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Inequalities in digital literacy: exploring the disparity in tangible outcomes of internet use among college students in China

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Introduction: In the age of digitization, digital literacy plays a crucial role in ensuring that college students thrive in an increasingly digital world. While many studies have examined disparities in digital literacy focusing on access and skills, there is still a research gap concerning the tangible benefits college students derive from internet use. Using an internet outcome framework, our study scrutinizes the potential disparities in benefits derived from internet use among college students from varied social backgrounds in China.

Methods: This quantitative study employed an online survey to collect data from 463 college students across various economic regions in China, ensuring a diverse and representative sample. The survey gathered information on students' internet usage patterns and their perceived benefits across eight outcome dimensions. To identify which groups of students benefit most from internet use, we conducted logistic regression analyses examining the relationships between the eight outcome factors and socio-economic status variables. This analytical approach allowed us to assess the influence of various predictors on the likelihood of students experiencing specific internet use outcomes.

Results: We found that students from a higher socio-economic status generally obtain more benefits from internet usage. Interestingly, female students appear to capitalize on certain advantages more than their male counterparts.

Discussion: These findings indicate that online experiences might amplify offline inequalities, suggesting that the internet could produce varied outcomes based on the student's background. Hence, we need to reevaluate the notion of digital natives and the presumed universal access to and use of digital technology among college students.

KEYWORDS

inequalities, digital literacy, college students, internet outcomes, female students

Introduction

Digital literacy, generally defined as individuals' access to and usage of digital technologies, has become increasingly crucial for sustainable development at both the individual and national level (Ainley et al., 2016). For individuals, digital literacy is essential in various aspects of life, including enhancing employability in the labor market (Bejaković and Mrnjavac, 2020), participating in civic activities (Milenkova and Lendzhova, 2021), supporting lifelong learning sustainability (Anthonysamy et al., 2020), and promoting wellbeing through effectively managing online risks (Bahramian et al., 2018; Vissenberg et al., 2022). Consequently, at the national level, individuals' digital literacy plays a critical role in enhancing national competence in the global landscape by fostering productivity and innovation across the economic, social, political, and cultural domains.

Despite its significance for sustainable development, digital literacy—which consists of access, skills, and benefits of digital technology usage—is not uniformly distributed

among individuals. Some people still lack physical or material access to digital technologies (Van Deursen and Van Dijk, 2019). Among those who do have access, there is often a disparity in their levels of digital literacy such as knowledge, skills, etc. (Heponiemi et al., 2023). Furthermore, these varying levels of digital literacy result in unequal benefits derived from using these technologies (Livingstone et al., 2023). For instance, individuals with a higher level of digital literacy tend to have a greater chance of being employed in the job market, compared to those without adequate digital literacy (Bejaković and Mrnjavac, 2020). Similarly, countries with a higher percentage of digitally skilled citizens are more competitive in the international community. The unequal development of digital literacy among individuals and nations has raised concerns regarding issues such as social exclusion and international conflicts.

To address the inequality in digital literacy, extensive research has been conducted to examine the dynamics surrounding the unequal distribution of digital literacy. Over the last two decades, numerous studies have extensively explored the realm of digital inequality (e.g., Van Deursen et al., 2017). These studies have thoroughly examined disparities in access and skills associated with digital technologies, including the internet and digital devices. Their valuable insights have significantly contributed to our understanding of digital literacy inequality, a critical foundation for formulating initiatives and policies that promote sustainable development.

Despite the extensive body of research in this domain, several significant research gaps persist. Firstly, most studies predominantly focus on achieving equal footing in digital access and skills, despite for several recent studies conducted to investigate differential outcomes (Livingstone et al., 2023). Yet, simply ensuring equal access and skills doesn't necessarily translate to equal benefits derived from the utilization of these technologies. Secondly, research on digital literacy inequality among college students is scarce. Most existing studies spotlight marginalized groups, such as those from lower socio-economic backgrounds, the elderly, or those with restricted access to digital resources (e.g., Van Deursen and Van Dijk, 2019). This oversight is partly due to the pervasive "digital native" myth, which posits that younger demographics inherently navigate the digital realm more adeptly than older generations. While universities typically offer internet access, the COVID-19 pandemic has highlighted the challenges confronting students lacking dependable internet access at home (The Education Trust-West, 2020). Consequently, this study endeavors to discern whether disparities in digital literacy, particularly in the tangible benefits of internet usage, are present among college students of diverse social origins.

Literature review

The concept of digital literacy

The concept of digital literacy has evolved alongside the development of various digital technologies, their individual usage patterns, and their implications for social inclusion. Initially, the emphasis was on digital access, assessing whether an individual had the means to use digital technology. Subsequently, the focus

shifted toward evaluating an individual's proficiency in using these technologies effectively. More recently, the concept has expanded to encompass the idea of equitable access to the benefits derived from the use of digital technology.

