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Digital Inequalities in the Age of Artificial Intelligence and Big Data

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Digital Inequalities in the Age of Artificial Intelligence and Big Data

Abstract

In this literature review, I summarize key concepts and findings from the rich academic literature on digital inequalities. I propose that digital inequalities research should look more into labor- and big data-related questions such as inequalities in online labor markets and the negative effects of algorithmic decision-making for vulnerable population groups. The article engages with the sociological literature on digital inequalities and explains the general approach to digital inequalities, based on the distinction of first-, second-, and third-level digital divides. First, inequalities in access to digital technologies are discussed. This discussion is extended to emerging technologies, including the Internet-of-things and AI-powered systems such as smart speakers. Second, inequalities in digital skills and technology use are reviewed and connected to the discourse on new forms of work such as the sharing economy or gig economy. Third and finally, the discourse on the outcomes, in the form of benefits or harms, from digital technology use are is taken up. Here, I propose to integrate the digital inequalities literature more strongly with critical algorithm studies and recent discussions about datafication, digital footprints, and information privacy.

Keywords: AI, digital divide, privacy

Introduction

Sociologists have long been interested in digital inequalities[1], understood as "the disparities in the structure of access to and use of ICT" as well as "the ways in which longstanding social inequalities shape beliefs and expectations regarding ICT and its impact on life chances" (Kvasny, 2006, p. 160). Since early adoption of the Internet, empirical investigations have researched aspects of Internet access, skills, uses, and outcomes (Van Dijk, 2006). Generally, this literature has found that digital inequalities tend to mirror existing social inequalities in terms of socio-economic status, education, gender, age, geographic location, employment status, and race (Robinson et al., 2015).[2] Traditionally disadvantaged citizens are similarly disadvantaged on the Internet, for example by having limited access to technology, restricted use opportunities, and by lacking important digital skills (Hargittai, 2002; Hargittai & Hinnant, 2010; Robinson, 2009; Sims, 2014; Zillien & Hargittai, 2009). Consequently, excluded population groups do not reap the benefits from information technology to the same extent as more privileged groups (Blank & Lutz, 2018; Van Deursen & Helsper, 2015). Therefore, optimistic claims that the Internet would create widespread social mobility and would lead to less stratified societies have been challenged by digital inequalities scholars (Norris, 2001).

The goal of this article is to summarize the central tenets and findings of the digital inequalities literature and to show the potential of this research stream for emerging technologies. I proceed in three steps, drawing on the distinction between first-, second-, and third-level digital divides (Hargittai, 2002; Van Deursen & Helsper, 2015). This distinction has emerged organically over more than two decades of research on digital inequalities. It offers a more straightforward and

[1] I use the plural form "digital inequalities" rather than the singular form "digital inequality" to acknowledge the plurality, multi-dimensionality and complexity of social stratification in the context of digital technology.
[2] As shown in more depth below, the degree to which variables such as socio-economic status, education, gender, age, and race predict the uptake and variegated uses of digital technologies depends on many factors. For some technologies, especially more established ones such as smartphones or broadband Internet, there might be less of a link, whereas for others, such as niche social media sites, the inequalities based on these variables can be more pronounced.

intuitive approach to structure the literature than, for example, Van Dijk's (2005) widely used differentiation of four digital divide types (motivational, material, skills, and usage) and related models. By relying on these three levels, I will sketch the conceptual foundations and key findings from the rich literature on Internet access (first-level divide), digital skills, technology uses, online participation (second-level divide), and outcomes in the form of benefits and harms (third-level digital divide). While I will discuss the achievements of digital inequalities research, I will also critically reflect on blind spots that merit further attention. Here, my focus is on emerging technologies and application areas, such as big data, AI, algorithms, and digitally mediated labor, where digital inequalities research has been a less powerful voice than it could be. Thus, digital inequalities scholarship risks being overheard in the discourse on emerging technologies, leaving the field to other disciplines such as computer science, law, philosophy, and human-computer-interaction. This risk is shown, for instance, by the underrepresentation of digital inequalities researchers in new venues that discuss bias in machine learning, such as the ACM FAT* conference on fairness, accountability and transparency in socio-technical systems. I will make the case for a more open and exploratory research approach among digital inequalities researchers, showing questions of current relevance, useful theories, and suitable methods.

