

Article

Impact of Living Conditions on Online Education: Evidence from China

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Abstract: Students need to maintain certain living conditions in order to pursue online learning at home. However, there is a lack of a scientific explanation for the extent to which students' performance in online at-home education is influenced by living conditions. Students from 2002 low-income households in China were surveyed, and a multivariate logistic regression analysis was conducted in order to explore the impact of living conditions on online education. The results showed that, rather than computers and smartphones, broadband Internet at home can affect students' performance in online learning. The larger the residence area, the better the children's performance in at-home e-learning. Moreover, children living in dilapidated houses are unable to satisfactorily perform in an e-learning environment. Contrarily, children who live in families with separate rooms and tap water show better performances. Additionally, the performance will be worse in the case of unattended students. Furthermore, children from low-income and -status families in the community are often at a disadvantage in an at-home e-learning environment. Cognition regarding the connection between living conditions and online education can be crucial for the improvement of the living conditions of low-income families in order to achieve online education equity.

Keywords: online education; living conditions; semiprivate space; COVID-19 pandemic; China



Citation: Gu, J. Impact of Living Conditions on Online Education: Evidence from China. *Sustainability* **2022**, *14*, 3231. <https://doi.org/10.3390/su14063231>

Academic Editors: Luis Fernández-Sanz, María Teresa Villalba de Benito and Ana Castillo Martínez

Received: 1 February 2022

Accepted: 7 March 2022

Published: 9 March 2022

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1. Introduction

The increasing popularity of online technology has been particularly notable in recent years [1]. Online education has achieved universal access because of its advantages of low cost and wide coverage [2–4]. Furthermore, the COVID-19 pandemic has led to an overnight transformation to online education, creating a myth that online education has universal access [5–7]. However, due to the differences in living conditions, some students cannot receive online education at home, while others do not perform well, thereby leading to inequality in online education [8,9]. According to a UNICEF report, at least a third of the world's schoolchildren—463 million children worldwide—were unable to access remote learning when COVID-19 led to the closure of schools [10]. Thus, online education has widened existing inequalities [11], making the reduction of inequality a common challenge faced by countries worldwide in the current and post-epidemic eras.

According to the learning ecology theory of online education, the living conditions of students have an impact on the learning effect of online education [12–14]. This approach looks at the e-learning process as a network of interdependencies among all of the elements in the setting, not only at the social level but also at the physical and symbolic levels. However, this theory has its limitations, such as overemphasizing environmental determinism while ignoring subjective initiatives in the education process. In contrast, the semiprivate space perspective emphasizes specific environmental factors related to online education and interaction in the teaching process, which can effectively overcome the disadvantages of environmental determinism [15]. The semiprivate space theory of online education states that the living conditions of students directly influence their learning activities and behaviors [15,16]. Therefore, living conditions and the students' learning activities are closely related and coexist. Based on the semiprivate space perspective, the latest empirical

evidence shows that students' housing conditions can significantly impact the accessibility of online education at home [17,18]. However, this relationship between living conditions and online education performance is still poorly understood, and lacks empirical evidence. The exploration of the impact of living conditions on the performance of e-learning at home helps us to understand the positive and negative factors affecting online education. This provides useful suggestions for the improvement of living conditions and the performance of online learning. Thus, this research can not only effectively expand the semiprivate space theory but also provide important theoretical support for the improvement of students' performance in online education at home by changing living conditions, which has important practical significance.

Economic development in China has continuously improved the living conditions of Chinese citizens. According to data from the National Bureau of Statistics of China, the per-capita housing area of urban and rural residents increased from 6.7 square meters and 8.1 square meters in 1978 to 36.9 square meters and 46.7 square meters in 2017, respectively. Recently, the scope of online education in China has expanded. According to the "Report on the Development of China's Online Education Industry in the First Half of 2020", the number of online education users in China has reached 450 million, accounting for 42.3% of the total Internet users. After the sudden outbreak of COVID-19 at the end of 2019, the Chinese government adopted the "School's Out, but Class is On" approach to provide online tutoring for students at home [19]. The largest online education activity in human history requires tens of millions of students to complete e-learning [20]. Due to the COVID-19 pandemic, 265 million school students turned to online courses, leading to an explosive growth in online learning at home. Consequently, the effect of living conditions on online education has become increasingly prominent.

Children from low-income families find it more difficult to receive online education, making this learning method unsuitable for them [9,10]. When explaining the performance of online education, semiprivate space theory, based on Rooney's [15] concept of the "semiprivate", provides a new perspective [16]. The current study aims to determine the functional connections between the performance of students receiving online education at home and the environmental conditions in which they live. Specifically, two questions need to be addressed:

Q1. What is the composition of semiprivate spaces for online education?

Q2. How do semiprivate spaces for online education affect online learning at home?

Based on 2020 survey data of low-income families in China, this study explores the composition of semiprivate spaces for online education and analyzes the influence of students' living conditions on the performance of online education. The remainder of the paper is organized as follows: Section 2 presents a literature review and hypothesis development. Section 3 describes the sample, variables, and methods used. Section 4 presents the results, and Section 5 discusses the results. Section 6 presents the conclusions of the study.