In the emergence of digital technology, particularly the internet, the digital literacy literature predominantly underscores access to devices such as computers, the internet, and mobile phones, as well as the factors that lead to differential access among various social groups (Van Dijk, 2012; Van Deursen and Van Dijk, 2019). The primary focus was on whether individuals had the opportunity to utilize digital technology in the emerging information society and the factors that either facilitated or impeded their access to this technology.

With the proliferation of digital technology, the concept of digital literacy has evolved from a focus on individuals' infrastructural access to an emphasis on their skills and patterns of technology usage (e.g., Heponiemi et al., 2023). The evolution of digital literacy, assessed primarily through digital skills, has transitioned from a singular technical dimension to a classification that encompasses various categories or levels. The categories encompass subtypes essential for living and working in a digital society, including operational, informational, communicational, creative, critical skills, etc. (Helsper and Eynon, 2013; van Laar et al., 2019). OECD highlighted the significance of digital skills as a component of digital literacy and defines digital literacy in the context of labor market inclusion, productivity, economic growth (Grundke et al., 2017; OECD, 2021a) and public sector governance (OECD, 2021b).

Recently, there has been a growing emphasis on the outcomes of digital literacy, with a focus on the benefits individuals can derive from using digital technology (Blank and Lutz, 2018; Livingstone et al., 2023; Scheerder et al., 2017). For example, Van Deursen and Helsper (2015) designed an internet outcomes framework to assess the tangible benefits of internet use and its correlation with digital inequalities. The authors categorized the benefits derived from internet usage into eight fields: (1) economic labor outcomes: e.g., finding a better job, earning more money; (2) economic commerce outcomes: e.g., obtaining cheaper products and vacation, trading goods; (3) social outcomes: e.g., more contact with family and friends, easier for family and friends to get ahold of, making more friends, meeting potential partner; (4) political outcomes: e.g., expressing political opinion, joining political organizations such as political association, union, or party; (5) institutional outcomes: e.g., better up-to-date with government information; (6) governmental outcomes: e.g., better contact with the government, entitled to a particular benefit, subsidy, or tax advantage; (7) institutional health outcomes: e.g., determining the health conditions, having healthier life due to online medical information, finding the best hospital for suffering conditions; (8) educational outcomes: e.g., finding a suitable educational course, following a course. From this perspective, digital literacy is defined as an individual's ability to utilize digital technology to achieve tangible and high-quality results in everyday life (Helsper, 2016; Helsper et al., 2015; Van Deursen and Helsper, 2018). Research and policy practice center around the benefits that individuals can gain from proficient use of digital technology, with digital skills seen as a means to achieve these outcomes.

As our understanding of what constitutes digital literacy expanded, so did empirical studies investigate the disparities among different social groups in this realm. Notably, the mere proliferation of digital technology access and its increased use among various sections of society does not guarantee equitable outcomes. The evidence suggests that the digital divide, rather than diminishing, might be shifting from mere access to disparities in benefits derived from technology use. Hence, there's an emphasized need to examine the tangible outcomes and benefits from internet use.

Inequality in digital literacy

For many years, research on digital literacy inequality has primarily centered on the dimensions of access and skills. This body of research delves into the disparities in digital infrastructure access and the unequal distribution of digital skills across different social groups (e.g., Dodel and Mesch, 2018; Hargittai et al., 2019; Van Deursen and Van Dijk, 2014) and among nations (Vuorikari et al., 2016). Such studies have been pivotal in exploring the dynamics of this uneven distribution and in addressing issues related to digital exclusion (Chen and Li, 2022).

In recent years, the results of empirical studies have also revealed inequality in the outcomes of digital technology usage, impacting almost every aspect of individuals' work and life (Blank and Lutz, 2018; Van Deursen and Helsper, 2018). Specifically, in the workplace, individuals with varying levels of digital skills tend to receive different wages. For instance, in OECD countries, the wage gap between those with higher-level digital skills and those with basic skills was, on average, 27%. In some countries like England, the United States, and Singapore, this wage gap exceeded 50%. Additionally, workers with no digital skills earned, on average, 10% less in wages than those with basic skills (Falck et al., 2016).

It seems that individuals with higher social status tend to gain greater benefits than those from disadvantaged groups. A qualitative study conducted among Dutch families reveal that the benefits derived from internet use are influenced by one's educational background (Scheerder et al., 2020). More specifically, compared to those with lower educational backgrounds, individuals with higher education are more often successful in deriving benefits in personal, cultural, and economic areas. Additionally, they tend to mitigate the influence of the internet on their personal lives by intentionally disconnecting from it when possible.

The studies mentioned above provide evidence of persistent inequality in the benefits of internet use among different social groups, particularly disadvantaged ones. While it's essential to prioritize marginalized groups, given their heightened vulnerability to the adverse effects of the digital divide, it's also important to consider other demographics. For instance, college students, despite their high-level internet access and skills in an advanced educational setting, come from a variety of socioeconomic, cultural, and educational backgrounds. Such diversity can lead to disparities in the benefits they derive from internet use. With the swift digitalization of higher education, especially in the post-pandemic world, it becomes crucial to examine digital literacy disparities among college students. Such an understanding can guide the creation of more inclusive educational strategies and policies.

