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Beyond structural inequality: a socio-technical approach to the digital divide in the platform environment

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With the widespread use of social media platforms, human-technology interactions in platform environments provide a new perspective for understanding digital inequality. This article constructs a conceptual framework through the analytical tool of "platform affordance" to reveal how the mutual construction of humans and technology extends the boundaries of digital inequality beyond structural factors. The framework considers the positive sequential relationship between technology-efficacy and self-efficacy, highlighting their dominant role in promoting stratified uses and outcomes on social media platforms. Using survey data from Sina Weibo users in China, we find that users' perceptions of the location of the feature's icon and methods of operation shape online content creation through their perceived capabilities and needs, resulting in an unequal distribution of digital capital. On the one hand, platform affordance weakens the mechanisms that reproduce social inequality; it does so by revealing the fundamental role of interaction between technological properties and personal expectations in guiding online activities. On the other hand, platform affordance also reshapes how social structural factors operate; it does so by triggering moderating effects of personal and positional characteristics on the relationship between technology-efficacy and self-efficacy.

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Introduction

Over the past decades, social media platforms have become a new organizational model for all social sectors. This technological transformation has fostered a participatory culture, wherein individuals across different strata engage in cultural consumption, exchange, and creation (Blank and Reisdorf, 2012; Jenkins et al., 2009). In addition, by quantifying and commodifying attention, these platforms have introduced new status markers characterized by metrics like follower and retweet statistics (Van Dijck et al., 2018; Webster, 2014), making room for social mobility.

However, the trajectory of technology diffusion implies that active participants on platforms gain digital privilege while others are excluded from the digital inclusion system, resulting in the digital divide (Livingstone and Helsper, 2007; Robinson et al., 2015). Within the digital divide framework, specific usage patterns tend to favor users or creators of high-frequency, multifaceted services, instrumental-oriented to more physical and digital resources than passive consumers (Brake, 2014; Hoffmann et al., 2015). Even digital resources exhibit a power law distribution: a few websites attract most internet users, and only a fraction of blogs gain substantial attention from the large user base (Hindman, 2009).

The conventional explanation for the digital divide relies on the reproduction of social structure, where personal and positional characteristics determine the opportunity for technology adoption, leading to unequal resource allocation related to institutionalized stratification systems (Blank, 2013; Hargittai and Walejko, 2008; van Deursen and van Dijk, 2014). Research primarily emphasizes addressing structural or social inequalities concerning product availability, skills training, and organizational support to bridge the digital divide. However, this framework falls short in elucidating the new dynamics of a platformed society. Firstly, technological features, including machine learning and algorithmic prediction, shape daily online activities (Davis, 2023; Santos and Faure, 2018). Secondly, quantified attention and online traffic create digital capital, which is valuable in navigating this platform-centric society (Van Dijck, 2013; Webster, 2014). These emerging dynamics challenge the prevailing social construction perspective of the digital divide by highlighting technology's impact on social systems. In this paper, we consider how the mutuality of society and technology contributes to the generative logic of the digital divide and stress the significance of digital capital in improving life chances.

The Chinese context presents a compelling case. China has experienced remarkable internet user growth, from 0.62 million users in 1997 to 1.079 billion in 2023 (CNNIC, 1997; 2023). By 2023, four Chinese platform enterprises made the Fortune Global 500 list, constituting half of the total entries. Among China's booming platform industries, Sina Weibo now boasts 593 million monthly active users, inviting individuals from all social classes to participate (Sina, 2023). Nonetheless, this rapid technological progress has led to multifaceted stratification: an advanced digital economy with weak infrastructure, significant internet penetration rates alongside polarizing regional disparities, and diverse technological products versus the less motivated "mobile underclass" (Qiu et al., 2019; van Dijk, 2020). It is imperative to acknowledge that China's digitization, especially the growth of platforms, has not bridged the digital divide but underscores the adverse repercussions of rapid technological evolution.

This article adopts a socio-technical perspective on the digital divide in platform-driven societies. Primarily, we argue that the digital divide is not solely due to unequal resource distribution through social structures, or technology's control over user engagement. For one thing, social media platforms' vague social responsibility and opaque operational logic allow them to detach from institutional legitimacy. For another, structural inequalities, like algorithmic bias, reveal the social nature of digital technology. Based on this, we propose that the essence of the digital divide lies in the concept of affordance, which describes the range of action possibilities in interactions between technological characteristics and human agency (Gibson, 2015). In a data-fueled and algorithm-driven platform environment, affordance can clarify the connection between users and technological features, making technology choices and their social impacts apparent (Davis, 2023). Secondly, we recognize the significance of digital identities in reconceptualizing the challenges posed by platformization. Social media platforms influence individual behavior by transforming data metrics into a novel source of legitimacy for personal identities, capabilities, and preferences. We suggest that the number of followers renders an individual's accumulated digital capital evident, providing a foundation for investigating emerging norms of digital stratification.

Through a quantitative analysis using data from China's Sina Weibo users ($N = 903$), this study illuminates the role of social media platforms in shaping stratified uses and outcomes, both by exploring how platform affordance works as a mechanism for the digital divide and by elucidating the unequal distribution of digital resources. In addition, we compare the relative explanatory power of structural and socio-technical factors in the digital divide and discuss how social structures adapt through moderating effects within platform environments, offering alternative pathways for structural inequalities.

Theoretical background

The three levels of the digital divide. The digital divide is commonly categorized into three levels, highlighting disparities in adopting information and communication technology (ICT) among different social groups. The first-level digital divide, known as the "access gap", focuses on whether individuals possess internet connectivity at home or work (Hilbert, 2016; van Dijk, 2020). Once computer and internet access are established, the second-level digital divide reveals a stratified structure for digital skills and usage patterns in accessing targeted information (Blank and Groselj, 2014; Hargittai, 2010). As the internet permeates various aspects of social life, inequalities in the benefits derived from ICT become more pronounced, leading to the emergence of the "third-level digital divide" (Ragnedda, 2017; van Deursen and Helsper, 2015).

The three levels of digital divides observed in Western contexts are also prevalent in developing countries, particularly in China. For the first-level divide, a dualistic pattern has emerged between urban-rural and eastern-western. Some individuals possess various devices and connectivity options, while others rely primarily on a single device, often a mobile phone (CNNIC, 2023; Thomala, 2023). Regarding the second-level divide, the absence of digital skills is a significant barrier for nonusers in China (CNNIC, 2023). Even among internet users, a usage gap exists in weekly online time, diversity of locations, and usage purposes (Cartier et al., 2005; Thomala, 2023). As for the third-level divide, those with advantages in physical access, digital skills, and usage patterns have access to more substantial benefits (Qiu et al., 2019).