2. Literature Review and Hypothesis Development

The semiprivate space theory provides rich connotations for online learning at home. It points out that family factors—including the family space, the living environment, online learning equipment, the family's economic and social characteristics, and the personal living space of students—impact online learning activities at home. Based on the perspective of semiprivate space, this research explores the impact of family living conditions on the performance of online learning at home.

2.1. Semiprivate Space Theory

Urry [21] stated that, in social sciences, the incorporation of the temporal and spatial aspects of social life has proven somewhat intractable. However, scholarship in online education often connects to the ecological composition theory [22,23], which views teaching and learning as inextricably embedded in space and time. Rose [24] emphasized that

individual learning is situated in a larger temporal and spatial context, which echoes Harvey's [25] opinion. An increasing number of scholars emphasize that online education is not conducted in a purely virtual space but is closely related to the local ecology where students live [13,26]. During online education at home, students' living conditions become an important part of their local ecology, which further affects their learning performance. Therefore, online education needs to be explicitly positioned in the local ecology of students' lives, including their living conditions.

As early as the 1960s, based on students' families, the education circle had already realized that the local ecology influences students' academic performance [27]. However, the importance of living conditions was ignored at the time. Hum [14] tried to integrate family and online spaces into an online learning environment through complex system theory. Rooney introduced the concept of a semiprivate space in the field of education, and advanced the famous thesis "the classroom is a semiprivate room" [15]. The concept of semiprivate space is closely related to Lefebvre's [28] concept of social space and Habermas' [29] concept of public space. Wahlstedt et al. [30] argued that e-learning environments are currently more like "buildings", or learning spaces, rather than "schools", or places for learning. They also promoted the transformation of e-learning spaces to e-learning places. Jung and Latchem [31] extended the spatial model of e-education, emphasizing the extended nature of teaching and learning spaces in recent years. As the online education space continues to expand, it will naturally extend from the online space to the offline living space of students, changing the students' living space into a kind of semiprivate space. Fielding [16] analyzed the courses of 32 first-year students at Purdue University Northwestern in 2013, and proposed the semiprivate space theory of online education by applying Rooney's "semiprivate" concept.

Fielding's [16] semiprivate space theory of online education emphasizes the influence of the family on online learning performance, which echoes the Coleman report [27]. However, this theory has certain limitations. First, it emphasizes online education network space while ignoring the influence of students' living conditions. Second, the study lacks a systematic discussion of the specific elements of the semiprivate space of online education at the level of the students' living conditions. Considering the above limitations, in order to expand the semiprivate space theory, the research focus must be shifted from the online space to the family space of students and the elements of students' living conditions, and their impact on the performance of online education must be investigated. This research will be very helpful for the improvement of the online teaching design and students' online learning performance [32,33].

Hypothesis Development

Living conditions refer to various physical and humanistic conditions related to residence and life [34]. Physical conditions refer to the facility conditions inside and outside the living space, and humanistic conditions refer to the various cultural and social relations inside and outside the living space [35]. Living conditions, including the individual (family) housing and the environmental conditions of the students' community, are key social factors affecting education. Poor living conditions may lead to poor learning performance [36]. Children in poor and overcrowded living conditions cannot learn effectively [37]. As the living environment is where people spend most of their time [38], it helps individuals to connect with the primary members of their social network [39]. For most people, housing also represents their main economic and personal investment [40]. As a "space animal" [41], people's body, psychology, and emotions are deeply affected by their housing and community environmental conditions. Thus, students receiving online education at home will also be affected and restricted by their living conditions. School shutdowns due to COVID-19 have forced many schools to rely on in-person learning for online education, and have forced students to learn at home, thereby highlighting the impact of living conditions on online education [6,16].

In this research, the living conditions specifically refer to the family and community conditions related to the online education of students at home. Regarding the construction of a semiprivate space for online education, living conditions typically include online education facilities, housing conditions, student care, family economic conditions, community status, and so on. Online education facilities refer to the general facilities that students need for online learning at home, such as computers, smartphones, and broadband Internet. Housing conditions refer to the physical condition of a family's home, such as the housing area, housing depletion, individual room condition, and tap water condition. Student care is an important element of the family learning atmosphere. In this study, it refers to whether students are looked after by their parents or elders during online studies. Family economic conditions refer to the family's remuneration for labor or other economic income. Community status refers to the economic and social status of the community, which is an integral part of living conditions. All of these elements affect the construction of the semiprivate space for at-home e-learning, and directly or indirectly influence learning performance.

The analysis framework of this study is summarized in Figure 1. In this theoretical framework, online educational facilities are necessary for children to conduct online learning at home. Good housing conditions are an important guarantee for high-quality home-based online learning. Non-physical conditions, including socioeconomic conditions, constitute an important environment for home-based online learning, which will have a significant projection effect on the effectiveness of online learning. Together, these three dimensions constitute a semiprivate space for online education at home. In the past, online education research focused on the first dimension while ignoring the importance of the second and third dimensions, resulting in the neglect of the education-related connotations of these two dimensions. This study will explore the education-related connotations of these dimensions, and will explore their impact on the effect of online education.