Inequalities in digital literacy in higher education

Numerous studies have explored digital literacy among higher education students since the emergence of the digital era (Audrin and Audrin, 2022; Öncül, 2021). Many early studies perceive college students as a homogenous group of "digital natives" or "tech-savvy" individuals, positing that they have advantages in digital literacy compared to other age groups. The digital myth of college students seems plausible given their broader access to technology and proficiency of internet use compared to other age groups. Results of survey have shown that even nearly two decades ago in the U.S. college students have almost universal access to the internet (Cotten and Jelenewicz, 2006; Fortson et al., 2007), which was much higher compared to other age groups. This widespread access appears to underscore the digital equity among college students and affirms their advantage as digital natives.

However, the assumption that college students uniformly possess high levels of digital literacy needs to be reconsidered, especially in light of the COVID-19 pandemic and the varied social backgrounds they come from. The shift to remote learning during lockdowns exposed significant disparities in students' access to digital devices, stable internet connections, and digital skills necessary for effective online learning (Jaggars et al., 2021; Tejedor et al., 2020). These findings suggest that digital literacy cannot be taken for granted even among university students, particularly those from rural or lower-income families.

Variabilities in skill of internet use arise from factors such as demographics, family status, university rankings, and previous digital experiences and expertise, all of which can contribute to diverse levels of digital skills and internet usage patterns. Differences in family backgrounds and individual psychological characteristics further diversify their digital literacy (Paus-Hasebrink et al., 2014; Helsper, 2016). For instance, even though university freshmen generally have widespread internet access, there are noticeable disparities in their engagement with various internet activities and their skill levels (Ricoy et al., 2013).

The inequality on access and skills of digital literacy may further contribute to disparities in benefits in terms of their education and professional futures derived from the use of digital technology (Yustika and Iswati, 2020). Both demographic and socioeconomic factors influence the benefits college students reap from using digital technology. Some studies have delved into the impact of young people's internet use, offering insights into the varying outcomes among different youth demographics. For example, a survey predominantly involving college students revealed that male and proficient users are more likely to achieve positive internet outcomes spanning economic, social bridging, social bonding, entertainment, institutional, and health benefits (Brinkman, 2016).

While many studies address digital literacy, significant research gap remains regarding the consistent benefits college students derive from internet usage. Additionally, there's a dearth of research exploring internet outcomes through the lens of a digital literacy framework. In response to this gap, our study utilizes the digital literacy framework to investigate internet outcomes among college students in China, aiming to discern whether students from varied backgrounds genuinely receive equivalent advantages from their internet use.

Methodology

Objective and hypothesis

Our study seeks to investigate inequalities in digital literacy among college students in China based on the outcomes derived from internet use. Specifically, we hypothesize that:

- (1) There will be significant differences in the economic outcomes of internet use among college students with different gender, number of siblings, grade, parents' socioeconomic status, and place of origin.
- (2) There will be significant differences in the social outcomes of internet use among college students with different gender, number of siblings, grade, parents' socioeconomic status, and place of origin.
- (3) There will be significant differences in the political outcomes of internet use among college students with different gender, number of siblings, grade, parents' socioeconomic status, and place of origin.
- (4) There will be significant differences in the institutional outcomes of internet use among college students with different gender, number of siblings, grade, parents' socioeconomic status, and place of origin.
- (5) There will be significant differences in the educational outcomes of internet use among college students with different gender, number of siblings, grade, parents' socioeconomic status, and place of origin.

Sample and data collection

We conducted an exploratory study among university students in China, a demographic with almost universal access to the internet and other digital technologies, such as smartphones. By the end of September 2020, the number of internet users in China had surged to 940 million, with students accounting for nearly a quarter (23.7%) of this population [China Internet Network Information Center (CNNIC), 2020]. Most university students access the internet using infrastructure provided by their respective institutions, making them some of the most active internet users in the country. A study indicates that over 40% of students spend more than 5 h online daily, engaging in a variety of activities. These include chatting with friends on social media (83.93%), searching for information (62.46%), listening to music (58.61%), studying and reading (53.93%), shopping (48.93%), watching TV programs and movies (45.49%), passing time (41.8%), viewing online and livestream videos (39.48%), reading the news (36.56%), and playing games (31.97%) (China Youth Network, 2019). Given the near-universal internet access, the time they invest online, and the breadth of online activities they engage in, university students in China present an ideal context for our study.

Regarding the data collection process, we integrated China's local online survey service with a social media platform. First, we designed the questionnaire using a professional online survey platform named Wenjuanxing (Questionnaire Star), which is the most prevalent online survey platform in China (Questionnaire Star, n.d.). As of February 21, 2020, it boasted over 59 million users, and the number of completed questionnaires exceeded 4.2 billion.