Undoubtedly, the digital divide induced by technological advancements manifests cross-regional characteristics. This trajectory aligns with Castells' conceptualization of the social impact of ICTs, where internet connectivity drives processes of informatization, networking, and globalization in social production and development (Castells, 2000). While the internet connects people with information, it also exposes systematic

biases and inequalities across domains and regions. Whether within or between countries, those closely connected to ICTs tend to belong to more privileged groups. From a longitudinal perspective, it is evident that the digital divide exposed by ICTs is more profound and long-lasting than the knowledge gap caused by mass media (van Dijk, 2020). This is primarily due to the fact that internet has expanded connectivity in terms of information, people, and organizations, thereby creating new life chances (Ragnedda, 2017). Consequently, the reinforcement of technological connectivity will likely coincide with the deepening and widening digital divide.

New digital divide issues raised by social media platforms. In contemporary society, social media platforms contribute to the digital divide by enhancing connectivity among people and between people and technology. The emergence of User-Generated Content platforms has nurtured a participatory culture centered around "tightening social connections" (Jenkins et al., 2009; Blank and Reisdorf, 2012). This culture aims to lower barriers to artistic creation and civic engagement, thus narrowing gaps in physical access and digital skills. A prime example is Sina Weibo, rooted in China, which has evolved from an information-sharing medium to an online participation platform. Despite its social media nature, Sina Weibo has enabled a crucial socio-technical field for producing and disseminating breaking news, improving governmental efficiency, and serving social interests (Li, 2021).

Nevertheless, a noticeable usage gap related to creating creative and cultural content has emerged. This division has even facilitated a two-tiered social system comprising content creators and information consumers (Blank, 2013; Hargittai and Walejko, 2008). Although online content creation (OCC) may not always offer explicit benefits, it alters data presentation through platform algorithms, resulting in implicit symbolic power (Helsper, 2021). Drawing from Blank and Groselj's (2014) dimensions of internet use, OCC also depicts a three-aspect digital division. First, the decision to create or not is the threshold for accessing resources. Second, the creation frequency represents the degree of online participation. Third, the diversity of content types created reflects the breadth of information resources users engaged. Notably, youth, males, and individuals with higher socioeconomic status (SES) exhibit greater capacity and engagement in OCC (Hargittai, 2010; Hoffmann et al., 2015; van Deursen and van Dijk, 2014).

Another emerging concern is the unequal distribution of digital capital, echoing the third-level digital divide. Extensive studies argue that individuals who effectively convert online participation into tangible or intangible benefits are digitally privileged, resulting in stratified outcomes across various domains (van Deursen and Helsper, 2015; van Deursen, 2020; van Dijk, 2020). Beyond the direct impact of ICTs adoption on offline capital, current disparities are linked to digital resource distribution (Helsper, 2021; Nguyen et al., 2021), such as variation in digital communication use during the COVID-19 pandemic. This highlights the growing significance of ICT-related digital resources in accessing life chances. Indeed, social media platforms can play a pivotal role in bridging the online-offline gap, primarily through data (Van Dijck et al., 2018), which includes economic benefits from algorithmic recommendations for advertisers and the influence of key opinion leaders (KOLs) through strategic use of algorithmically weighted keywords. Undoubtedly, social media platforms facilitate the conversion of various forms of capital.

For individuals, unlocking digital dividends within platform data lies not in data ownership or algorithmic models but in digital capital. Scholars define *digital capital* as combine of technology-related externalized resources and internalized abilities and aptitudes (Ignatow and Robinson, 2017; Ragnedda and Ruiu, 2020). Broadly, digital capital signifies one's inclusion in physical access and digital skills. In a narrower sense, quantified metrics as a form of digital capital can activate the residual value of data. In the digital field, visible and quantifiable attention is crucial for gaining traffic and influence (Webster, 2014). Followers on profiles represent this type of digital capital, symbolizing social identity and economic benefits in the network society (Helsper, 2021). Sina Weibo, for instance, employs follower counts to categorize the online population as ordinary users and head users (with over 20,000 followers) or general accounts and verified accounts (with over 500,000 followers) (Sina Weibo, 2019). Different user identities correspond to hierarchical microblogging services, discourse power, and account traffic. Besides, follower count is a universal data metric across mainstream social media platforms, allowing this type of digital capital to circulate and transform across platforms through the power of identity. However, while digital capital is expected to be acquired through sustained online participation, as with van Dijk's (2020) Resource and Appropriation model, the number of followers also determines the reach of information dissemination and the impetus for further propagation. Consequently, the Matthew Effect, where the rich get richer, becomes evident in this context as well.

Building on social stratification, studies have found intricate connections between the digital divide and underlying structural inequalities. Personal and positional characteristics like gender, age, education, occupation, income, and ethnicity confine platform users to hierarchical usage patterns and internet outcomes driven by the reproduction mechanisms of social structures (Hargittai and Walejko, 2008; Livingstone and Helsper, 2007; van Deursen and van Dijk, 2014). For one thing, the inequality of opportunity triggered by class distinctions extends from physical access to the hierarchical distribution of digital rewards. For another, autonomous online participation does not guarantee equitable distribution of digital returns. Despite significant investments in time and costs, marginalized groups struggle to achieve comparable returns (Blank and Groselj, 2014; van Dijk, 2020). In this context, the conventional digital divide narrative predominantly aligns with sociodemographic-based stratification regarding use and outcome (Hargittai and Walejko, 2008; Helsper et al., 2015). However, it fails to understand the digital divide within the platform environment comprehensively. Empirically, social media platforms position themselves as intermediaries connecting diverse groups and information, often evading institutional regulation and sidestepping social responsibility. Thus, the platform environment is unlikely to undertake the tools voluntarily for class reproduction (Van Dijck et al., 2018). Theoretically, uncertainties persist about why platforms, despite fostering a participatory culture and employing various technological tools to conceal individual social identities, still erode human autonomy and contribute to the digital divide (Llorente-Barroso et al., 2023).

Considering the strong connectivity of social media platforms and the non-neutral nature of ICTs feeding social life (Halford and Savage, 2010; Van Dijck, 2013), examining the manifestations of socio-technical interactions and their specific dynamics is essential. For social media platforms, the function goes beyond technical buttons; the symbols and connotations they carry matter how users interact with the platform (Bucher and Helmond, 2018). A telling example is Twitter, where recent changes to logo styles provoked varied user responses, revealing the non-uniform perception of the social significance of these functions. Likewise, despite Sina Weibo's efforts to broaden its target demographic by offering a wide range of functions, its

"entertainment-oriented" vernacular has not fully embraced diverse audiences (Zhang and Pentina, 2012). Moreover, functions encompass the underlying technical support for quantifying account traffic and user interaction and recording digital traces, all of which constitute diverse manifestations of data within the platforms (Cirucci, 2017; Van Dijck et al., 2018). By this means, the action possibilities that users derive from these platform functions are crucial in shaping differentiated user behavior and converting digital traces into digital capital, which sheds light on a socio-technical approach to the novel generative logic of the digital divide.