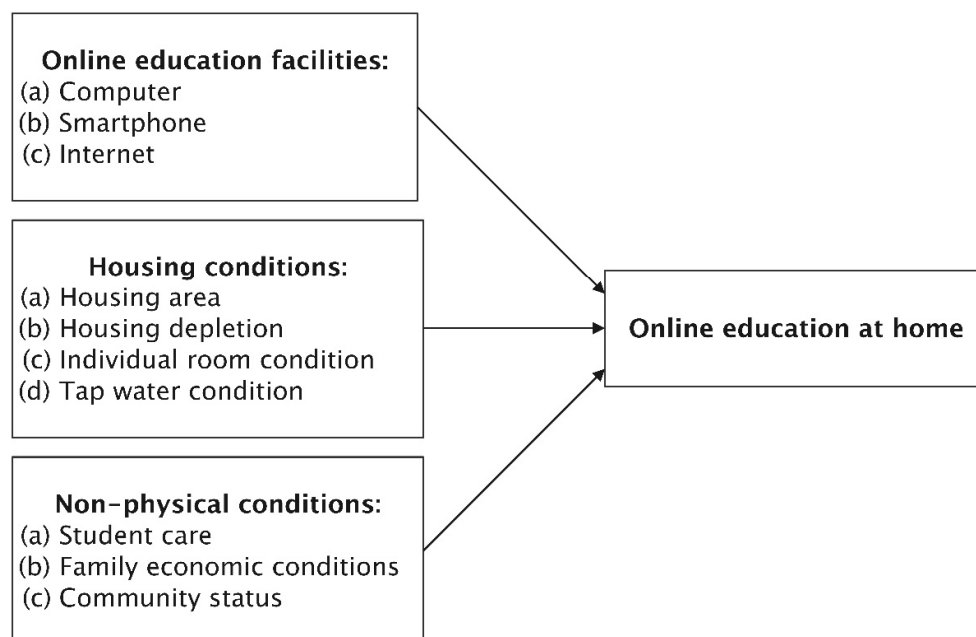


Figure 1. The analysis framework.

Computers and smartphones are important terminals for online learning, without which it is difficult to receive online education at home [9]. A computer is a modern electronic computing machine used for high-speed calculations. Current mainstream computer types include desktops, laptops, and tablets. High-income households are more likely to have computers, and are more likely to access to online education at home [42]. Smartphones can also implement mobile learning (mobile education), thereby creating a mobile semiprivate space which is suitable for online education [43–46]. These pieces of smart terminal equipment, such as computers and smartphones, are mainly connected and

used through broadband Internet [47]. Thus, broadband Internet and online education are complementary [48]. The lack of personal computers and smartphones force students to seek external help from neighbors, communities, and the local government [9,17]. In China, students borrow the equipment and network from their neighbor, seek the public facilities of the community, or receive assistance directly from the local government [17,18]. Sometimes, when the Internet signal at home is poor, students climb to the top of a nearby mountain to receive the signal for online learning. Given the above discussion, the following three hypotheses were formulated.

Hypothesis 1 (H1): *Having a computer at home has a positive impact on online education performance.*

Hypothesis 2 (H2): *Having smartphones at home has a positive impact on online education performance.*

Hypothesis 3 (H3): *Having broadband Internet at home has a positive impact on online education performance.*

When students receive online at-home education, the size of the housing space places realistic constraints on online learning performance. If the housing space is too small, the home will appear crowded and noisy, making it unsuitable for online learning [37]. However, in the case of a large housing space, children can continue their online learning in a relatively quiet environment, with effective results [49]. Furthermore, housing conditions are an important part of one's living conditions. A dilapidated house endangers the safety of users and third parties [50]. Living in such a house engulfs children in the psychological shadow of fear, hindering their wholehearted participation in online learning at home. This negatively impacts online learning performance [51]. If there is a separate room at home, children can benefit from the independent space by avoiding interference from other family members during the learning process, thus improving their online learning performance. Additionally, the availability of tap water is another indicator of the quality of living conditions. The absence of tap water at home indicates poor living conditions, thereby negatively influencing the remote learning process. Given the above discussion, the following four hypotheses were derived:

Hypothesis 4 (H4): *The larger the living area, the better the performance of online education at home.*

Hypothesis 5 (H5): *Living in a dilapidated house adversely affects online and at-home education performance.*

Hypothesis 6 (H6): *Having a separate room at home promotes online and at-home education performance.*

Hypothesis 7 (H7): *The availability of tap water at home is conducive to online at-home education.*

In remote rural areas in China, many parents leave their children in the care of elderly family members, in order to work in the city [52]. However, the elderly do not have the energy to care for these children [53] and, regardless of whether they are studying or living, these left-behind children must live on their own. Thus, the lack of parental care often has a negative impact on children's education [54]. Online education requires students to have strong self-management skills [55]. Generally, students in compulsory education are relatively young, and have poor self-management abilities [56,57]. Therefore, in the absence of parental care during online learning, students will be unable to focus and learn effectively. On the contrary, high parental support and care seems to reduce the effect of risk factors on resilience mechanisms, and seems to increase the effect of protective factors [58]. Care and support from parents help children to concentrate on online learning, thereby achieving good results. Given the above, the following hypothesis is proposed:

Hypothesis 8 (H8): *Being unattended is not conducive to online learning performance at home.*

The term “socioeconomic status” usually refers to the relative status of individuals, families, or groups in a stratified social system [59]. Socially superior groups perform better than socially disadvantaged groups in terms of the possibility of participating in online courses [60,61]. Family income is an important dimension of socioeconomic status, and it has a significant impact on children’s education [62]. Children from low-income families are more likely to have learning disabilities [63]. Additionally, the community also affects the performance of students’ education [64]. The lower the status of the family in the community, the more likely it is that children feel inferior, which is not good for their learning and growth [65]. Therefore, the following two hypotheses were formed.