Secondly, we used a social media platform for participant recruitment. We sourced participants through WeChat, a multi-purpose Chinese app that encompasses social media, messaging, and mobile payment functionalities, developed by Tencent. According to Statista, WeChat ranks as one of the world's most popular social networks, placing fifth in terms of active user count (Statista, 2021). A study by Chen (2016) found that almost all college students in China use WeChat daily, leveraging its multifaceted functionalities for communication, information access, and academic collaboration. Given this context, recruiting participants through WeChat allowed us to effectively reach a broad and representative sample of the college student population across various regions and socio-economic backgrounds in China. Specifically, we utilized two interactive features within WeChat: "Moments" and WeChat groups. "Moments" allows users to post images, texts, and short videos to share with friends on their contact list, while WeChat groups provided a means to directly engage with potential participants.

Thirdly, we distributed the questionnaires online via WeChat between December 2020 and January 2021. The link to the questionnaire on Wenjuanxing was disseminated primarily through two WeChat features: groups comprised of college students and the Moments service. Before conducting the survey, the purpose and content of the study were explained to the participants, and their consent was obtained. Participants were informed that their participation was voluntary and that they could withdraw at any time. As our study aimed to capture a comprehensive snapshot of the circumstances among college students in China, we did not focus on students with any specific demographic characteristics. We utilized a convenience sampling method. To enhance response rates and encourage sharing of the questionnaire with other college students on WeChat, we offered two incentives: a lottery prize for questionnaire completion and a WeChat red packet (hongbao)¹. In the end, we incorporated 463 responses into our data analysis; of these, 46% were from male students, and 54% were from female students.

Lastly, to enhance the generalizability of our findings, we ensured that our sample encompassed participants from across China's diverse economic regions. According to the National Bureau of Statistics of China, the country is divided into four primary economic regions: Eastern, Central, Western, and Northeastern. Our survey successfully included respondents from 31 out of the 32 provincial-level administrative units in China, covering all four economic regions. The distribution is as follows: 272 respondents from the Eastern region, 117 from the Western region, 39 from the Central region, and 35 from the Northeastern region. This broad geographic coverage ensures that our study captures a wide range of socio-economic and cultural contexts, thereby strengthening the applicability and relevance of our conclusions across different regions in China. In addition to regional diversity, our sample reflects a broad spectrum of administrative divisions, capturing various levels of urbanization, and socio-economic contexts. Specifically, the respondents' locales

¹ WeChat red envelope (or WeChat red packet) is a mobile application developed by Chinese technology company Tencent. The application offers users the ability to give monetary gifts in the form of virtual "credits" to other users of the application.

include: 139 respondents from villages and towns, 131 from county-level cities, 120 from tier-two to tier-five cities, and 73 from tier-one cities. This diverse representation across different administrative divisions and urbanization levels further enhances the comprehensiveness and applicability of our study's findings.

Measures

The internet outcome measures were adapted from Van Deursen and Helsper's (2015) internet outcomes framework. This framework is designed to measure tangible outcomes of internet use and connect them to digital inequalities. We made several modifications to better align with the circumstances of college students in China. Specifically: (1) in the realm of economic labor outcomes, we modified the statement "I found a (better) job" to "I found a (better) internship." (2) For political outcomes, we removed the items "I joined a political association, union, or party" and "I determined which political party to vote for." We introduced a new item: "I am more informed about current significant political topics." (3) In the domain of government outcomes, we adjusted the item "I have discovered that I am entitled to a particular benefit,

subsidy, or tax advantage" to "I have discovered that I am entitled to a specific benefit or funding" (see Table 1).

Gender was measured as a dichotomous variable. The number of siblings was assessed based on the presence of siblings in the family (yes/no for only child), taking into consideration the impact of China's one-child policy on social, economic, and educational outcomes (Hu and Shi, 2020; Wang et al., 2020). To determine the college year, respondents were asked about their current academic year.

Family SES was measured by the parents' income, occupation, educational level, and place of residence, drawing on previous studies regarding the measurement of parental SES (Jiang et al., 2018) and its relationship with children's economic, educational, and social performance (Zhang et al., 2020). More specifically, the measure of education level was based on the highest education level obtained between the two parents. The education levels were divided into three groups: high school, technical secondary school and below; college degree and equivalent degree; and

TABLE 1 The measurement of internet outcomes.

Field	Through the internet,...
Economic labor	I got an internship
	I earn more money
Economic commerce	I bought a product more cheaply than I could in the local store
	I booked a cheaper vocation
	I traded goods that I would not have sold otherwise
Social friends	I have more contact with family and friends
	It is easier for friends and family to get ahold of me
Social dating	I made new friends whom I met later offline
	I met a potential partner using online dating
Political	I expressed my political opinion in online discussions
	I am better up-to-date with current hot political topics
Institutional government	I am better up-to-date with government information
	I have better contact with the government
	I have discovered that I am entitled to a particular benefit, subsidy
Institutional health	I determined the medical condition from which I was suffering
	My life is healthier because of online medical information
	I found that best hospital for a condition I suffered from
Educational	I found an educational course that suits me
	I followed a course that I would not have been able to follow offline

TABLE 2 Description of sample.