First-Level Digital Divide

The first-level digital divide describes unequal *access* to the Internet. In this early use of the term, the digital divide referred to "the gap between those who do and those who do not have access to new forms of information technology" (Van Dijk, 2006, pp. 221-222). Research on the first-level digital divide often relied on large scale surveys, such as the Eurobarometer surveys in Europe and the National Telecommunications and Information Administration (NTIA) studies in the United States (e.g., NTIA, 2000, 2002), and showed large differences in

Internet access between different population segments (Van Dijk, 2006). With increasing Internet penetration in the late 1990s and 2000s, certain access gaps, (e.g., race and gender gaps) have largely closed in countries such as the United States (Hargittai & Hinnant, 2010), where around 90% of the population have access to the Internet (Pew, 2018a). Nevertheless, the global divide (Norris, 2001) is still very large, mirroring global economic inequalities (International Telecommunications Unit, 2017). Moreover, within richer countries certain population groups struggle to access the Internet, particularly individuals living in rural areas, those aged 65+, and those with less than a high school degree (Pew, 2018a). Thus, scholars have warned against abandoning the study of Internet access (Robinson, 2009; Van Deursen & Van Dijk, 2019).

Investigating Internet access is particularly important since the Internet is not a monolithic technology and new systems and applications are constantly being developed. For example, while general Internet access might be mostly saturated in rich countries, the same cannot be said about social media access (Blank & Lutz, 2017; Hargittai, 2015; Pew, 2018), the mobile Internet (Marler, 2018; Pearce & Rice, 2013), and AI-powered technologies such as smart speakers, smart homes, social robots, and Internet-of-things applications (Van der Zeeuw, Van Deursen, & Jansen, 2019). Thus, digital inequalities research in the tradition of the first-level digital divide is well advised to keep studying inequalities in technology adoption along socio-economic lines. It should do so in a theory-driven manner, since research on digital divides, especially the first-level digital divide, has been criticized for being atheoretical (Halford & Savage, 2010; Van Dijk, 2006).

As a good example for a theory-based first-level digital divide approach, Napoli and Obar (2014) developed the notion of the mobile Internet underclass to problematize mobile Internet access. According to this theory, mobile Internet access is second-class Internet access when compared to traditional/non-mobile Internet access. Mobile Internet access offers lower *functionality* in terms of speed, memory, and storage capacity. It also comes with physical limitations, for example regarding screen size and keyboard usability. Thus, complex but beneficial tasks such as editing text documents and tables (e.g., Google Docs, Google Sheets) are much harder to do on a mobile device (Gitau et al., 2010; Tsetsi & Rains, 2014). Accordingly, mobile Internet access is described as extractive, rather than immersive (Humphreys, von Pape, & Karnowski, 2009), centered on seemingly more superficial use modalities such as browsing, entertainment, and socializing. New-generation AI-powered technologies such as smart speakers might be even more restricting in terms of interactivity and functionality. For example, Amazon's Alexa and Apple's Siri are at this point conversational agents that do not provide the same breadth of use as a laptop with Internet connection (e.g., navigating, following links) and the same flexibility as a mobile phone (e.g., engaging with Siri or Alexa in a public transport setting is seen as socially less acceptable than using one's mobile phone for texting). They struggle with understanding dialects and accents (Paul, 2017), thus potentially excluding less privileged and educated users. At the same time, smart speakers have potential for making the lives of individuals with disabilities easier (Christopherson, 2016). Future digital inequalities research should study the tensions between exclusion and inclusion for emerging technologies such as smart speakers.

A second shortcoming of mobile Internet access is *limited content availability*. Traditional websites often lack a mobile-friendly version and navigating websites not designed for mobile devices is cumbersome at best, impossible at worst (Napoli & Obar, 2014). Especially smaller and local websites are less likely to be mobile-friendly, so that in emerging markets, individuals often rely exclusively on large platforms such as Facebook, which increases their dominance further (Mirani, 2015). If a website is made available in a mobile-friendly version, certain information often has to be left out to still enable a user-friendly experience. This leads to a less information-rich interaction (Napoli & Obar, 2014). Compared with mobile-friendly websites and apps, the issue of content availability is more pronounced for emerging AI-powered technology such as smart speakers. Here, even less content is available and popular media accounts show the limitation of these devices in delivering information (e.g., Murnane, 2018). Future digital inequalities research should systematically assess content availability of such systems, comparing it with the mobile and non-mobile Internet and studying the potential access gaps.

A third limitation of the mobile Internet is that it operates on *less open and flexible platforms*. The notion of walled gardens is used to describe this eco-system, where users access the Internet mostly through apps, which are more controlled and less open than the non-mobile Internet (Isomorsu, Hinman, Isomursu, & Spasojevic, 2007; Napoli & Obar, 2014). Consequently, modifying, adapting, and creating software based on open source code has become more difficult. Thus, “mobile device connectivity to the Internet is, to some extent, contradictory to the very nature of the Internet’s origins and growth […]” (Napoli & Obar, 2014, p. 327). Comparing mobile and traditional access with new generation devices such as smart speakers and smart homes, we find an even stronger issue of walled gardens. These systems are proprietary, practically impossible to modify, and highly opaque. However, Apple and Amazon have started to allow third-party developers to create “skills” or apps, making for an emerging eco-system that requires academic investigation. Still, the underlying core infrastructure of smart homes and smart speakers remains in the hands of a few large organizations. In a sense, these systems are not only walled gardens but prison yards, coming with less freedom of navigation, more control, and surveillance. Table 1 summarizes the key limitations of mobile Internet access and extends these to IoT and AI-enabled systems.