Hypothesis 9 (H9): *Family income is positively correlated with online education performance at home.*

Hypothesis 10 (H10): *Community status is positively correlated with online education performance at home.*

3. Sample, Variables, and Method

3.1. Sample

The data used in this study were derived from a comprehensive survey of China’s low-income families in 2020, which was designed by the Ministry of Civil Affairs of the People’s Republic of China and conducted by the China Social Science Research Center (ISSS). The survey sample comprised participants from low-income households, such as urban and rural minimum living guarantee families and marginal minimum living guarantee families. The majority of the low-income families in China receive a significant subsistence allowance from the nation’s minimum living standard guarantee system. Households with a family per-capita income lower than the local minimum living standard guarantee thresholds can apply for this allowance, and such families are referred to as minimum living guarantee families. The marginal minimum living guarantee families are families whose per capita income is slightly higher than the minimum living standard guarantee threshold, who cannot be covered by the minimum living guarantee system.

This system aims to reflect objectively the economic status of families in terms of difficulties, reasons for poverty, and the need for social policies. The survey was conducted through computer-assisted telephone interviews. In the 2020 questionnaire, questions related to the COVID-19 pandemic were added in order to assess its impact on low-income families, such as how children from low-income families receive online education at home. The household response rate for the survey was 87.3%. The sample comprised 2683 households with children, of which 2401 households had children receiving compulsory education. Among them, 2002 families reported that they had children receiving online education at home during the COVID-19 pandemic. Therefore, these families were used as the final sample for this study.

3.2. Measures

3.2.1. Performance of Online Education as the Dependent Variable

Online education performance evaluation is abundant [66,67]. The evaluation’s subject, its dimensionality, and its means are diversification [68,69]. Generally, the performance evaluation of e-learning includes four levels: the learning environment, the learning process, the learning results, and the emotional experience [70]. In this study, in terms of operational definition, the performance of online education at home specifically refers to the learning environment, the learning process, and the emotional experience of students receiving online education at home. A self-reported evaluation by students was adopted as the measurement method, which is also a commonly used evaluation method for online education performance [71,72]. In order to obtain the distribution of dependent variables, the respondents were asked, “What do you think is the main reason that affects the quality

of children's online lessons?" If the answer was "No effect", it was assigned a score of 1, which means that the performance of online education at home is good. If the answer was "The network is unstable", "The home is too small to find a quiet space", "Parents do not have time to supervise", "There is no wireless network", or "Other reasons", it was assigned 0, implying that the performance of online education is not good enough.

3.2.2. Measurement Variables of Living Conditions

This study used a set of binary variables related to the hardware requirements of online education to measure the availability of hardware facilities such as computers, smartphones, and broadband Internet at students' homes. For example, the respondents were asked: "Currently, do you have the following items in your home?" Positive and negative answers were assigned scores of 1 and 0, respectively.

Living space refers to not only to the physical space that a person lives or works in, it also has the symbolic meaning of "home", giving family members a sense of belongingness and security [73]. In the operational definition of this research, living space conditions mainly include two dimensions: the housing area and the housing quality. Correspondingly, the living space conditions were primarily measured using the following variables. In order to obtain the residential variables, the respondents were asked, "What is the floor area of your current house in square meters?" This indicator was used to measure the area of living space. In China, dilapidated houses refer specifically to the dilapidated houses in village-in-the-city communities, stone-structured houses in urban reconstruction areas, and rural dilapidated houses [74]. Such houses are generally characterized by a long building service life, poor housing quality, high potential safety hazards, and imperfect use functions. The availability of a separate room is also an important indicator for the measurement of the quality of life. Another important indicator is the availability of tap water. The absence of tap water at home shows that the residence is not in an urban area, and is generally located in remote and backward mountainous areas [75]. Correspondingly, three variables were used to measure the quality of the living space. The respondents were asked the following questions: "Is your current house dilapidated?", "Does your adult member or his/her spouse have a separate room?", and "Does your current house have tap water facility?" If the answer was "yes", it was assigned a score of 1, otherwise, it was assigned a score of 0. All of these variables were binary variables.

Childcare refers to whether the student is under the care of parents or elders during online studies, which is a particularly important aspect of online classes [18,76]. Left-behind children generally do not receive the care of their parents and other elders at home; hence, they lack the consciousness and self-discipline required for online education [77]. Regarding childcare, the respondents were asked: "Since the beginning of 2020, in which of the following aspects has your family been affected by the COVID-19 pandemic?" If the answer was "School suspension leaves home students unattended", it was assigned a score of 1; otherwise, it was assigned a score of 0.