Variables	N	%
Gender		
Male	213	46
Female	250	54
Having siblings in family		
yes	205	44.28
no, only child	258	55.72
College year		
First year	98	21.17
Second year	189	40.82
Third year	54	11.66
Fourth year and above	122	27.35
Parental educational level		
High school, technical secondary school and below	207	44.71
College degree and equivalent degree	88	19.01
Bachelor degree and above	168	36.29
Parental occupation		
Outside the system	229	49.46
Within the system	234	50.54
Annual family income		
Below CNY 52,087 (average annual family income)	157	33.91
Equal and above CNY 52,087	306	66.09
Parent residency		
Village and town	139	30.2
County-level city	131	28.29
Tier-two, tier-three, tier-four and tier-five city	120	25.92
Tier-one city	73	15.77

bachelor’s degree and above. To assess parents’ occupation, we first collected descriptions from college students regarding their parents’ occupation and job category in the survey. Subsequently, after considering the Chinese cultural background and the ranking of occupation types designed by Li (2005), parents’ occupations were divided into two groups: outside the system and within the system (those working in institutional units, government-affiliated institutions, and state-owned companies). Concerning family income, we used the total family disposable income over the last 12 months to measure parental income. It was assessed as a dichotomous variable: below CNY 52,087 and equal to or above CNY 52,087. According to the China Household Finance Survey (Liu Z. et al., 2020), CNY 52,087 was the average annual household disposable income. Parental residency was assessed on a 4-point scale, ranging from village and town to tier-one city (see Table 2).

Our study utilized a total of 463 valid responses, with no missing data across any of the survey items. This complete dataset ensures the robustness of our analysis and the reliability of our findings. To evaluate the internal consistency of the survey instrument, we calculated Cronbach’s alpha coefficient. The overall Cronbach’s alpha for the instrument was 0.79, which

exceeds the commonly accepted threshold of 0.70 for acceptable reliability. This indicates a good level of internal consistency among the survey items, suggesting that they reliably measure the intended constructs.

Results

To determine which group of university students benefits most from internet use, this study examined the relationship between the eight outcome factors and the independent variables using logistic regression. The results, as detailed in Tables 3 and 4, will be discussed in relation to the eight outcome fields below.

Economic outcomes

Gender, number of siblings, and parental occupation were not significantly related to any of the economic outcome indicators. However, factors such as college year, original family income level, and parental residency exhibited a connection with both

TABLE 3 Logistic regression analyses for internet outcomes cluster.

Explanatory variables	Economic commerce odds-ratio	Economic labor odds-ratio	Social friends odds-ratio	Social dating odds-ratio	Political odds-ratio	Institutional government odds-ratio	Institutional health odds-ratio	Educational odds-ratio
Constant	0.49	0.12***	6.92**	0.58***	5.86**	10.10**	1.45	3.84**
Gender								
Female	0.86	0.76	2.53**	0.79	3.74**	2.47**	1.73**	2.19**
Having siblings (ref. yes)								
Only child	1.38	1.02	1.69	0.97	1.04	2.64**	0.78	1.34
College year (ref. first year)								
Second year	1.36	2.44**	0.43	1.24	0.56	0.69	1.15	0.47*
Third year	3.07**	3.89***	0.80	1.17	0.57	0.67	0.97	0.63
Fourth year	6.10***	3.99***	0.45	1.54	1.26	0.64	1.68	1.13
Parental education level (ref. below college degree)								
College degree and above	0.99	0.55**	0.92	0.82	1.31	0.84	0.56**	0.69
Parental occupation (ref. outside the system)								
Within the system	1.09	0.71	0.35**	0.74	0.83	0.52	1.43	0.74
Family income (ref. below average)								
Average and above	1.76**	2.03**	1.53	1.71	1.30	0.98	1.22	1.17
Parent residency (ref. rural)								
County-level city	2.13**	2.15**	3.47*	1.07	1.34	2.16	0.91	1.92
Tier-two to Tier-five city	1.85	2.07**	1.43	1.86	0.62	0.91	1.30	2.43*
Tier-one city	1.30	2.18**	2.61	1.64	0.61	0.71	1.40	1.44
Pseudo R2	0.12	0.08	0.08	0.03	0.08	0.04	0.04	0.07
Chi-square	58.19***	51.52***	18.45*	10.33	21.18**	15.12	18.96*	24.44*

Base-All respondents to the survey N = 463.
*significant at the 5% level, **significant at the 1% level, *** significant at the 0.1% level.

TABLE 4 Logistic regression analyses for internet outcome clusters incorporating the interaction term between gender and sibling status.