Platform affordance embedded in the platform environment. To shift the focus toward a more nuanced conceptual understanding of why platform functions might engender stratified uses and outcomes, we argue that the interplay between the technological properties and human agency resonates with the "affordance" concept.

Affordance, originally used to explain the interactive characteristics between subjects and objects, refers to the action possibilities arising from the interplay of the environment and humans or animals (Gibson, 2015). This framework helps explain why subjects exhibit various behaviors when confronted with the same object, leading to differentiated results (Hsieh, 2012; Hutchby, 2001). Gibson's affordance concept operates on two fundamental principles. Firstly, affordance emerges from the mutuality between the subject and the object. Affordances transcend individual experiences and physical surfaces or layouts. Instead, they represent action possibilities facilitated by environmental properties through the reciprocal interplay between these two elements (Gibson, 1982). Secondly, perception is the mechanism that actualizes affordance. Much like the digital divide in motivation and attitudes, affordance emphasizes that actions are fundamentally psychological (Davis and Chouinard, 2016; van Dijk, 2020). What ecological elements afford is not determined by their appearance or how the subject views them. Rather, it hinges on the perception of properties or meanings embedded within objects, which varies among different organisms. This perspective redirects our attention to understanding why specific social groups consistently make relatively unchanging choices within dynamic contexts while complementing the materialist view of the path dependence between social structures, usage preferences, or cultural tastes.

In the context of ICTs, affordance is frequently used to explore innovative dynamics and new forms of social interactions enabled by diverse features. Research in this area can be categorized into two main groups. The first category of research refines affordances as attributes of social media platforms, encompassing a range of technology-enabled actions that empower users to connect with individuals and information, such as portability, replicability, and others (Schrock, 2015; Treem and Leonardi, 2013). The human agency only serves as an element that renders affordances embedded within technical features visible. The second category shifts the focus to user-perceived outcomes. It argues that experiences and beliefs not only influence how users interact with technology but also shape the upgrading and operation of digital media (McVeigh-Schultz and Baym, 2015; Nagy and Neff, 2015). From this perspective, the action possibilities facilitated by affordances vary with subjectivity. We believe that the integration of these two research categories is essential to uncover the rationale behind how affordance operates in a platform environment. On the one hand, digital artifacts have altered social interactions and information exchange by creating detached action possibilities from the physical world. On the other hand, machine learning has established a timely feedback loop between users and technology, making users' digital traces and habitus crucial for optimizing platform functions.

Scholars moving from ecological to technological realms have widely acknowledged the significant role of affordances in unraveling the inner workings of black-box technologies and their ties to social and digital inequalities (Davis, 2023; Hsieh, 2012). ICTs, fundamentally a social construct, reflect social norms and actively shape social systems. This underscores the central idea that individual actions result from the dynamic interplay between society and technology, essentially the affordance between technological properties and personal expectations. However, a compelling argument exists to bring the current conceptualization of affordances within social media platforms closer to the original Gibsonian perspective. Firstly, affordances are often oversimplified as technical attributes and communicative actions or excessively tied only to social practices and personal experiences. Secondly, existing research has underemphasized external influences on behavioral choices from institutional legitimacy and demographic structures.

Conceptual framework of digital divide through platform affordance. This paper defines *platform affordance* as action possibilities unleashed by socio-technical interactions between technological properties and personal expectations. Unlike a static relationship or attribute, platform affordance is a mechanism that triggers differentiated user responses to technology. Following Bucher and Helmond's (2018) platform-sensitive approach, the perception of functions is a key site for making affordances visible within the platform environment. This perception extends beyond the intended use of functions envisioned by designers. It revolves around users' beliefs regarding what they can achieve within the platform's prompts, which can be materialized as the principle of efficacy expectations—an overlooked aspect.

In practice, we deconstruct the operational logic of platform affordance into two dimensions. Firstly, "technology-efficacy" involves how users perceive the technological surface and layout, which sets the boundaries for action possibilities. In the Gibsonian sense, material composition, surface layout, and layout alternations are predetermined before engaging with a specific environment (Gibson, 1982). These fixed technological features become a source of invariance for affordance, explaining why attributes like portability and editability do not truly represent affordance. Facing the programmability of the user interface determined by designers, what people know about this technological feature is the perceptual process of generating differentiated action possibilities (Davis, 2023). Thus, technology-efficacy reflects how individuals perceive what the platform functions offer. Secondly, "self-efficacy" considers the impact of individual capabilities and needs on selecting action possibilities, constituting a prerequisite for specific actions. Drawing from Social Cognitive theory, individual's confidence in their skills correlates with their execution to perform a specific function (Bandura, 1986). On one hand, action possibilities are only invoked when individuals believe they can master a particular function. On the other hand, when confronted with redundant information and personalized interfaces, demand becomes a driving factor for actions (DiMaggio et al., 2004). In this regard, both the perception of capabilities and needs are essential in activating specific action possibilities within the afforded physical properties.

Recognizing the sequential relationship between technology-efficacy and self-efficacy is crucial. In the ecological environment, the walk-on-ability remains constant regardless of the chosen path (Gibson, 2015). Likewise, the platform's programmability remains unchanged, whether it prioritizes user-friendliness or

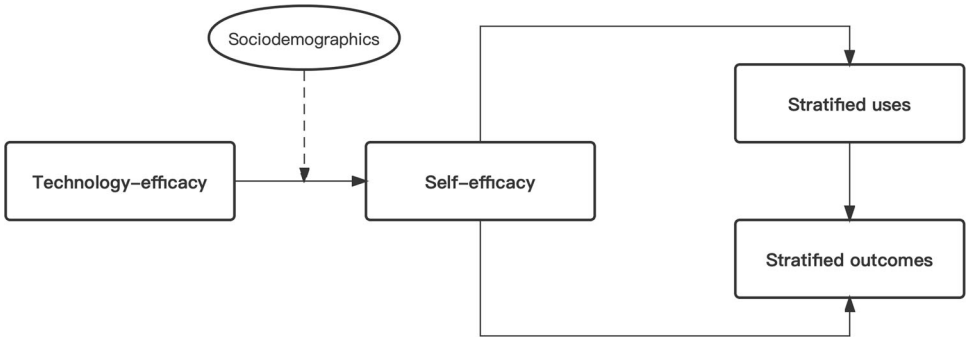

Fig. 1 Conceptual framework for generative logic of the digital divides in platform environments. The relationship between platform affordances, as exemplified by technology-efficacy and self-efficacy, and the digital divide regarding stratified uses and outcomes.

caters to a diverse user base. Conversely, only when users recognize the potential properties of the platform environment can they determine whether they are allowed, encouraged, or refused access to a particular use (Davis and Chouinard, 2016; Lee, 2023; McVeigh-Schultz and Baym, 2015). This implies that after configuring a user's perception of the surface or layout of platform functions to afford limited action possibilities, distinct behaviors are activated depending on the perception of capabilities and demands. Consequently, technology-efficacy assumes precedence over self-efficacy. The more diverse the technological features perceived by users, the easier it becomes to satisfy and invoke latent capabilities and needs through a wide range of action possibilities. Therefore, the first hypothesis concerns how platform affordances work in the platform environment:

H1: Technology-efficacy positively influences self-efficacy within the platform environment.