Aspects	**Mobile Devices** (smartphones, tablets)	**IoT and AI-Powered Systems** (smart speakers, smart homes)
Functionality	Limited: smaller screen, lower keyboard usability	Very limited: mostly restricted to voice-based interaction and specific application areas
Content availability	Limited: websites often not accurately rendered, apps offer a reduced experience of the website	Very limited: AI not overly sophisticated, content pulled from few sources (e.g., Wikipedia), limited number of skills/apps
Openness and flexibility of platforms	Limited: less open source than on non-mobile platforms, increasingly difficult for users to modify programs and adapt the hardware	Very limited: high market concentration and closed eco-systems, more control by the suppliers of the systems, very limited opportunities for modification of hardware and software
Metaphor	Walled garden	Prison yard

Table 1: Summary of Key Limitations of Mobile Decives and AI-Powered Systems

Second-Level Digital Divide

The term second-level digital divide was coined by Hargittai (2002) to differentiate binary inequalities in Internet access (first-level) from inequalities in skills and uses (second-level). The research attention of digital inequalities research has increasingly shifted from access to skills and uses, so that by now a considerable body of research on this topic exists (e.g., Gui & Argentin, 2010; Hargittai, 2010; Hargittai & Hinnant, 2010; Van Deursen & Van Dijk, 2011, 2014; Van Dijk, 2006; Zillien & Hargittai, 2009). These studies have shown differentiated inequalities along socio-economic lines. Blank and Groselj (2014), for example, in an in-depth survey of 1498 British Internet users, identified ten types of Internet use, showing how age, gender and education have a substantial effect on how often individuals perform each type. Generally, young, male and educated users have the highest use frequency for most of these types. However, each use type reveals different social structuration. Other second-level digital divide studies have focused on online participation and social media, differentiating active content creators from passive consumers and identifying the user characteristics of specific social media platforms (e.g., Blank, 2013; Blank & Lutz, 2017; Brake, 2014; Correa, 2010; Hargittai, 2007, 2015; Hargittai & Walejko, 2008; Hoffmann, Lutz, & Meckel, 2015; Schradie, 2011). The findings here are mixed, not allowing for strong associations between socio-economic status and online participation or social media use (Lutz, 2016). However, across most studies, age has proven to be a strong predictor of online participation and social media use, and some platforms are clearly gendered (Pew, 2018b).

Research on second-level digital divides has focused strongly on individuals' online activities for recreational purposes and outside of work. It has only started to engage with digital inequalities at work. However, across disciplines, new phenomena at the intersection of leisure and business have sparked considerable research interest. The so-called sharing economy, platform, economy, or gig economy has developed rapidly in the last years, making digital forms of work more common than ever (Kittur et al., 2013; Sundararajan, 2016). Digital inequalities research has been slow in investigating the emerging digital economy (Schor, Fitzmaurice, Carfagna, Attwood-Charles, & Poteat, 2016, for a good counter-example). What we know today about participation in the digital economy is that emerging forms of digital (e.g., Upwork, Amazon Mechincal Turk) or digitally mediated (e.g., Uber, TaskRabbit) work come with new challenges, for example in terms of surveillance and control (Rosenblat & Stark, 2016; Wood, Graham, Lehdonvirta, & Hjorth, 2018) as well as collective action (Newlands, Lutz, & Fieseler, 2018; Wood, Lehdonvirta, & Graham, 2018). However, how these challenges connect to structural inequalities – for example whether economically advantaged workers are better able to avoid algorithmic control and organize collectively – remains an open question that digital inequalities research should set out to answer. Beyond this, future research within a digital inequalities paradigm should study the distinction mechanisms and new hierarchies in the digital economy (Schor et al., 2016), also in terms of new skills such as algorithmic literacy (Klawitter & Hargittai, 2018). The research should not only systematically assess who is earning money as a freelancer or provider on digital platforms such as Airbnb and Uber but also who is using on-demand services as a consumer (Andreotti et al., 2017; Smith, 2016) or user-by-proxy (Newlands, Lutz, & Hoffmann, 2018).