Explanatory variables	Economic commerce odds-ratio	Economic labor odds-ratio	Social friends odds-ratio	Social dating odds-ratio	Political odds-ratio	Institutional government odds-ratio	Institutional health odds-ratio	Educational odds-ratio
Constant	0.44	0.24**	15.57**	0.62	4.13	8.22*	1.26	6.54*
Gender								
Female	0.67	0.39**	1.69	0.93	2.12	2.85*	1.58	1.78
Having siblings (ref. yes)								
Only child	1.12	0.65	1.15	0.98	1.54	2.74*	0.86	1.09
College year (ref. first year)								
Second year	1.43	2.35**	0.47	1.32	0.95	0.74	1.17	0.47
Third year	3.2*	3.99***	0.53	1.40	0.92	0.75	1.06	0.63
Fourth year	5.04***	4.04***	0.47	1.31	0.71	0.51	1.63	1.04
Parental education level (ref. below college degree)								
College degree and above	1.00	0.57	1.02	0.69	0.66	0.64	0.56	0.82
Parental occupation (ref. outside the system)								
Within the system	1.12	0.70	0.58	1.04	0.64	0.90	1.41	0.69
Family income (ref. below average)								
Average and above	1.91*	2.15**	1.20	1.02	1.72	1.02	1.09	1.12
Parent residency (ref. rural)								
County-level city	2.23*	2.27**	2.04*	1.07	1.60	1.52	1.12	1.95
Tier-two to Tier-five city	2.10	2.3*	1.37	1.86	1.39	1.00	1.48	2.43
Tier-one city	1.37	2.2*	2.61	2.05	0.82	0.83	1.51	1.40
Gender# Having siblings (ref. male# yes)								
Gender# Having siblings	1.94	2.63*	1.65	0.53	0.83	0.45	1.03	1.63
Pseudo R2	0.13	0.13	0.03	0.22	0.03	0.02	0.03	0.06
Chi-square	64.89***	61.95***	13.35	10.23	13.54	10.89	16.15	26.63*

Base-All respondents to the survey N = 463.
*significant at the 5% level, **significant at the 1% level, *** significant at the 0.1% level.

commerce and labor outcomes. Second-year, third-year, and fourth-year college students were more likely to achieve labor outcomes compared to their first-year counterparts. Additionally, third-year and fourth-year students showed a higher likelihood of experiencing economic outcomes related to commerce than first-year students. Intriguingly, students whose parents held advanced degrees, such as a bachelor’s, master’s, or Ph.D., were less likely to achieve economic labor outcomes. Meanwhile, female college students who are only child are more likely to benefit from economic labor opportunities facilitated by internet use. Furthermore, students from households with average or above-average incomes seemed to benefit more from internet use compared to those from below-average income households. As for regional disparities, students whose parents reside in county-level cities were more likely to gain economic commerce benefits from internet usage compared to their peers from rural backgrounds.

Likewise, students hailing from urban areas generally gained more in terms of economic labor benefits from the internet than their counterparts from rural settings.

Specifically, in terms of economic commerce benefits, compared to first-year students, third-year students were 3.07 times more likely, and fourth-year students were 6.10 times more likely, to derive benefits from economic commerce related internet activities. Furthermore, students whose parents had annual incomes equal to or above the annual average were 1.76 times more likely to benefit from economic commerce outcomes compared to those whose parents’ incomes were below the average. In terms of parental residency, students originating from county-level cities were 2.13 times more likely to gain advantages from Economic Commerce internet use than their counterparts from rural areas.

In terms of the likelihood of obtaining economic labor benefits, compared to first-year college students, second-year, third-year,

and fourth-year students are 2.44, 3.89, and 3.99 times more likely, respectively, to gain such benefits. Furthermore, students whose parents have a college degree or above are only 0.55 times as likely to obtain economic labor benefits compared to those whose parents do not hold a college degree. Additionally, students whose parents' annual income is equal to or above the national average are 2.03 times more likely to benefit from economic labor opportunities than those whose parents' income is below the average. Regarding parental residence, students whose parents live in county-level cities, tier-two to tier-five cities, or tier-one cities are all more than twice as likely to obtain economic labor benefits compared to those whose parents reside in rural areas.

Social outcomes

Among college students, none of the explanatory variables seemed to significantly relate to achieving outcomes in terms of dating from internet use. However, factors such as gender, parental occupation, and parental residency correlated with deriving social benefits from internet use. Such benefits include enhanced contact with family, relatives, and friends; ease of accessibility for family and friends to reach the student; and the ability to make new online friends and subsequently meet them offline.

Specifically, female college students were more likely than their male counterparts to enjoy these social advantages. Interestingly, students whose parents held positions within the system were less inclined to experience such benefits compared to those with parents working outside the system. Moreover, students coming from county-level cities exhibited a higher likelihood of achieving these social benefits than those from rural backgrounds. Female college students are 2.53 times more likely than male students to gain social connection benefits from internet use. College students whose parents work within the institutional system are only 0.35 times as likely to obtain social connection benefits compared to those whose parents are employed outside the institutional system. Students whose parents reside in county-level cities are 3.47 times more likely to benefit from social connections online compared to those whose parents live in rural areas.