Differences in how individuals perceive technological features and personal experiences at various life stages prompt an inquiry into the self-detecting of affordances (Gibson, 1982). From an ecological psychology perspective, people naturally learn to perceive affordances. In sociology, the dynamics of environmental perception are often attributed to structural factors, with shared social class moderating the learning process. The latter is true in connecting platform affordance with social inequality. Regardless of what perceived action possibilities suggest or encourage, we must recognize the constraints imposed by cultural and institutional legitimacy on technology choices (Davis, 2023). This theoretical reflection prescribes the rationale that the latent physical properties within platform functions are more visible to specific occupations or identity groups (Tandoc, 2014). We hypothesize the moderating effect of personal and positional characteristics:

H2: Personal and positional characteristics of platform users moderate the relationship between technology-efficacy and self-efficacy within the platform environment.

The framework of platform affordances introduces a novel lens to comprehend the digital divide. According to scholars such as Bucher and Helmond (2018) and Cirucci (2017), platform affordance challenges the dichotomous image of "afford or not afford" by affording hierarchical action possibilities among users. While Gibson (1982) highlighted that perception varies by degree across subjects, many studies have primarily focused on how affordances influence opportunities for action, neglecting their impact on the action levels. Indeed, the core mechanism of the subject (users) - object (platform) interaction presents a gradation distinction, including request, demand, allow, encourage, discourage, and refuse (Davis and Chouinard, 2016; Davis, 2020). In the first scenario, the same object, surface, or layout can serve multiple properties. For instance, "retweeting" can either propagate fake news or share high-quality original content. Implicit in these action possibilities is a hierarchical arrangement, with actions aligned with the platform's interests often being strongly encouraged (Bucher and Helmond, 2018). In the second scenario, the range of action possibilities suggested by the same physical properties of objects varies with context. Although both Twitter and Sina Weibo once imposed a 140-character limit, linguistic differences enabled Chinese users to express themselves more comprehensively (Zhang and Pentina, 2012). This variation in the perceived interaction between subject and object naturally ushers in multifaceted mechanisms of affordance.

This graduated mechanism explicates why similar technology with comparable affordance can categorize actors into distinct actions. In the platform environment, users who are included in the mainstream action possibilities are consistently encouraged to use specific features more frequently and diversely, compared to users lacking technology-efficacy and self-efficacy. Following different stages of technology adoption, these stratified usage patterns can extend to the distribution of digital capital. Thus, the impact of platform affordance on digital divides is hypothesized:

H3a: Platform affordance contributes to the stratification of usage patterns within the platform environment.

H3b: Platform affordance and usage patterns collectively contribute to the stratification of digital capital within the platform environment.

Figure 1 illustrates the conceptual framework used in this paper. In terms of theoretical legitimacy, echoing the general model of Mechanisms and Conditions Framework of Affordances by Davis and Chouinard (2016, 2020), this paper categorizes affordance's operational principles into three interconnected dimensions: technological features (technology-efficacy), personal experiences (self-efficacy), and structural factors (sociodemographics). Within the range of action possibilities defined by technology-efficacy, users form graduated self-efficacy, and this sociodemographic-moderated relationship causes stratified usage patterns that ultimately produce unequal digital outcomes. In this view, the critique of platform affordance lies in its potential to reshape structural issues in the platform environment and create new digital resource-based inequalities.

Method

Sample. We collected survey data of Chinese netizens through Internet-based questionnaires. To conduct the "Chinese Platform Netizen Online Participation Survey" research project in 2021 and distribute the questionnaire, we cooperated with Hanyi Big Data, a professional social survey company with 600,000 active sample banks across China. According to the demographics of Chinese netizens and the profiles of Weibo users (CNNIC, 2023; Sina, 2023), the survey set quotas for gender (male 51%, female

Table 1 Four categories of function in Sina Weibo.

Category of functions	Target users	Button designs	Physical properties
Basic functions (post-Weibo, comment, forward, hashtags, like)	All ordinary and head users, both individual and organizational.	Appears visually in the upper right corner of the user interface and beneath each tweet with a commonly recognized icon.	The most traditional functions of social media platforms, including the production, circulation, dissemination, and browsing of information.
Simplified functions (quick forward, forward while commenting)	Heavy or interest-based users aiming to expand their network and increase exposure to specific content.	Placed in the collapsed area of the forwarding function, and users can manually select "Comment at the same time" when editing forwarded text content.	In line with the reading habits of users in the fragmented era, and can save the cost of browsing and sharing information.
Multimedia functions (Weibo stories[a], Weibo videos)	Users with advanced content creation skills.	Placed in the upper right corner of the user interface, within the plus area, and in the collapsed area where the original text content was created.	Enrich the content in forms other than words.
Topic functions (Weibo articles[b], super-topic community)	KOL or organizational accounts known for their original content.	Weibo Articles is situated towards the later section of the Post-Weibo collapsible area. Super-topic community is confined within the page for editing original textual content, or in the second section at the bottom of the user interface.	Gather users with the same interests and specialized knowledge to promote communication among homogeneous groups.

[a]Weibo stories have been officially merged into the Weibo video channels in 2022. This questionnaire was conducted in 2021, when Weibo stories were still in use.
[b]Weibo articles were officially integrated into the Headlines articles in 2022, with no significant changes in their basic properties and purposes.

49%), age (<30 years 30%, 31–54 years 50%, >55 years 20%), and education (junior high school or less 30%, senior high school/some college 30%, bachelor's degree or more 40%). In total, we collected 1737 valid adult questionnaires, among which Sina Weibo users' sample size is 903. In order to meet the younger and highly skilled characteristics of the target group of the social media platform, we adjusted and refined the categories of variables for age (18–30 years, 31–45 years, and >45 years) and education (senior high school or less, some college, bachelor's degree, and master's degree or more). See Appendix 1 for sample characteristics and Appendix 2 for detailed measurement of key variables.

