| Mode of distance learning | N (Col %) | Smartphone (Row %) | PC (Row %) | TV (Row %) | Multiple (Row %) | N (Row %) | p ($\chi^2$) |
|--------------------------|-----------|---------------------|------------|------------|------------------|-----------|-------------|
| Gender                   |           |                     |            |            |                  |           |             |
| Male                     | 1,758 (51.6) | 1,002 (57) | 367 (20.9) | 55 (3.1) | 334 (19) | 1,758 (100) | .082 (6.7) |
| Female                   | 1,647 (48.4) | 954 (57.9) | 326 (19.8) | 31 (1.9) | 336 (20.4) | 1,647 (100) |             |
| Grade                    |           |                     |            |            |                  |           |             |
| Primary (1st–6th)        | 2,234 (65.6) | 1,337 (59.9) | 440 (19.7) | 59 (2.6) | 398 (17.8) | 2,234 (100) | .000 (25.3) |
| Secondary (7th–12th)     | 1,171 (34.4) | 619 (52.9) | 253 (21.6) | 27 (2.3) | 272 (23.2) | 1,171 (100) |             |
| Location                 |           |                     |            |            |                  |           |             |
| Urban                    | 2,627 (77.1) | 1,440 (54.9) | 576 (21.9) | 72 (2.7) | 539 (20.5) | 2,627 (100) | .000 (35.9) |
| Rural                    | 778 (22.9) | 516 (66.3) | 117 (15.1) | 14 (1.8) | 131 (16.8) | 778 (100) |             |
| Total Col %              | 3,405 (100) |                     |            |            |                  |           |             |

Source. Original Survey, Author’s compilation.
Flexible Learning and Digital Resilience in China

In the succeeding section, findings are presented for the policy document analysis which tracked national and provincial-level COVID-19 education response in China since the initial outbreak. For organizational purpose, instead of describing the contents of each document chronologically, this study elected to group and present the analysis by thematic areas, lessons drawn, and provide citations where necessary.

China, as one of the first education systems to experience system-wide school closures due to COVID-19, announced in early February of 2020 its plan to implement “Disrupted Classes, Undisrupted Learning” (DCUL) initiative. The Chinese Ministry of Education (MOE) detailed its DCUL initiative as a new policy aimed at providing flexible learning opportunities to students at home (Huang, Liu et al., 2020). Relatedly, theoretical discussions around flexible learning has highlighted the importance of bolstering learner agency through supporting learner-centered instruction (Lewis & Spencer, 1986). In fact, there has been extensive research on flexible learning, which encompasses flexibility and resilience in terms of learning environment, content delivery, instructional pedagogy, and outcomes assessment (Goode et al., 2007; Lundin, 1999; Ryan & Tilbury, 2013). In essence, flexible learning puts student learning experience at the center of pedagogy and emphasizes the enabling function of technology to empower learners through building digital resilience (Wanner & Palmer, 2015).

Notwithstanding, implementation of DCUL in China faces a significant challenge: unequal distribution of digital resources at home (Huang, Tlili et al., 2020). For one, the country has large geographic variation in broadband bandwidth and high-speed mobile network coverage (CNNIC, 2020). For another, there exists significant disparity in terms of device ownership at home (Liu, 2020a). Given unprecedented national-level policy efforts to put flexible learning into practice at a massive scale involving 241 million students (UNICEF, 2020), it becomes critical to examine how policy developments in China tackled challenges posed by digital exclusion. While conclusive evidence on what works remains inadequate, this study identifies several unique policy lessons drawn from a vertical case study of ministerial, provincial, and municipal policy implementation, from which three observations on key policy principles that show promise at this early stage can be generalized.

Firstly, there was concerted national-local coordination in terms of policy response to mitigate learning disruption. Within a month of the initial MOE announcement to delay school start, more than 30 provinces had committed to and adapted the national DCUL education plan (see Figure 1), among which most devised specific sections addressing remote learning options for students from disadvantaged backgrounds. The localization of DCUL initiatives was highly unconventional, in the sense that time-sensitive programming decisions are made locally. To a large extent, localized DCUL plans reflected local learning needs and paid attention to contextual factors that may hinder learning; education authorities also partnered with schools to develop flexible learning arrangements that cater to specific teacher and student needs (Liu, 2020b). While national DCUL guidelines covered broad policy principles and legal standards, localized versions were differentiated to address varied contextual learning needs, and were designed to be practice-driven with hands-on protocol, resource contact, and FAQ information. Creating high-level policy commitment, mobilizing intermediate-level institutional resources, and providing local-level operational guidance became instrumental in early efforts to advance DCUL campaign at scale.