Political outcomes

The number of siblings, college year, all variables concerning the socioeconomic status of the students' parents, and parental residency were not found to have a significant relation to political participation. The only determinant that showed a significant correlation with political outcomes from internet use was gender. Specifically, female college students were 3.74 times more likely than their male counterparts to engage in activities such as monitoring current online political hotspots and voicing their political opinions online.

Institutional outcomes

While the explanatory variables did not show a significant relationship with the achievement of institutional outcomes related

to public services from the government, there were significant correlations concerning gender and the educational level of the students' parents in relation to healthcare-related institutional outcomes. Specifically, female college students were 73% more likely than their male counterparts to derive health service outcomes from internet use. On the other hand, students whose parents hold a college degree or higher were 44% less likely to access healthcare-related institutional outcomes via the internet compared to those whose parents have a lower educational level. This includes identifying their medical conditions, leading a healthier life due to online medical information, and finding the best hospitals for their specific ailments.

Educational outcomes

While the number of siblings, socioeconomic status variables of the students' parents, and parental residency did not show a significant relationship with educational outcomes, other factors did. Specifically, female college students were 2.19 times more likely than their male counterparts to experience educational benefits through internet use. Additionally, second-year college students were less likely to benefit from internet use compared to their first-year counterparts. Furthermore, college students whose parents reside in tier-two to tier-five cities are 2.43 times more likely to derive benefits from internet use compared to those whose parents live in rural areas.

Discussion and conclusions

In this exploratory research, we delved into the specific benefits college students in China gain from internet use. Given that this group boasts nearly universal internet penetration and a high proficiency with online tools, their experiences offer valuable insights. The framework of Van Deursen and Helsper, which focuses on self-reported measures of beneficial outcomes, served as our guideline, and it has been previously validated to assess tangible outcomes in an individual's daily life (Van Deursen and Helsper, 2015).

Our analysis indicates that the internet significantly impacts various facets of Chinese college students' daily lives, spanning economic, social, political, educational, and institutional dimensions. Economically, the internet aids in tasks such as securing internships and improving financial standing. It also plays a role in commerce-related activities, such as acquiring goods at favorable prices and making travel arrangements. On a social front, the internet not only helps maintain relationships with close relationships like family and friends but also fosters new connections that often transition from online to in-person interactions. Political engagement too is enhanced through the internet by offering timely access to political topics and fostering discussions. Additionally, institutional benefits, particularly in healthcare, include discerning medical conditions and accessing critical online medical information. Lastly, in terms of education, the internet opens avenues for expansive online learning opportunities.

The findings underscore that despite college students having superior internet access and usage compared to other demographic groups, disparities in the benefits derived from internet use still persist. In essence, many of the indicators associated with digital literacy inequality, both in access and skills, remain significant determinants of these disparities. There exist notable gaps in economic outcomes, which can be attributed to various socio-economic factors, such as family income, parental residency, and parental education levels. In the realm of social outcomes, gender stands out as a notable differentiator. Political outcomes are influenced by societal resources, while institutional outcomes are shaped by both economic and social resources. Moreover, variances in educational outcomes are driven by factors like gender and parental residency. The findings imply that, despite the nearly equal distribution of internet access and usage among college students, internet utilization might, in some cases, intensify or even magnify existing offline inequalities.

The outcomes related to gender indicate that female college students are more advantaged in realizing social, political, institutional, and educational benefits from internet use compared to their male counterparts. This stands in contrast to numerous studies that highlight men's advantages in online engagement, potentially leading to offline inequalities stemming from internet use (Bhandari, 2019). However, our study's findings suggest a shift, showcasing advantages for female college students across various domains of internet benefits. This aligns with the observed decline in gender inequality, a shift in college enrollments that favors women (Wu and Zhang, 2010), and the evolving gender dynamics in post-reform China (Ji and Wu, 2018). China's one-child policy has had profound implications for the gendered dynamics of digital inequality. In particular, singleton daughters—who in previous generations may have faced educational and technological marginalization—have benefitted from a redirection of family resources, including intensified parental investment in education, digital access, and skill development (Cai and Feng, 2021). This targeted support has enabled many urban only daughters to overcome traditional gender disparities in digital participation. Consequently, the Chinese context illustrates a unique interaction between demographic policy and digital inequality theory, in which structural constraints (i.e., state-imposed family planning) inadvertently catalyzed shifts in gender roles and access to digital capital (Zhang et al., 2021).

The findings highlight disparities in outcomes based on the number of siblings students have and their respective academic years. Specifically, students who are the only child in their family appear to achieve more institutional government benefits, such as enhanced interactions with the government and increased subsidies, compared to their counterparts with siblings. Due to the one-child policy which was in effect until January 1, 2016, a significant number of college students in China are only children. Existing research has demonstrated that Chinese only children often outperform their peers with siblings in areas like academic achievement and character features due to their parents' advantages in providing more opportunities and educational resources (e.g., Falbo, 2018; Li et al., 2020; Liu J. et al., 2020). Thus, the observed advantages of only children in securing institutional benefits align well with these studies.