Measures. The platform function is a socio-technical window for connecting platform environments and users. As shown in Table 1, to mitigate the bias of user preferences, we grouped the Sina Weibo mobile app functions based on the target users, button design, and physical properties. The selected functions can be divided into basic, simplified, multimedia, and topic functions.

Technology-efficacy. The measurement model for platform affordance derives from Social Cognitive theory, which emphasizes an individual's confidence in performing specific technological tasks (Bandura, 1986; Correa, 2010). In the operational logic of platform affordance, this confidence is also influenced by the technology's accessibility and availability (Davis and Chouinard, 2016). Put simply, technology-efficacy reflects an individual's confidence in the technology's capability to perform specific tasks. For the surface and layout of platform functions, the perception of the placement of icons can indicate how aware a user is of the function's availability, which may encourage or discourage them from using specific functions (Davis, 2023; Van Dijck et al., 2018). The visibility of how functions operate impacts the learning cost users navigate since platforms often lack comprehensive usage instructions (Bucher and Helmond, 2018; Treem and Leonardi, 2013). These factors collectively determine the complexity of locating and accessing targeted information, thus defining the boundaries for action possibilities. To measure technology-efficacy, respondents rated the difficulty of finding icon locations and operation methods of four types of functions on two 1–5 point scales (1 = very difficult, 2 = difficult, 3 = general, 4 = simple, 5 = very simple). The average scores of these eight questions represented technology-efficacy (Cronbach's $\alpha = 0.93$, $M = 4.05$, $SD = 0.63$).

Self-efficacy. Another crucial aspect of platform affordance relates to how individuals perceive their capabilities and demands for various platform functions. This variable is echoed by constructs such as online self-efficacy and digital skills in digital divide studies, which significantly predict users' online participation and outcomes (Blank, 2013; Hoffmann et al., 2015; Schrock, 2015). In this study, subjective judgments towards platform functions were influenced not only by individuals' confidence in operating technical buttons, but also by the match between users' goals and the physical properties functions afforded. Respondents used five-point Likert-type scales to rate their proficiency in using the four types of functions (1 = very unskilled, 2 = unskilled, 3 = general, 4 = skilled, 5 = very skilled) and the perceived value of these functions to them (1 = *not helpful*, 5 = *very helpful*). Finally, we aggregated eight scores to compute the average self-efficacy value (Cronbach's $\alpha = 0.90$, $M = 3.82$, $SD = 0.62$).

Stratified uses. The dependent variables related to the second-level digital divide were measured with common typologies, including online activity, the frequency and amount of use, and use diversity (Blank and Groselj, 2014; van Dijk, 2020). For OCC-based social media platforms, the operationalization of stratified use in this article includes creation or not (74.75% engaged), creation frequency (1–7 categorical variables, $M = 4.01$, $SD = 1.79$), and the number of creative functions used, which we call creation diversity (1–8 counting variables, $M = 3.36$, $SD = 1.66$). Notably, we did not consider the diversity of content types created, as the variety of functions used increasingly serves as a necessary gateway to access resources, with the greater the types of functions used, the more diverse the resources.

Stratified outcomes. We consider the number of followers as a data indicator of the digital capital individuals accumulate, especially within Sina Weibo, where the number of followers is

the primary means of reaping digital dividends from online participation (Sina Weibo, 2019). To measure stratified outcomes, respondents reported their Weibo followers (1–5 categorical variables, $M = 1.55$, $SD = 0.73$).

Demographic variables. To test the moderating effect of structural factors on platform affordance, we retain the critical determiners of the classic digital divide research. In addition to gender, age, and education, we also consider participants' socioeconomic status, including occupation and income.

Other variables. Finally, we added a measure of Internet experience to control for access gaps (number of digital devices) and skill gaps (digital skills) in Sina Weibo.

Data analysis strategies. Initially, we conducted Multiple Linear Regression to test the prediction of self-efficacy by technology-efficacy under the platform scenario. After that, the marginal effect was used to test whether demographic characteristics moderate the relationship between these two variables.

Then, we present Logistic (Creation or not), Ordered (Creation frequency), and Poisson (Creation diversity) nested models to determine the similarities and differences between sociodemographic-based gaps (Model 1) and socio-technical stratification (Model 2 and 3). Through Model 2, we can confirm technology-efficacy's independent contribution and the net effect of on OCC-related behaviors. Model 3 shows whether the technology-efficacy still have a predictive ability for behavior after the self-efficacy is added to the model; it also shows the joint contribution of platform-user interaction to use gaps.

Finally, using four sets of Ordered Logistic Regression, we explored how different usage behaviors bring about the stratified use results, using four sets of ordered logistic regression. The first set of models (Model 1) presents the direct relationship between socio-technical variables and digital capital. In Model 2, we added OCC-related variables (creation or not) to observe whether there is a significant difference in digital returns between the creator and consumer. It is similar to Model 3 and Model 4, which further examine inequality by comparing the distribution of digital capital among creators based on the frequency of creation and the diversity of creation tools.

Results

The connection between technology-efficacy and self-efficacy towards platform functions. Figure 2 indicates the impact of technology-efficacy on self-efficacy (see full results in Appendix 3). Notably, individuals in government employment and those with higher incomes exhibit the most positive self-efficacy, yet the highly educated are less well than the least educated. As expected, stronger perceptions of platform functions' accessibility and availability tend to trigger positive cognitive feedback regarding one's capabilities and needs. Therefore, H1 is supported.

The second research hypothesis investigates how sociodemographic characteristics interact with technology-efficacy and self-efficacy (see full results in Appendix 3). Figure 3 illustrates that gender, age, and education significantly affect the formation of platform affordances. As with Gibson's (2015) assumption, stimuli or releasers like age introduce uncertainty in the "self-detection of affordances". Precisely, lower technology-efficacy corresponds to heightened gender inequality. Generational gaps are most pronounced between young individuals (18–30 years) and older ones (>45 years), with older adults' strengths in self-efficacy diminishing as technology-efficacy increases. Educational differences within the platform environment narrow as technology-efficacy rises. Although highly educated individuals

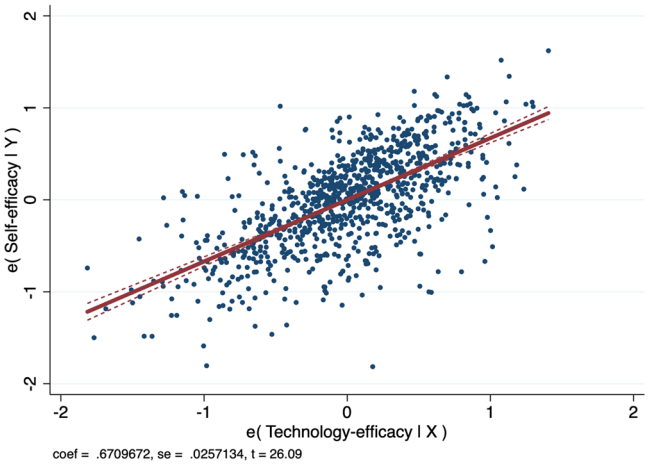

Fig. 2 Regression model: technology-efficacy and self-efficacy. The solid red line presents the predicted correlation between technology-efficacy and self-efficacy, the dashed red line is the 95% confidence interval, and the blue scatter is the actual distribution of the sample.

exhibited a disadvantage in self-efficacy, they managed to cultivate a more positive perception of their capabilities and demands when facing the same technological surface or layout. However, we did not find evidence supporting the moderating effect of social position, and H2 is partially supported.