The annual family income was divided into three levels: CNY 0–29,999, 30,000–59,999, and 60,000+. The reference group was at the first level (<30,000). In recent years, with the rapid development of China and the differentiation of social income levels, neighborhoods have undergone a change from residential differentiation to residential isolation, and there has been a clear division of community levels [78]. The change in the economic status of neighborhoods is an important driver of community stratification [79]. Here, community status refers to the economic and social status of the community, which is the measurement of the family's economic status based on its economic income in the community. Regarding community status, the respondents were asked, "At what level do you think the family's economic status is in this community?" The respondents had to select one of the following options: Upper, Upper Middle, Middle, Lower Middle, or Lower. If the answer was "Lower", it was assigned a score of 1; otherwise, it was assigned a score of 0.

3.2.3. Measurement of the Control Variables

China has established a minimum living guarantee system in order to guarantee a minimum standard of living for the lowest-income families. “Minimum living guarantee” families are headed by parents whose monthly income is lower than the standard local minimum living allowance, due to physical disability or illness [80]. These parents can avail themselves of a national minimum living guarantee subsidy, and the government provides educational subsidies to fund their children’s education [17]. The qualification of low-income families for the subsistence allowance determines whether the family can obtain a series of government subsidies in the fields of housing, health, education, and so on. Additionally, household registration and residential conditions may impact online education at home. Hukou, also known as household registration, refers to a legal document prepared by the state administrative agency in charge of household registration to record and retain basic information about the household population. It is also an identity certificate for every citizen. Hukou are divided into two types: agricultural and non-agricultural. Agricultural Hukou refers to residents living in rural areas who rely on their own food production. Non-agricultural Hukou refers to urban residents who rely on the state to distribute rations [81]. The place of residence is an important variable in the study of urban–rural differences [82]. In order to account for these differences, we considered the variables of subsistence allowance, Hukou (non-agricultural or agricultural), and place of residence (rural or urban) as control variables.

3.3. Statistical Modeling

We used chi-square analysis and *t*-tests to analyze the binary correlations between the influencing factors and online education performance. Stata software (version 16.0, Stata Corp., College Station, TX, USA) was used to conduct the multivariate logistic regression analysis, and each hypothesis in the theoretical model was tested.

4. Results

Data regarding the respondents’ online education behaviors are presented in Table 1. In 2020, 33.72% of students in the sample families reported a good performance of online education at home ($n = 675$), while 66.28% of students reported that the performance was not satisfactory ($n = 1327$).

Regarding hardware facilities for online education, the proportions of households with computers and smartphones were 26% and 80%, respectively. A total of 66.1% of the households had broadband Internet. In terms of the physical conditions of households, families with dilapidated houses, separate rooms, and indoor tap water accounted for 14.2%, 73.6%, and 94.5% of the total, respectively. Regarding parental care, unattended students accounted for 19.4% of the total.

In terms of their income level, families with an annual income of less than CNY 30,000, between CNY 30,000 and 60,000, and more than CNY 60,000 accounted for 35.1%, 40%, and 35.1% of the total, respectively. Regarding education level, junior high and high school education accounted for 35.7% and 24.9% of the total, respectively. In terms of community status, families in the bottom layer and the upper and middle layers accounted for 60.6% and 39.4%, respectively. In terms of control variables, families with subsistence allowances, families with agricultural Hukou, and families residing in rural areas accounted for 55.6%, 69%, and 62.7%, respectively.

Table 1 also shows the combinations of the online education performance and living condition characteristics in 2020. The binary cross-tabs show that students who performed well in online education were more likely to have broadband Internet, while having a computer at home may also affect online learning performance at home. Students can carry out streaming homework, take notes, and make presentations through computers, which are a more convenient medium than smart phones. Compared with smart phones, computers also have the advantages of a long battery life, durability, and more functions. According to the instructional design, the iron triangle depicts the balance of effectiveness,

efficiency, and appeal [32]. These advantages make computers more likely than smart phones to become the main smart terminal for students' online education at home.

Table 1. Distribution and chi-square of the general characteristics.