Regarding family background, urban students seem to derive more advantages from internet use across economic, social, and educational spheres. Notably, students from families with annual household disposable incomes equal to or exceeding the national average were more likely to realize economic benefits through internet use compared to their peers from families with incomes below this threshold. Conversely, data suggests that students whose parents have lower educational and occupational levels tend to gain greater online benefits in certain areas than those with more educated and professionally established parents. For instance, students whose parents have attained a college degree or higher appear to benefit less from the internet, especially in economic labor and institutional health sectors, than those whose parents have an education below the college degree level. Similarly, students whose parents work within the system—such as government offices or state-owned companies—seem to accrue fewer social advantages from online interactions.

At a cursory glance, these findings might seem indicative of a shift in digital inequality among college students. However, a deeper analysis suggests these disparities are more likely indicative of the perpetuation of offline inequalities. Parents with a college degree, who are often employed within the system, typically exercise stricter supervision of their children's social lives and possess the economic resources to ensure their offspring have ample internship or earning opportunities compared to their less-educated counterparts. Analyses from the Chinese College Student Survey data reveal that students from higher socioeconomic backgrounds tend to enroll in elite universities and subsequently secure preferable job placements (Luo et al., 2018). This underscores the likelihood that students from less affluent backgrounds might turn to the internet to offset their offline disadvantages in economic and social arenas. However, the extent to which these online benefits translate to future job market advantages remains a topic worthy of further exploration.

Our primary conclusion is that, despite nearly universal access to and use of the internet among college students in China, the internet appears to be more beneficial for those from higher socioeconomic backgrounds in several crucial outcome domains. The outcomes identified in this study are pivotal for individuals to amass various forms of capital, including economic, social, and cultural capital. More precisely, individuals can secure economic capital by accessing commercial and labor resources, build social capital by preserving and expanding online social networks, and acquire cultural capital through enriched learning experiences. Given the significance of these types of capital in determining an individual's position within the social spectrum, it's evident that internet usage may perpetuate or even exacerbate social disparities among groups of differing social statuses.

Hence, we need to reevaluate the notion of digital natives and the presumed universal access to and use of digital technology among college students. Policymakers and educational institutions should implement tiered digital literacy training programs tailored to students' backgrounds, particularly targeting those from disadvantaged backgrounds. Universities should incorporate digital literacy as a core competency in general

education curricula, including modules on critical digital skills. Moreover, it is crucial to build cross-section collaborations between government agencies, technology companies, and educational organizations to help create inclusive digital ecosystems. Lastly, routine assessment mechanisms should be established to monitor digital literacy disparities across regions, genders, and socio-economic groups, allowing for responsive and data-driven policy adjustments.

These findings contribute to the broader literature on digital inequality by reaffirming that students from socioeconomically advantaged backgrounds are more likely to benefit from internet use—an observation consistent with studies in developed countries (e.g., Van Deursen and Van Dijk, 2019; Van Deursen and Helsper, 2018). This suggests that while China has a unique sociocultural context, certain mechanisms of digital inequality are transnational and structurally persistent. Furthermore, the transformed gender divide seen among China's singleton daughters, who have received concentrated educational and digital investment, provides insight for other developing countries. It highlights the potential of targeted family support and policy interventions in mitigating digital disparities among marginalized groups. While cultural and policy environments vary, this case suggests that digital inequalities are not static and can be reshaped through strategic social investment.

Furthermore, the definitions and measurements of digital literacy need to evolve alongside advancements in digital technologies. Notably, with the burgeoning integration of AI and algorithms into nearly every facet of daily life, the scope of digital literacy needs to expand to include algorithmic literacy. In the realm of education, AI technology, especially algorithms, is increasingly utilized to gather data for automated decisions, such as determining who gets invited for a college interview, identifying those at risk, or deciding who qualifies for support from the institution. Regrettably, many students, from whom data is collected, lack adequate understanding of how these algorithms function and the subsequent impacts on their education and daily lives. This doesn't even take into account potential biases in algorithmic decision-making that might affect them. Thereby, it might be worthwhile for future research to explore college students' AI-related literacy and its implications for digital and social disparities.

The data for this study were collected during the COVID-19 pandemic, a period marked by significant disruptions to higher education. Most college students were under lockdown and engaged in online learning from home, relying on digital access outside of the traditional campus environment. This shift in learning context likely influenced students' online behaviors and outcomes. Differences in household internet access, availability of digital devices, and parental or familial support may have shaped students' engagement with digital technologies and affected the benefits they derived from them. These pandemic-related conditions may have temporarily reshaped digital practices, but they also exposed structural inequalities in digital readiness that could persist beyond the crisis (Jaggars et al., 2021; Tejedor et al., 2020). As such, the findings of this study should be interpreted with

consideration for the unique temporal and social dynamics that characterized the data collection period.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

Ethical approval was not required for the studies involving humans. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin in accordance with the national legislation and institutional requirements. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

WF: Writing – review & editing, Writing – original draft, Conceptualization. CN: Methodology, Formal analysis, Writing – review & editing.

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Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

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