How does the platform intervene in the digital divide?

Platform affordance and stratified uses. Platform affordance's role in shaping usage patterns is examined in Table 2. In Model 1 of 'Create or not', individuals over 45 are less likely to create content than the youngest people. Compared with institutional workers, users without a stable occupation are unwilling to publish original content online. Those with average salaries are more likely to become creators. When technology-efficacy is considered in Model 2, a positive perception of icon location and operation methods correlates with a greater willingness to contribute content among participants. However, personal and positional differences are shrunk in distinguishing between creators and consumers. Model 3 reveals that a positive self-efficacy increases the likelihood of becoming a content creator, and interestingly, technology-efficacy becomes insignificant.

Regarding creation frequency, females are more active compared to male (Model 1, Creation frequency), while the highly educated display less active than those with the lowest. As expected, technology-efficacy positively affects the frequency of creation (Model 2), but this effect disappears when self-efficacy is considered (Model 3).

For insight into creation diversity, SES-related variables play a significant role. Both core independent variables are positively correlated, indicating that positive perceptions of function surfaces and layouts, as well as individual capabilities and needs, motivate users to adopt a wider range of creative tools. In addition, technology-efficacy indirectly predicts the creation diversity through its influence on self-efficacy.

Comparing effect sizes across models, the influence of platform affordance on usage patterns surpasses that of structural factors. Smaller AIC and BIC value in logistic regression indicate a better model fit. Therefore, a more severe and complicated stratification mechanism, guided by platform affordance, has emerged in the digital age. In addition, platform affordance plays a more prominent role when considering both technology-efficacy and self-efficacy (Model 2 and Model 3). In this context, self-efficacy

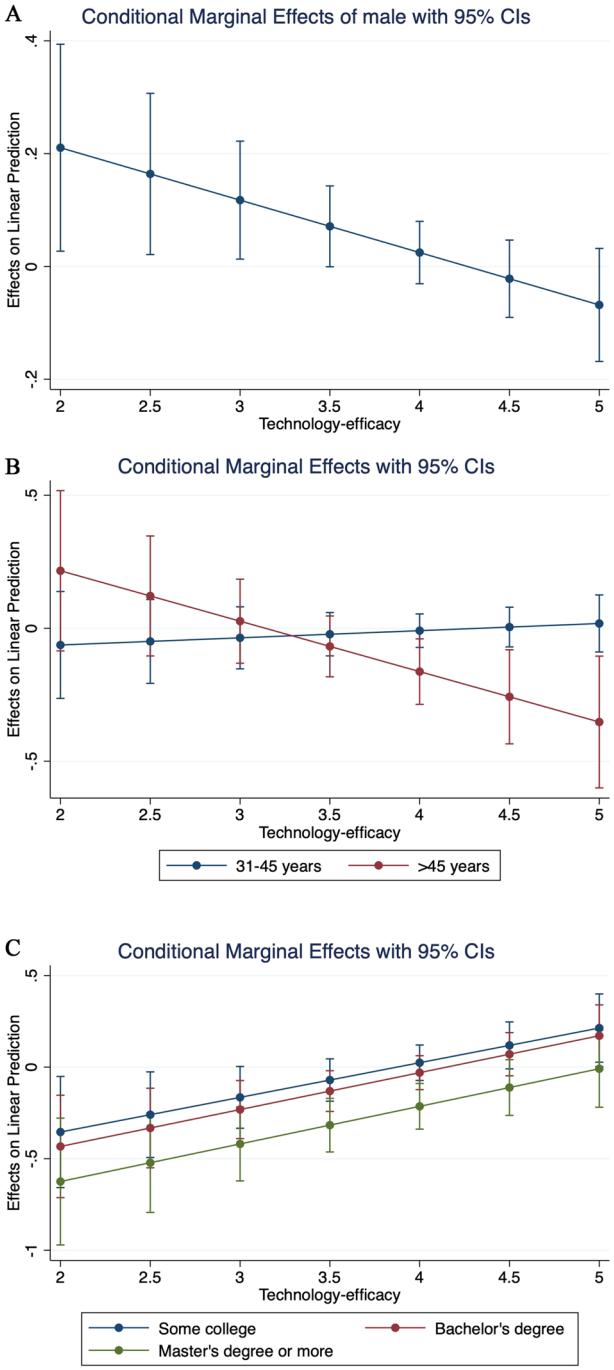

Fig. 3 The moderating effect of sociodemographic on platform affordances. Panels (**A**) depicts trends in the differences in self-efficacy between males and females as technology-efficacy increases. Panel (**B**) compares individuals aged 31–45 and over 45 years with those aged 18–30. Panel (**C**) demonstrates how the differences in self-efficacy between individuals with less than a senior high school education and those with a college degree, bachelor's degree, or postgraduate education change as technology-efficacy increases.

assumes a significant intermediary between technology-efficacy and online participation. Thus, H3a is supported.

Platform affordance and stratified outcomes. The final research hypothesis examines the factors influencing the unequal distribution of digital capital (Table 3). Initially, we identified occupation and income as indicators for explaining follower count. Secondly, technology-efficacy still does not directly contribute to the stratified outcomes, while self-efficacy suggests that the number of followers accumulated depends to some extent on individuals' perceived abilities and needs, even within the two-tiered system of creators and consumers. Nevertheless, when we control for creation frequency and diversity, the self-efficacy is no longer significant.

As anticipated, models that incorporate both platform affordances and usage patterns (Models 2 to 4) show a significantly better fit than those confined to structural mechanisms only (Model 1). These results indicate that, among a group of creators, platform affordance primarily contributes to the emergence of the third-level digital divide by mobilizing online participation. Consequently, individual actions and their interaction with platform functions emerge as crucial factors in accumulating digital capital to reap internet benefits.