Classification		Participants (<i>n</i> = 2002)	Performance of Online Education at Home		χ^2 (<i>p</i>)
		<i>n</i> (%)	Good <i>n</i> (%)	No Good <i>n</i> (%)	
Computer	Yes	520 (26.0)	195 (28.9)	325 (24.5)	4.5 ** (0.034)
	No	1482 (74.0)	480 (71.1)	1002 (75.5)	
Smart Phone	Yes	1802 (80.0)	617 (91.4)	1185 (89.3)	2.212 (0.137)
	No	200 (10.0)	58 (8.6)	142 (10.7)	
Internet	Yes	1324 (66.1)	481 (71.3)	843 (63.5)	11.944 *** (0.001)
	No	678 (33.9)	194 (28.7)	484 (36.5)	
Dilapidated House	Yes	284 (14.2)	67 (9.9)	217 (16.4)	15.18 *** (0.000)
	No	1718 (85.8)	608 (90.1)	1110 (83.6)	
Separate room	Yes	1473 (73.6)	547 (81.0)	926 (69.8)	29.155 *** (0.000)
	No	529 (26.4)	128 (19.0)	401 (30.2)	
Indoor tap water	Yes	1892 (94.5)	654 (96.9)	1238 (93.3)	11.14 *** (0.001)
	No	110 (5.5)	21 (3.1)	89 (6.7)	
Unattended students	Yes	389 (19.4)	57 (8.4)	332 (25.0)	78.511 *** (0.000)
	No	1613 (80.6)	618 (91.6)	995 (75.0)	
Income	0–30,000 yuan	703 (35.1)	219 (32.4)	484 (36.5)	13.954 *** (0.001)
	30,000–60,000 yuan	801 (40.0)	254 (37.6)	547 (41.2)	
	>60,000 yuan	498 (24.9)	202 (29.9)	296 (22.3)	
Community status	Bottom layer	1214 (60.6)	466 (69.0)	748 (56.4)	30.088 *** (0.000)
	Upper and middle layer	788 (39.4)	209 (31.0)	579 (43.6)	
Subsistence Allowance	Yes	1113 (55.6)	374 (55.4)	739 (55.7)	0.014 (0.904)
	No	889 (44.4)	301 (44.6)	588 (44.3)	
<i>Hukou</i>	Agricultural	1382 (69.0)	498 (73.8)	884 (66.6)	10.733 *** (0.001)
	Non-agricultural	620 (31.0)	177 (26.2)	443 (33.4)	
Place of Residence	Rural	1256 (62.7)	460 (68.1)	796 (60.0)	12.754 *** (0.001)
	Urban	746 (37.3)	215 (31.9)	531 (40.0)	
Online Education Performance	Good	675 (33.72)	-	-	-
	No Good	1327 (66.28)	-	-	

Note: ** significant at the 5% level; *** significant at the 1% level.

Unattended students in families with dilapidated houses were less likely to perform well in online classes, while students in families with separate rooms and indoor tap water were more likely to perform well. Family income and community status also affect online education performance. In terms of the control variables, *Hukou* and the place of residence may affect the performance of online education, while subsistence allowance may not.

Table 2 presents the results of the multivariate logistic regression analysis. The Cox and Snell R^2 values were 0.152, and ρ^2 (Nagelkerke) was 0.271. The value of the -2 log likelihood was 2389.32. The value of χ^2 was 169.77, which was significant ($p = 0.000$). The results of this analysis show that, in 2020, having a computer at home had no significant impact on the performance of online education (OR = 1.113; 95% CI: 0.873–1.42). Thus, Hypothesis 1 is not supported. Similarly, having smartphones at home had no significant impact on the performance of online education (OR = 0.905; 95% CI: 0.582–0.632). Thus, Hypothesis 2 is not supported. However, students in families with broadband Internet were

more likely to perform better in online education than those in families without broadband Internet (OR = 1.264; 95% CI: 1.004–1.593). Thus, Hypothesis 3 was supported.

Table 2. Multivariable logistic regression analysis.

Characteristics	Online Education Performance		
	Odds Ratio	95% CI	p-Value
Computer: yes vs. no	1.113	0.873–1.42	0.386
Smart Phone: yes vs. no	0.905	0.582–0.632	0.582
Internet: yes vs. no	1.264 **	1.004–1.593	0.046
Residential area	1.003 *	0.998–1.005	0.074
Dilapidated house: yes vs. no	0.771 **	0.566–1.043	0.098
Separate room: yes vs. no	1.47 ***	1.155–1.872	0.002
Indoor tap water: yes vs. no	2.08 ***	1.26–3.432	0.004
Unattended students at home: yes vs. no	0.306 ***	0.226–0.414	0.000
Income (Re: <30,000 yuan)			
30,000–60,000 yuan	0.928	0.735–1.171	0.528
>60,000 yuan	1.266 *	0.96–1.67	0.095
Community status: bottom layer vs. upper and middle layer	0.726 ***	0.587–0.897	0.003
Subsistence Allowance: yes vs. no	0.945	0.77–1.16	0.589
Hukou: non-agricultural vs. agricultural	1.168	0.834–1.637	0.366
Place of Residence: rural vs. urban	1.161	0.84–1.605	0.367
Constant	0.152 ***	0.076–0.305	0.000

Note: * significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level.

Additionally, the type of residential area had a positive and significant impact on the performance of online education (OR = 1.003; 95% CI: 0.998–1.005). Thus, Hypothesis 4 was supported. Students in families with dilapidated houses were less likely to perform well in online education than others (OR = 0.771; 95% CI: 0.566–1.043). Thus, Hypothesis 5 was supported. Students in families with separate rooms were more likely to perform well in online education than others (OR = 1.47; 95% CI: 1.155–1.872). Thus, Hypothesis 6 was supported. Students in families with indoor tap water were more likely to show a good performance in online education than others (OR = 2.08; 95% CI: 1.26–3.432). Thus, Hypothesis 7 was supported. Unattended students were less likely to show a good performance in online education than others (OR = 0.306; 95% CI: 0.226–0.414). Thus, Hypothesis 8 was supported.