Third-Level Digital Divide

Earlier key texts on digital inequalities have already pointed to outcomes of Internet use (DiMaggio et al., 2004; Van Dijk, 2005). However, the actual concept of a third-level digital divide, as an extension of first- and second-level divides, is more recent (Van Deursen & Helsper, 2015; Scheerder, Van Deursen, & Van Dijk, 2017; Wei, Teo, Chan, & Tan, 2011). Such third-level digital divides refer to differences in the gains from Internet use, particularly where access and use patterns are roughly similar. “Third-level divides, therefore, relate to gaps in individuals’ capacity to translate their internet access and use into favorable offline outcomes” (Van Deursen & Helsper, 2015, p. 30). This understanding builds on the assumption of feedback loops, where certain individuals profit disproportionally from Internet use and can leverage these benefits to strengthen their social position, thus exacerbating existing social inequalities (Van Dijk, 2005; Tichenor, Donohue, & Ollien, 1970 for a similar argumentation within the knowledge gap paradigm on mass media rather than digital media). The dynamic is described by a Matthew effect, where the rich get richer and use technology to strengthen their position in society. As an example, the Winkelvoss brothers, already from privileged backgrounds, have invested heavily in cryptocurrencies, becoming the first crypto-billionaires as of 2018[3] (Kauflin, 2018). On the other hand, bitcoin, while sometimes touted as solution to

[3] Given the volatility of cryptocurrencies, this might of course have changed already or change in the future.

fight poverty (Forbes, 2015), faces a lot of structural barriers and is at this point not a viable solution for underprivileged citizens (Biggs, 2016).

What is new about the third-level digital divide literature is the systematic study of Internet outcomes (Blank & Lutz, 2018, Van Deursen & Helsper, 2015; Van Deursen & Helsper, 2018; Van Deursen, Helsper, Eynon, & Van Dijk, 2017). Commonly, studies on the third-level digital divide investigate tangible offline outcomes from Internet use in economic, social, political, and cultural terms (Van Deursen & Helsper, 2015). Outcomes are mostly measured through surveys, where individuals are asked, for example, if they saved money by using the Internet, if they found information online that helped improve their health (Blank & Lutz, 2018), or if they have more contact with family and friends thanks to digital technology (Van Deursen & Helsper, 2015). The results indicate that actual uses and skills as well as attitudes are more predictive for Internet outcomes than demographic or socio-economic characteristics (Blank & Lutz, 2018; Van Deursen & Helsper, 2018). Among the demographic characteristics, age has the most pronounced effect but its directionality is inconclusive (Blank and Lutz, 2018 find a positive age effect on both benefits and harms, while Van Deursen & Helsper, 2018, find negative or no age effects on benefits but positive effects on satisfaction, depending on the type of outcome). Blank and Lutz (2018) make the important point that third-level digital divide research should not only study the benefits from Internet use but also the harms. However, the literature on harms differs from the one on benefits, making holistic approaches more difficult. While research on risks and harms is prominent in the children and media as well as the privacy literature, research on benefits is inspired by uses and gratifications theory, media appropriation, and technology acceptance (Blank & Lutz, 2018). Beyond tangible outcomes, digital inequalities scholarship has started to look at intangible outcomes such as social wellbeing, showing how perceptions – especially of belongingness – affect well-being more than Internet use and skills (Büchi, Festic, & Latzer, 2018). Similarly, the psychological literature about the relationship between smartphone screen time and wellbeing has shown that these effects tend to be small and follow a goldilocks pattern (Orben & Przybylski, 2019; Przybylski & Weinstein, 2017).

Third-level digital divide studies have so far focused on the links between antecedents, such as demographic characteristics, technology attitudes, skills, and differentiated Internet uses on the one hand, and outcomes on the other hand (Van Deursen et al., 2017). However, Micheli, Lutz and Büchi (2018) have argued for the integration of digital traces into the scope of digital inequalities. "What users do online matters; but what is online about them also has consequences" (Micheli et al., 2018, p. 243). In an age of big data and AI, where most interactions that happen through and with digital technologies are tracked, passive participation becomes a matter of increasing concern for digital inequalities scholarship (Lutz & Hoffmann, 2017). Excellent contributions by Madden, Gilman, Levy and Marwick (2017) as well as by the articles in the International Journal of Communication special section edited by Marwick and boyd (2018) demonstrate an increased attention to the vulnerabilities of those "at the margins" of society. They show how disadvantaged population groups suffer most from large-scale surveillance based on their digital traces. For example, underprivileged users are more likely to fall victim to fraudulent offers or predatory websites (Madden et al., 2017). According to an interviewee in Eubanks (2014), "poor women are the test subjects for surveillance technology", as they are disproportionately monitored by the government. A key argument in the emerging literature on the social implications of AI is that data-driven algorithms often reinforce established structural inequalities rather than shaking them up (Noble, 2018). Research on the third-level digital divide should include digital traces, algorithmic surveillance, and data-based discrimination into its "syllabus". Again, the reliance on social theories combined with both established and emerging methods such as walkthroughs (Light, Burgess,

& Duguay, 2018), trace interviews (Dubois & Ford, 2015), and computational methods (Lewis, Zamith, & Hermida, 2013) could yield fruitful results.