Secondly, local-level DCUL education plan focused on offering an array of flexible learning alternatives, particularly offline options for students and families from disadvantaged socioeconomic backgrounds. For instance, education authorities in Ningxia Hui Autonomous Region, a self-governing Muslim majority province in Northwest China,

| Table 3. Descriptive Statistics and T-Test Results (N=3,405). |
|---------------------------------------------------------------|
| Length of distance learning per day (hours)                   |
| Mean       | SD       | Mean (1) − mean (2) | p Value |
| Length of distance learning per day (hours)                   | 3.87      | 2.29                     | —        | —        |
| Gender                                               |          |                         |          |          |
| Male        | 3.79      | 2.26                    | −0.17    | .030     |
| Female      | 3.96      | 2.32                    | —        | —        |
| Grade                                                 |          |                         |          |          |
| Primary (1st–6th) | 2.90      | 1.87                    | 2.81     | .000     |
| Secondary (7th–12th) | 5.71      | 1.85                    | —        | —        |
| Location                                            |          |                         |          |          |
| Urban       | 3.91      | 2.33                    | −0.17    | .070     |
| Rural       | 3.74      | 2.15                    | —        | —        |

Source. Original Survey, Author’s compilation.
worked with major telecommunication carriers to waive cellular data and broadband internet usage fees for low-income communities to access online learning content (Ningxia Provincial Department of Education, 2020). In another example, local education authorities in Hubei province, developed synchronized and asynchronized distance learning modalities, which are offered through radio, television, telephone, and internet (Hubei Provincial Department of Education, 2020). Television and radio stations were rapidly mobilized to provide additional airtime for pre-recorded “Classrooms on Air” lesson content, which was streamed 5 days a week, 9 am to 8 pm, in a line-up of 20-minute-long lessons. Content includes both grade-specific instructional lessons such as language studies and mathematics, as well as pandemic-relevant content such as strategies to promote psychological and physical well-being. Hence, making available a menu of distance learning opportunities is essential for synergizing meaningful participation and ensuring programmatic support to those needing it the most.

Thirdly, public-private-partnerships were quickly formed to generate cross-platform solutions to better support remote instruction and learning. Importantly, education authorities leveraged private-sector technology expertise in both hardware and software to rapidly expand online instructional capacity and to provide better online learning experiences for students. Coordinated partnerships with educational technology firms enabled wider and more timely coverage of students, as well as enhanced standardization of delivery quality. For instance, more than 40 municipal education bureaus collaborated with Tencent Classroom and Rain Classroom to make available free synchronized and asynchronized lessons, with a variety of attendance, assessment, and interactive tools that aims to enhance student experience (Huang, Liu et al., 2020). In addition, schools partnered with telecommunication carriers to text-message parents with information on lesson reminders, activity guidance, and student progress (UNICEF, 2020). Moreover, public-sector actors actively ensured open-access of learning materials in DCUL roll-out. For instance, National Public Service Platform for Education Resources (EDUYUN) spearheaded initiatives to purchase and make e-versions of textbooks and instructional toolkits publicly available. These EDUYN initiatives covered a wide range of subjects and grade-levels, and included a multi-medium platform where teachers could share, review, and discuss pedagogical ideas, lesson plans, and instructional resources. Admittedly, assembling a consortium of inter-sectoral actors and prioritizing inter-sectoral programing can generate resource pools that benefit from a variety of thematic expertise.

Discussion and Conclusions

In this study, the research objective is to shed light on the criticality of addressing the widening digital divide in education, particularly during times of the COVID-19 pandemic. Quite rapidly, COVID-19 has transformed the world in drastic ways, and is reshaping how children learn around the world. Using a two-step analytic approach, this case study shines a spotlight on China, one of the first countries to implement a nationwide distance learning experiment. In concrete terms, this study evaluated the degree of digital divide in the
More broadly, pandemic-led school closures have forced education systems to witness in real-time the learning barriers posted by systemic inequality. For all countries, ensuring continuity of learning during COVID-19 is a high priority. Many education systems have introduced a variety of online substitute learning modalities, in order to safely resume learning before conditions for reopening schools are present. In this case study, concerns against the distressing consequences of digital divide in the face of pandemic-led school closures are raised, and the study identifies adverse restricting effects on learners worldwide. As the global community unites in a common fight against COVID-19, education systems must respond to school-closures in equity-meaningful ways, such as through effective policy measures illuminated in this case study. Providing equitable access to learning opportunities, both offline and online, is foundational to creating a sustainable future and must be a global policy imperative. To put simply, COVID-19 is a moment of forced opportunity for all to reimagine a socially just future of learning. Undoubtedly, the future has arrived quicker than expected, and the world risks amplifying already-existing inequalities if policies are not put in place to safeguard against the prospect of a divided future of learning. Most critically, the promise of an undivided future of learning can only be achieved if policy-makers worldwide start treating digital disparity in education seriously, leveraging new evidence and emerging experience on what works.

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