There was no significant difference in the performance of online education between students with a family income between CNY 30,000 and 60,000 and those with a family income of less than CNY 30,000, while students with a family income of more than CNY 60,000 were more likely to perform well than those with a family income of less than CNY 30,000 (OR = 1.266; 95% CI: 0.96–1.67). Thus, Hypothesis 9 was supported. Finally, students belonging to households in the bottom layer of the community were less likely to show a good performance in online education than those belonging to households in the upper and middle layers (OR = 0.726; 95% CI: 0.587–0.897). Thus, Hypothesis 10 was also supported.

In terms of control variables, subsistence allowance and Hukou did not affect the performance of online education or the place of residence.

5. Discussion

5.1. Empirical Contributions

The online education space is not a public space, as stated by Habermas [29], but a semiprivate space: there are clear costs and barriers to entry, and not everyone can enter. The different living conditions of students lead to the construction of dissimilar semiprivate spaces for online education, resulting in different effects of online learning at home. The empirical contributions of this research mainly reflect the composition and testing of the semi-private space where students receive online education at home.

The results of this study show that children from families with broadband Internet are significantly more likely to demonstrate a good performance in online education than those without broadband Internet. The lack of broadband Internet at home, or having unstable internet, has a negative impact on the performance of online learning [47,48]. Of course, educational materials can be delivered to these learners in paper form, or they can use distance education via radio. However, in the digital age, the efficiency of these measures is relatively low. Furthermore, the presence or absence of a computer at home was not found to influence the performance of online education. One reason for this is that students who do not have a computer at home can access online classes through their smartphones. The presence or absence of smartphones at home has little influence on the performance of online education. This is primarily because the penetration rate of smartphones in the sample households was relatively high, with 80% owning smartphones. Very few individuals in the sample had neither a computer nor a smartphone at home. In order to ensure that the “leave school without leaving teaching, suspension of classes without suspension” approach can be applied to these students, the school will coordinate with the community to provide a space with Internet access and computers for these students to benefit from online classes [83]. For students from families that have neither a computer nor a smartphone at home, the community will arrange to conduct online classes in a community public learning area equipped with computers and broadband networks, which can provide learners with adequate conditions to receive online education. This is done in order to construct a semiprivate space in the community which is suitable for specific students to take online lessons.

The semiprivate space of online education is constrained and affected by actual living space conditions. This study’s findings show that the larger the living area, the better the students’ online learning performance at home. This is similar to the results of Ohta and Akayama [49]. If the housing space is too small, the home will appear crowded and noisy, which is not conducive to online learning [37]. Moreover, students who live in spaces with independent rooms and indoor tap water are more likely to focus on and achieve good results in online education, while students living in dilapidated houses do not perform well. Rooney (2002) introduced the concept of semiprivate space to the field of education with the famous thesis “the classroom is a semiprivate room” [15]. When students receive online education at home, the living space becomes a part of the e-learning classroom; it is no longer a purely private space but a semiprivate space. This research shows that once the residential space becomes a semiprivate space for online education, its attributes and characteristics will also become a part of the semi-private space, thereby influencing the performance of online education.

In addition to the physical factors in living conditions, non-physical factors also influence the effects and performance of online education at home. This study shows that online education is less effective for students who do not receive adequate care at home. Children lack self-control, such that it is difficult to concentrate on online learning at home without the supervision of family members [56]. Support from parents can increase children’s confidence and enhance the effect of online learning [58]. Thus, in the process of semiprivate space construction in online education, not only should we pay attention to the construction and improvement of the physical facilities of the living space but also to the non-physical construction of the living space, and we should promote parent-child relationships, optimize the family education environment, and let parents become educators in order to advance children’s growth.

Building a semi-private space for online education requires a certain economic foundation, which will also be affected by community factors, such as the family’s social status in the community. This study shows that children from families with low incomes and status are less likely to perform well in online learning at home, confirming the conclusions of previous studies [60,61,63,64]. This study also shows that Hukou and the place of residence do not affect online education performance at home. Therefore, the performance of online education does not differ according to urban and rural differences.

5.2. Theoretical Implications

This study has important theoretical implications. Though research on online education has been conducted for more than 30 years [84], it remains an intriguing topic in the field of education. In particular, the outbreak of the COVID-19 pandemic has further enriched the connotations of online education [6]. All levels and types of education were experienced deeply, and the importance of online education was realized. This may be an unprecedented and truly global online education movement. From a theoretical point of view, only change, adaptation, and evolution can lead to mainstreaming. Therefore, researchers and practitioners of online education have introduced their own theories based on the adoption of educational theories with universal significance. Among these various theories, Fielding's [16] semiprivate space theory promotes our understanding of online education, and helps advance its development. The results of this study show that the living conditions of students constitute a semiprivate space for online learning, thereby influencing its adequate performance. The findings not only support Fielding's [16] opinion but also confirm the spatial extension mechanism of online education from the online virtual space to the living space of students [31]. On a theoretical level, it explores the tangible and intangible components of the semiprivate space of online education, and empirically tests the influence of living conditions on the performance of online education. Thus, this study enriches the connotation of semiprivate space theory [18,85].