Conclusion

In this contribution, I traced the development of digital inequalities scholarship, from the first-level digital divide, to the second- and third-level digital divide. The review has shown how the research attention has increasingly shifted from access, to skills and uses, to outcomes. Using novel research contexts and helpful theories across all three divide types, I hope to show that the study of digital inequalities is as urgent as ever. Emerging technologies bring new inequalities in access and come with issues of functionality, content availability, and openness, as pointed out by the theory of the mobile underclass (Napoli & Obar, 2014). These shortcomings are likely to be exacerbated with cutting edge AI technology such as virtual assistants.

For the second-level digital divide, digital inequalities scholarship has a strong voice in accounting for aspects of skills and uses from a critical perspective, also when it comes to AI and big data-based technologies as well as the digital economy. Given that work and leisure are increasingly algorithmically mediated, algorithmic literacy and everyday users' engagement with algorithms is a promising but young strand of research (Bucher, 2017; Duffy, Pruchniewska, & Scolere, 2017; Eslami et al., 2017; Geiger, 2017; Klawitter & Hargittai, 2018; Rader & Gray, 2015). Digital inequalities scholarship could have an important voice in this area by pointing to the ways in which social factors, including social milieu and different forms of capital, influence algorithmic practices and literacies. Interpretative approaches could be complemented by surveys and experiments to quantify and generalize individuals' understanding of and interaction with algorithms. Bourdieu's social theory offers useful conceptual tools to guide such studies (Ignatow & Robinson, 2017). Actor-network theories and feminist theories have further been proposed as promising avenues for the study of digital inequalities and are useful for applying the second-level digital divide to emerging technologies (Halford & Savage, 2010).

Finally, the third-level digital divide is the next frontier of digital inequalities research. I discussed how this relatively young approach to digital inequalities does not only consider aspects of technology access, skills, and use but also takes into account the differentiated outcomes from using emerging technologies. In today's datafied world, data traces are a particularly important outcome of Internet use (Micheli et al., 2018), including the engagement with emerging technologies such as smart speakers and online labor platforms. The section on the third-level digital divide has shown how such traces might themselves lead to advantages or disadvantages, which are unevenly distributed in society (Madden et al., 2017). A focus only on benefits, rather than on benefits *and* harms (Blank & Lutz, 2018), misses the opportunity to connect this research strand to emerging literature on privacy risks and surveillance, particularly at the margins of society (Marwick & boyd, 2018). Instead, third-level digital divide research should assess the benefits and harms from what people do online and from what data traces are associated with them (Micheli et al., 2018).

In a sense, digital inequalities research has now arrived at a point where early contributors had already directed it to (DiMaggio et al., 2004; Van Dijk, 2005): how life chances are enhanced or constrained by individuals' interaction with emerging technologies. In an age of ubiquitous data mining, analytics and AI, life chances are at stake through algorithmic sorting and management, ratings, scoring, and a host of data-driven practices commonly associated with surveillance capitalism (Zuboff, 2015). Digital inequalities are a more important topic to address than ever.

References

Andreotti, A., Anselmi, G., Eichhorn, T., Hoffmann, C. P., & Micheli, M. (2017). European perspectives on participation in the sharing economy. SSRN Electronic Journal. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3046550

Biggs, J. (2016). Why bitcoin can't help the poorest – yet. *Techcrunch*, 10 January 2016. Retrieved from https://techcrunch.com/2016/01/10/why-bitcoin-cant-help-the-poorest-yet/

Blank, G. (2013). Who creates content? *Information, Communication & Society, 16*(4), 590-612.

Blank, G. & Groselj, D. (2014). The dimensions of Internet use: Amount, variety and types. *Information, Communication & Society, 17*(4), 417-435.

Blank, G., & Lutz, C. (2017). Representativeness of social media in Great Britain: Investigating Facebook, Linkedin, Twitter, Pinterest, Google+, and Instagram. *American Behavioral Scientist, 61*(7), 741-756.

Blank, G., & Lutz, C. (2018). Benefits and harms from Internet use: A differentiated analysis of Great Britain. *New Media & Society, 20*(2), 618-640.

Brake, D. (2014). Are we all online content creators now? Web 2.0 and digital divides. *Journal of Computer-Mediated Communication, 19*(3), 591-609.

Bucher, T. (2017). The algorithmic imaginary: exploring the ordinary affects of Facebook algorithms. *Information, Communication & Society, 20*(1), 30-44.

Büchi, M., Festic, N., & Latzer, M. (2018). How social well-being is affected by digital inequalities. *International Journal of Communication, 12*, 3686-3706.