All main effects passed the robustness check, see full results in Appendix 6–8.

Discussion

Via a socio-technical approach, this article explores the novel dynamics of digital divides within social media platforms. We argue that the concept of platform affordance offers a framework to comprehend the persistence of hierarchical distinctions in participatory culture and the distribution of digital capital resulting from platform datafication. Our findings reveal the positive sequential relationship between technology-efficacy and self-efficacy, moderated by structural inequality, which shapes stratified uses and outcomes within the platform environment.

One significant contribution of this research is the dissection of how platform affordance operates. Firstly, we contend that platform affordance can be operationalized as a positive sequential connection between technology-efficacy and self-efficacy. Our analysis uncovers that users' perception of the function's surface or layout positively influence their belief in capabilities and needs. This insight clarifies that technology-efficacy defines the boundaries of action possibilities, and self-efficacy emphasizes that positive attitudes toward technology adoption are only activated to the extent that potential technology features are perceived. It signifies a nuanced perspective on the mutuality between society and technology.

In the technologically advanced context, motivation and attitude play central roles in digital engagement, sometimes even causing digital disconnection and "dropouts" (Nguyen and Hargittai, 2023; van Dijk, 2020). How individuals perceive and value these technologies constitutes the initial barrier to achieving digital inclusion. Platform affordance sheds light on the underlying reasons for technology adoption at the psychological level. Notably, we have observed that highly educated users perceive their capabilities and demands more negatively compared to their less-educated counterparts. This challenges conventional digital divide findings, which typically suggest that socially privileged individuals have an advantage in technology adoption. However, this differing finding does not a lack of confidence in using functions and achieving individual goals but rather from diverse perceptions of the platform environment. The majority of platform users view Sina Weibo primarily as an entertainment platform (as detailed in Appendix 9 to 11). As Hoffmann and others (2015) found that highly educated users are less likely to create entertainment content. This has two key implications for digital divide studies employing the platform affordance framework: firstly, platform vernacular may "prevent" non-mainstream users from adopting and adapting to new functions; secondly, a saturated functional infrastructure may not activate all action possibilities among platform enthusiasts.

Table 2 Regression models: Platform affordances and Sina Weibo uses.

	Create or not			Creation frequency			Creation diversity		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Male	−0.27	−0.17	−0.18	−0.33*	−0.20	−0.20	−0.06	−0.01	−0.02
Age (18–30 years)									
31–44 years	−0.25	−0.22	−0.20	0.02	0.05	0.04	−0.00	−0.00	−0.00
>45 years	−0.66*	−0.59+	−0.55+	−0.38	−0.37	−0.26	0.03	0.05	0.08
Education (senior high school or less)									
Some college	−0.39	−0.36	−0.35	−0.14	−0.05	−0.05	−0.05	−0.02	−0.02
B. A. degree	−0.07	−0.02	−0.02	0.14	0.16	0.17	−0.02	−0.01	0.00
M. A. degree or more	−0.09	0.27	0.29	−0.95**	−0.81*	−0.64+	−0.33**	−0.27*	−0.20+
Occupation (government institutions)									
Private institutions	0.07	0.04	0.05	0.27	0.27	0.24	0.09	0.09+	0.09+
Student	0.01	−0.05	−0.05	0.02	0.03	0.07	0.15+	0.14	0.17+
Unemployed	−0.73+	−0.69	−0.58	−0.24	−0.21	−0.13	−0.14	−0.10	−0.05
Income (below average)									
Average	0.44*	0.43*	0.40+	0.16	0.17	0.13	0.15**	0.14*	0.12*
Above average	0.17	0.16	0.10	0.21	0.21	0.16	0.04	0.03	0.01
Technology-efficacy		0.71***	0.28		0.76***	0.12		0.26***	0.01
Self-efficacy			0.68***			0.95***			0.35***
Constant	−1.27*	−2.84***	−3.43***	Cuts	Cuts	Cuts	0.05	−0.40+	−0.56*
N	903	903	903	675	675	675	675	675	675
AIC	980.79	960.98	951.44	2459.47	2431.63	2409.11	2510.23	2477.89	2443.55
BIC	1048.07	1033.07	1028.33	2545.25	2521.93	2503.92	2573.44	2545.61	2515.78

+$p < 0.1$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Moreover, this research proposes that structural inequality has taken a digital alternative path by moderating the interplay between technology-efficacy and self-efficacy. In our overarching framework, sociodemographic predictors lose their dominance in shaping usage patterns and outcomes in the platform environment. Nevertheless, this does not imply that Sina Weibo has eliminated structural inequalities. Our findings suggest that impact of technology-efficacy on self-efficacy fluctuates across gender, age, and educational disparities. On the surface, certain subgroups are better at amplifying their confidence in abilities and needs by positively perceiving the function's surface and layout. In reality, others enhance their efficiency to access resources by strategically connecting technology-efficacy with self-efficacy. To illustrate, highly educated individuals, initially negative about Sina Weibo's entertainment-oriented environment, counteract the adverse effects of platform affordance by cultivating more positive perceptual capabilities and demands within the limited action possibilities afforded by technological features. In this context, highly educated individuals often find themselves in a passive role on Sina Weibo due to their limited recognition and confidence in the platform's surface and layout. However, when engaged in an inclusive platform environment, they demonstrate a more efficient conversion between technology-efficacy and self-efficacy. In summary, there has been a fundamental shift in how social structure guides platform users' behavior, showing how platform affordance encourages technology to exploit the social structure's "invisible embeddedness" properties.

Another contribution of this article lies in clarifying how platform affordance influences the digital divide. As expected, when individuals encounter the same platform functions, the perceived action possibilities vary not only between individuals but also gradated by degree. This finding validates Davis's (2020) argument that platform affordance operates on a gradated mechanism, allowing certain groups to access and accumulate resources more than others. In the case of Sina Weibo, users with positive technology-efficacy and self-efficacy often become frequent contributors and creators, utilizing various platform functions. Take super-topic community as an example, which differs from typical public microblogging services by establishing interest-based private communities. In terms of technology-efficacy, the super-topic community affords more opportunities for peer production and strong ties, although they present icon location and operation implicitly. In regard to self-efficacy, the super-topic community requires higher content creation skills, prompting users to assess the effort required based on their needs and capabilities. The perceptual result is that the platform affordance inherent in the super-topic community aligns more with characteristics favored by fandom, including hierarchical management and collective action.