Another important theoretical contribution of this research is the expansion of instructional planning theory. This theory emphasizes the creation and realization of inclusive learning environments by balancing effectiveness, efficiency, and appeal [32,33]. This research discusses the semi-private space where students receive online education at home, and proposes theories to promote the inclusiveness and equality of online education, thereby concretizing and theorizing inclusive learning environments. It provides important theoretical support for online education, from a "traditional" learning experience to an innovative learning experience [86]. It also helps teachers to customize their approaches in order to make online resources accessible to students when designing online courses [87].

5.3. Practical Implications

This study identifies the factors that limit students' online education performance at the family level, and which can help the government in the formulation of specific policies to overcome these constraints. At the micro level, due to the difference in a family's living environment, students may have different needs with respect to undertaking online education at home. Therefore, it is necessary to conduct a demand analysis according to different living conditions and community conditions, and then to provide targeted online education services. For example, children from families in remote mountainous areas face issues related to accessibility, and would want smart terminal devices that can connect to the Internet. However, for children in the city, the physical equipment required for online learning is already available; hence, they would need rich, diverse, and attractive online education content and form. According to the instructional design iron triangle depicting the balance of effectiveness, efficiency, and appeal [32], with respect to online education, for students from remote and mountainous areas, first the problem of efficiency must be resolved, while for urban students, the problem of effectiveness and attractiveness (appeal) must be overcome. A very important reason for this trade-off and sacrifice, emphasized by Honebein and Honebein [32], is that students with different family conditions have different needs for online education.

This research also provides important practical guidance for suppliers of commercial online education services. In the past, online education companies focused on the collection, monitoring, and analysis of data related to online teaching activities, whilst ignoring offline data. However, a student's home situation and other offline environmental factors also have an important impact on online education activities. Therefore, online education companies should pay attention to the collection of offline data as well, should strengthen their understanding of students' family situations, and should provide corresponding

services and support. In addition, this study also emphasizes that parents should support their children's education and create favorable conditions and atmosphere so that the children can effectively participate in online education at home. Furthermore, for children who face difficulties at home and cannot receive online education, the community should provide assistance in order to ensure that every child is able to receive online education.

If the housing space allows, it is necessary to give children a separate room for home-based online learning. On the one hand, once children have their own exclusive space, they will have a sense of self-territoriality, and it will be easier to cultivate their independent online learning. On the other hand, children receiving online education in a separate room will not be disturbed by other factors at home, and it is easier to concentrate on online learning, such that it is easier to achieve a good performance of online learning. If the housing space is limited and it is impossible to arrange a separate room for the child's online learning at home, parents should try to create a quiet home environment so that the child can receive online education at home without being disturbed by noise or trivial matters. This is also an important way to improve the performance of children's online education at home.

5.4. Limitations

This study has three limitations. First, further systematic investigations of the components of the semiprivate space may identify other significant elements affecting online education. Second, this study uses cross-sectional data instead of panel data. Therefore, the discussion strictly focuses on the correlation, and causality cannot be tested. Third, the meaning of living conditions is becoming increasingly complex, and often interacts with personal characteristics. This further necessitates the need to study the relationship between the living conditions of low-income families and their children's online learning performance at home.

6. Conclusions

In contrast to previous research on the effect of online education for the general population, this study focuses on the living conditions and online education of children from low-income families. The conclusions show that the residence area, presence of broadband Internet, condition of the house, presence of separate rooms, availability of running water, and parental care and attention towards children affect the performance of online education at home. Additionally, family income and community status also influence the effect of online learning at home. This study shows that due to the obvious disadvantages of low-income families in terms of living conditions, it is necessary to focus on their improvement. This will enable the children from such families to effectively participate in online learning. Therefore, the government should ensure that steps for the improvement of the living conditions of low-income families are included in the policy regarding education equity.

Undoubtedly, there are other ways to solve the problem of inequality in online education. For example, the issue of the so called "usage gap" in online education can be solved through the design and optimization of online education courses [87]. However, in the rapid shift to the online medium, online education design should fully consider the family living conditions of students when designing inclusive learning environments for emergent requirements. When students receive online education at home, the home is no longer a private space but a semiprivate space for online learning, which is an important and inseparable part of inclusive learning environments for online learning at home.

Funding: The author discloses the receipt of the following financial support for the research, authorship, and/or publication of this article: this research was funded by the Peking University Education Big Data Project (2020YBC16).

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board (or Ethics Committee) of Peking University (protocol code IRB00001052-14010 on 8 October 2009, which was renewed every year).

Informed Consent Statement: Informed consent was obtained from all of the study participants by ISSS.

Data Availability Statement: The data for this research can be applied for and downloaded from the Peking University Open Research Data Platform website (<https://opendata.pku.edu.cn/dataverse/CFPS>) (accessed on 25 June 2021).

Acknowledgments: The author gratefully acknowledges the Peking University Education Big Data Project (2020YBC16) for the support of this research. The authors would also like to thank the editor and anonymous reviewers for their insightful comments and suggestions.

Conflicts of Interest: The author declares no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

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