Christopherson, R. (2016). How do Alexa and Amazon Echo help disabled people? AbilityNet, 5 December 2016. Retrieved from https://www.abilitynet.org.uk/news-blogs/how-do-alexa-and-amazon-echo-help-disabled-people

Correa, T. (2010). The participation divide among "online experts": Experience, skills and psychological factors as predictors of college students' web content creation. *Journal of Computer-Mediated Communication, 16*(1), 71-92.

DiMaggio, P., Hargittai, E., Celeste, C., & Shafer, S. (2004). Digital inequality: From unequal access to differentiated use. In K. M. Neckerman (Ed.), *Social Inequality* (pp. 355-400). New York, NY: Russell Sage Foundation.

Dubois, E., & Ford, H. (2015). Qualitative political communication| trace interviews: An actor-centered approach. *International Journal of Communication, 9*, 2067-2091.

Eslami, M., Rickman, A., Vaccaro, K., Aleyasen, A., Vuong, A., Karahalios, K., ... & Sandvig, C. (2015). I always assumed that I wasn't really that close to [her]: Reasoning about Invisible Algorithms in News Feeds. In *CHI'15: Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems* (pp. 153-162). ACM.

Eubanks, V. (2014). Want to predict the future of surveillance? Ask poor communities. *The American Prospect*, 15 January 2014. Retrieved from https://prospect.org/article/want-predict-future-surveillance-ask-poor-communities

Forbes, S. (2015). How bitcoin will end poverty. *Forbes*, 2 April 2015. Retrieved from https://www.forbes.com/sites/steveforbes/2015/04/02/how-bitcoin-will-end-world-poverty/

Geiger, R. S. (2017). Beyond opening up the black box: Investigating the role of algorithmic systems in Wikipedian organizational culture. *Big Data & Society, 4*(2). Retrieved from https://journals.sagepub.com/doi/abs/10.1177/2053951717730735

Gitau, S., Marsden, G., & Donner, J. (2010). After access: Challenges facing mobile-only Internet users in the developing world. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 2603-2606). ACM.

Gui, M., & Argentin, G. (2011). Digital skills of internet natives: Different forms of digital literacy in a random sample of northern Italian high school students. *New Media & Society, 13*(6), 963-980.

Halford, S. & Savage, M. (2010). Reconceptualizing digital social inequality. *Information, Communication & Society, 13*(7), 937-955.

Hargittai, E. (2002). Second-level digital divide: Differences in people's online skills. *First Monday, 7*(4). Retrieved from http://firstmonday.org/article/view/942/864

Hargittai, E. (2007). Whose space? Differences among users and non-users of social network sites. *Journal of Computer-Mediated Communication, 13*(1), 276-297.

Hargittai, E. (2010). Digital na(t)ives? Variation in Internet skills and uses among members of the "net generation". *Sociological Inquiry, 80*(1), 92-113.

Hargittai, E. (2015). Is bigger always better? Potential biases of big data derived from social network sites. *The ANNALS of the American Academy of Political and Social Science, 659*(1), 63-76.

Hargittai, E., & Hinnant, A. (2008). Digital inequality: Differences in young adults' use of the Internet. *Communication Research, 3*5(5), 602-621.

Hargittai, E. & Walejko, G. (2008). The participation divide: Content creation and sharing in the digital age. *Information, Communication & Society, 11*(2), 239-256.

Hoffmann, C. P., Lutz, C., & Meckel, M. (2015). Content creation on the Internet: A social cognitive perspective on the participation divide. *Information, Communication & Society, 18*(6), 696-716.

Humphreys, L., Von Pape, T., & Karnowski, V. (2013). Evolving mobile media: Uses and conceptualizations of the mobile Internet. Journal of Computer-Mediated Communication, 18(4), 491-507.

Isomursu, P., Hinman, R., Isomursu, M., & Spasojevic, M. (2007). Metaphors for the mobile Internet. *Knowledge, Technology & Policy, 20*(4), 259-268.

Ignatow, G., & Robinson, L. (2017). Pierre Bourdieu: theorizing the digital. *Information, Communication & Society, 20*(7), 950-966.

International Telecommunications Union (2017). ICT facts and figures. *International Telecommunications Union (ITU)*, Geneva. Retrieved from https://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2017.pdf

Kauflin, J. (2018). Return of the Winklevii: How the twins built a crypto fortune to last. *Forbes*, 7 February 2018. Retrieved from https://www.forbes.com/sites/jeffkauflin/2018/02/07/fintech-crypto-billionaires-tyler-and-cameron-winklevoss

Kittur, A., Nickerson, J. V., Bernstein, M., Gerber, E., Shaw, A., Zimmerman, J., ... & Horton, J. (2013). The future of crowd work. In *CSCW'13: Proceedings of the 2013 Conference on Computer Supported Cooperative Work* (pp. 1301-1318). ACM.