In the context of the connectivity of social media platforms, individual users are situated within an extensive platform environment. We argue that the perceptions of technological features and personal experiences are not isolated psychological processes, but rather social practices influenced by the choices made by other users. When a particular property of Sina Weibo's function becomes widely perceived, this collectively shapes the dominant action possibilities for that function, or more informally, a bias. Correspondingly, if a function's "mainstream" property is perceived and valued, platforms, organizations, or individuals are more willing to engage in online activities, and vice versa. In this respect, the entertainment-oriented label attached to Sina Weibo results from ongoing user-function interactions. A similar instance can be observed on Twitter, where the "favorite" icon was changed from a star to a heart, making the function's properties more explicitly perceptible to new users (Bucher and Helmond, 2018). This change aimed to break the path dependency between old users and the specific action possibilities. In this vein, the proficiency of socially privileged individuals in capital-enhancing usage patterns is not solely due to their gender,

Table 3 Regression models: Platform affordances and Sina Weibo outcomes.

	The number of followers			
	Model 1	**Model 2**	**Model 3**	**Model 4**
Male	−0.20	−0.16	−0.05	−0.08
Age (18–30 years)				
31–44years	−0.02	−0.00	0.06	0.06
>45yaers	−0.53	−0.42	−0.12	−0.25
Education (senior high school or less)				
Some college	0.30	0.37	0.24	0.23
B. A. degree	0.40	0.42	0.24	0.30
M. A. degree or more	0.50	0.48	0.47	0.39
Occupation (government institutions)				
Private institutions	0.40*	0.40*	0.38+	0.40*
Student	−0.27	−0.26	−0.14	−0.21
Unemployed	−0.97+	−0.89+	−0.86	−0.89
Income (below average)				
Average	0.39*	0.33+	0.10	0.06
Above average	0.27	0.24	0.21	0.23
Technology-efficacy	0.13	0.12	0.20	0.20
Self-efficacy	0.63***	0.52**	0.18	0.26
Create or not		0.97***		
Frequency of creation			0.30***	
Creation diversity				0.16**
N	903	903	675	675
AIC	1602.01	1575.82	1264.30	1294.33
BIC	1693.32	1671.94	1354.59	1384.62

+$p < 0.1$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

age, or elite status. Instead, it results from network effects that promote competition for and monopolization of platform resources by prioritizing specific action possibilities.

Moreover, this study exposes another understudied issue: the unequal distribution of digital capital. Our empirical analysis reveals that stratified uses, constrained by the mutuality of users and functions, play a vital role in gaining followers. When comparing creators with consumers and among creators, it becomes evident that individuals who frequently contribute and utilize various functions are more likely to accumulate considerable digital capital. This contribution addresses theoretical gaps in current research on digital capital from two perspectives. At the first glance, it highlights how platform affordance and online participation affect and obscure the institutionalized stratification system. This underscores the distinction between broad digital capital, closely intertwined with offline capital (Ragnedda and Ruiu, 2020), and narrow digital capital, represented by the number of followers, which constructs a user's digital identity, somewhat independent of their social identity. For individual users in social media platforms, the distribution of such narrow digital capital transcends the social construction framework familiar in digital inequality research. Secondly, our study highlights the significant role played by the usage patterns in acquiring digital capital. While platform affordance does prompt stratified usage behaviors, it is not the central determinant of stratified outcomes. This supports Gibson's (2015) understanding of the limitations of affordance, which suggests, encourages, or guides subjects on what to do, rather than determining what they can achieve. In essence, whether on a specific social media platform or the broader internet landscape, active online participation is key to accessing various types of capital and converting accumulated resources into tangible or intangible benefits.

Conclusion

This article exposes the novel generative logic of the digital divide from a socio-technical perspective. Although many studies recognize the role of social structure in deepening and widening digital division related to ICT, it has remained unclear how social media platforms intervene in shaping the digital divide and governing the distribution of digital resource. Neither technological characteristics nor social changes alone can fully elucidate an individual's online behavior. To fill this theoretical gap, the concept of platform affordance offers a valuable framework for understanding how users interact with functions, the pathways that unequalize usage patterns and digital capital, and how new factors intersect with traditional ones. Drawing on data from Chinese platform enthusiasts, this study demonstrates a sequential relationship between technology-efficacy and self-efficacy, moderated by demographic characteristics. These factors collectively facilitate the gradated action possibilities, subsequently influencing engagement in creation or not, creation frequency, creation diversity, and the uneven distribution of followers.

The digital divide driven by platform affordance, exemplified by China's Sina Weibo, carries implications for the broader platform ecosystem. By building a general conceptual framework, this paper crystallizes the co-construction of social structures and technological features in platform environments, highlighting how this dynamic process plays a critical role in bridging and generating the digital divide. Even in cases where it is impossible to trace the technological black boxes, sociologists and communication scholars can still discern general patterns of technological interventions in social processes by examining the interaction between artifacts and users. However, algorithmic models and technological configurations vary across platforms, making it difficult to provide a generalized answer regarding how affordances will exacerbate existing gaps and inequalities or reduce them while promoting digital dividends. Therefore, platform comparisons and cross-platform analyses present efficient avenues for future studies to comprehensively explore digital divide issues in the evolving landscape of technology and human relations.

Limitations and future directions. This study has several limitations that need to be addressed. First, the cross-sectional data used in this study cannot be utilized to dissect the path through which the technological environment promotes social stratification. Future studies should work with panel data over multiple years or generations to delve into the general processes of resource conversion, the robustness of socio-technical factors in reinforcing inequality, and the dynamic reciprocal processes of technical algorithms and user behavior. Second, the accessibility and visibility of the platform functions were measured through a self-reported questionnaire, which may have resulted in respondents' self-biases and personal experiences distorting the objective nature and physical properties of technology. In addition, the technological characteristics of the platform may imperceptibly reinforce existing inequality or create new forms of inequality through algorithmic recommendation mechanisms, limiting us from sketching an actual scene of inequality through more sophisticated research methods.

Data availability

Since the datasets supporting the study's findings are not from publicly available datasets, we do not currently have the right to provide data without the consent of other researchers. Thank you for understanding.

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Author contributions
These authors contributed equally to this work, sharing first authorship. All authors made significant contributions to the article and approved the submitted version.

Competing interests
The authors declare no competing interests.

Ethical approval
The questionnaire design used in this study was approved by the appropriate legal and ethical review committees of Hanyi Big Data company and the Institute of Empirical Social Sciences Research of Xi'an Jiaotong University. All online questionnaires were obtained by considering the informed consent of the respondents. The questionnaire's content does not involve personal privacy or health information; all respondents completed it voluntarily and anonymously.

Informed consent
At the beginning of each web-based questionnaire, respondents were informed of the purpose of the survey and their right to participate voluntarily. We provided respondents with an introduction letter to the purpose of the survey and a commitment to privacy protection before starting the questionnaire. All respondents were allowed to discontinue or withdraw during the survey.

Additional information
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