Klawitter, E., & Hargittai, E. (2018). "It's like learning a whole other language": The role of algorithmic skills in the curation of creative goods. *International Journal of Communication, 12*, 3490-3510.

Kvasny, L. (2006). Cultural (re) production of digital inequality in a US community technology initiative. *Information, Communication & Society, 9*(2), 160-181.

Lewis, S. C., Zamith, R., & Hermida, A. (2013). Content analysis in an era of big data: A hybrid approach to computational and manual methods. *Journal of Broadcasting & Electronic Media, 57*(1), 34-52.

Light, B., Burgess, J., & Duguay, S. (2018). The walkthrough method: An approach to the study of apps. *New Media & Society, 20*(3), 881-900.

Lutz, C. (2016). A social milieu approach to the online participation divides in Germany. *Social Media + Society, 2*(1). Retrieved from https://journals.sagepub.com/doi/abs/10.1177/2056305115626749

Lutz, C., & Hoffmann, C. P. (2017). The dark side of online participation: exploring non-, passive and negative participation. *Information, Communication & Society, 20*(6), 876-897.

Madden, M., Gilman, M., Levy, K., & Marwick, A. (2017). Privacy, poverty, and Big Data: A matrix of vulnerabilities for poor Americans. *Washington University Law Review, 95*, 53-126.

Marler, W. (2018). Mobile phones and inequality: Findings, trends, and future directions. *New Media & Society, 20*(9), 3498-3520.

Marwick, A., & boyd, d. (2018). Understanding privacy at the margins. *International Journal of Communication*, *12*, 1157-1165.

Micheli, M., Lutz, C., & Büchi, M. (2018). Digital footprints: an emerging dimension of digital inequality. *Journal of Information, Communication and Ethics in Society, 16*(3), 242-251.

Mirani, L. (2015). Millions of Facebook users have no idea they're using the internet. *Quartz*, 9 February 2015. Retrieved from https://qz.com/333313/milliions-of-facebook-users-have-no-idea-theyre-using-the-internet/

Murnane, K. (2018). Dumb and dumber: Comparing Alexa, Siri, Cortana and the Google Assistant. *Forbes*, 3 May 2018. Retrieved from https://www.forbes.com/sites/kevinmurnane/2018/05/03/dumb-and-dumber-comparing-alexa-siri-cortana-and-the-google-assistant/#7a41cb7e36e7

Napoli, P., & Obar, J. (2014). The emerging mobile Internet underclass: A critique of mobile Internet access. *The Information Society, 30*(5), 323-334.

Newlands, G., Lutz, C., & Fieseler, C. (2018). Collective action and provider classification in the sharing economy. *New Technology, Work and Employment*, *33*(3), 250-267.

Newlands, G., Lutz, C., & Hoffmann, C. P. (2018). Sharing by proxy: Invisible users in the sharing economy. *First Monday, 23*(11), 1-14. Retrieved from https://firstmonday.org/ojs/index.php/fm/article/view/8159/7604

NTIA (2000). Falling through the Net II: toward digital inclusion. Retrieved September from http://www.ntia.doc.gov/ntiahome/fttn00/contents00.html

NTIA (2002). A nation online: how Americans are expanding their use of the Internet. Retrieved from http://www.ntia.doc.gov/ntiahome/dn/index.html

Noble, S. U. (2018). *Algorithms of oppression: How search engines reinforce racism*. New York: NYU Press.

Norris, P. (2001). *Digital divide: Civic engagement, information poverty, and the Internet worldwide*. Cambridge: Cambridge University Press.

Orben, A., & Przybylski, A. K. (2019). The association between adolescent well-being and digital technology use. *Nature Human Behaviour, 3*, 173-182.

Paul. S. (2017). Voice is the next big platform, unless you have an accent. *Wired*, 20 March 2017. Retrieved from https://www.wired.com/2017/03/voice-is-the-next-big-platform-unless-you-have-an-accent/

Pearce, K., & Rice, R. (2013). Digital divides from access to activities: Comparing mobile and personal computer Internet users. *Journal of Communication, 63*(4), 721-744.

Pew (2018a). Internet/broadband fact sheet. *Pew Research Center: Internet & Technology*, 5 February 2018. Retrieved from http://www.pewinternet.org/fact-sheet/internet-broadband/

Pew (2018b). Social media fact sheet. *Pew Research Center: Internet & Technology*, 5 February 2018. Retrieved from http://www.pewinternet.org/fact-sheet/social-media/

Przybylski, A. K., & Weinstein, N. (2013). Can you connect with me now? How the presence of mobile communication technology influences face-to-face conversation quality. *Journal of Social and Personal Relationships, 30*(3), 237-246.

Rader, E., & Gray, R. (2015). Understanding user beliefs about algorithmic curation in the Facebook news feed. In *CHI'15: Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems* (pp. 173-182). ACM.

Robinson, L. (2009). A taste for the necessary: A Bourdieuian approach to digital inequality. *Information, Communication & Society, 12*(4), 488-507.

Robinson, L., Cotten, S., Ono, H., Quan-Haase, A., Mesch, G., Chen, W., ... & Stern, M. (2015). Digital inequalities and why they matter. *Information, Communication & Society, 18*(5), 569-582.

Rosenblat, A., & Stark, L. (2016). Algorithmic Labor and Information Asymmetries: A Case Study of Uber's Drivers. *International Journal of Communication, 10*, 3758-3784.

Scheerder, A., Van Deursen, A., & Van Dijk, J. (2017). Determinants of Internet skills, uses and outcomes. A systematic review of the second-and third-level digital divide. *Telematics and Informatics, 34*(8), 1607-1624.

Schor, J., Fitzmaurice, C., Carfagna, L., Attwood-Charles, W., & Poteat, E. (2016). Paradoxes of openness and distinction in the sharing economy. *Poetics, 54*, 66-81.

Schradie, J. (2011). The digital production gap: The digital divide and web 2.0 collide. *Poetics, 39*(2), 145-168.

Sims, C. (2014). From differentiated use to differentiating practices: Negotiating legitimate participation and the production of privileged identities. *Information, Communication & Society, 17*(6), 670-682.

Smith, A. (2016). Shared, collaborative and on demand: The new digital economy. *Pew Research Center: Internet & Technology*, 19 May 2016. Retrieved from http://www.pewinternet.org/2016/05/19/the-new-digital-economy/

Sundararajan, A. (2016). *The sharing economy: The end of employment and the rise of crowd-based capitalism*. Cambridge, MA: MIT Press.

Tichenor, P., Donohue, G., & Olien, C. (1970). Mass media flow and differential growth in knowledge. *Public Opinion Quarterly, 34*(2), 159-170.

Tsetsi, E., & Rains, S. (2017). Smartphone Internet access and use: Extending the digital divide and usage gap. *Mobile Media & Communication, 5*(3), 239-255.

Van der Zeeuw, A., Van Deursen, A., & Jansen, G. (2019). Inequalities in the social use of the Internet of things: A capital and skills perspective. *New Media & Society*, online first. doi: 10.1177/1461444818821067

Van Deursen, A., & Helsper, E. (2015). The third-level digital divide: Who benefits most from being online? In *Communication and Information Technologies Annual* (pp. 29-52). Bingley: Emerald.

Van Deursen, A., & Helsper, E. (2018). Collateral benefits of Internet use: Explaining the diverse outcomes of engaging with the Internet. *New Media & Society, 20*(7), 2333-2351.

Van Deursen, A., Helsper, E., Eynon, R., & Van Dijk, J. (2017). The compoundness and sequentiality of digital inequality. *International Journal of Communication, 11*, 452-473.

Van Deursen, A., & Van Dijk, J. (2011). Internet skills and the digital divide. *New Media & Society, 13*(6), 893-911.

Van Deursen, A., & Van Dijk, J. (2014). The digital divide shifts to differences in usage. *New Media & Society, 16*(3), 507-526.

Van Deursen, A., & Van Dijk, J. (2019). The first-level digital divide shifts from inequalities in physical access to inequalities in material access. *New Media & Society, 21*(2), 354-375.

Van Dijk, J. (2005). *The deepening divide: Inequality in the information society*. London: Sage.

Van Dijk, J. (2006). Digital divide research, achievements and shortcomings. *Poetics, 34*(4-5), 221-235.

Wei, K. K., Teo, H. H., Chan, H. C., & Tan, B. C. (2011). Conceptualizing and testing a social cognitive model of the digital divide. *Information Systems Research, 22*(1), 170-187.

Wood, A. J., Graham, M., Lehdonvirta, V., & Hjorth, I. (2018). Good gig, bad gig: autonomy and algorithmic control in the global gig economy. *Work, Employment and Society*, online first. doi: 10.1177/0950017018785616

Wood, A. J., Lehdonvirta, V., & Graham, M. (2018). Workers of the Internet unite? Online freelancer organisation among remote gig economy workers in six Asian and African countries. *New Technology, Work and Employment, 33*(2), 95-112.

Zillien, N. & Hargittai, E. (2009). Digital distinction? Status-specific types of Internet usage. *Social Science Quarterly, 90*(2), 274-291.

Zuboff, S. (2015). Big other: Surveillance capitalism and the prospects of an information civilization. *Journal of Information Technology, 30*(1), 75-89.

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