

Materialist Perspectives on Digital Technologies

Informing Debates on Digital Literacy and Competence

Holger Pötzsch

Abstract

The present article brings critical media research and science and technology studies (STS) into dialogue with approaches to digital literacy and digital competencies in educational contexts. In particular, it focuses on material aspects of new information and communication technologies (ICTs) such as technical infrastructure, economic conditions, ecological consequences, and code-based as well as embodied forms of impact, and argues that digital applications and devices have ambiguous and often contradictory affordances and effects that need to be addressed in academic literature and pedagogical practice. The main objective is to inform on-going debates on the nature and content of digital literacy and digital competence from a critical materialist vantage point, and to facilitate learning and teaching about, rather than with, digital technologies by highlighting salient issue areas in need of continued critical attention.

Keywords: digital media, digital competencies, media literacy, ICTs, education, materialism, STS

Introduction

Due to rapid technological developments, the digital has become a recurrent theme in contemporary discourses on education. From EU-funded studies (Ferrari 2012) via OECD-projects¹ to national curricula², concepts such as digital skills, digital literacy, digital competence, or new media literacy are in continuous use. However, as, among others, studies by Lund et.al. (2014), Ottestad et.al. (2014), Beck and Øgrim (2009), Erstad (2010), Haugsbakk (2011), or Buckingham (2006) have shown, what precisely amounts to digital skills, literacy, or competences is in continuous flux in line with changing technological frames and the shifting demands of teachers, students, educational institutions, and society at large.

The present article will not engage in this debate at a conceptual level, but presents a perspective ‘from the sideline’ of critical media studies that directs attention to technological, economic, and environmental aspects of increasingly ubiquitous digital technologies. The aim is to provide summaries of recent empirical findings in these fields and, this way, to inform debates about digital technologies in general, and about digital literacies and competencies in particular.

Aligning itself to a recent “move toward materiality” in media and communications research (Packer and Crofts Wiley 2012: 4), the article will address five thematic areas:

1. Technological infrastructure and issues of surveillance and privacy
2. Political economy, ownership, and the exploitation of immaterial labour
3. Ecological implications of a fast growing ICT industry
4. Implications of information management applications
5. Problems of manipulation, attention management, and affective design

The article concludes that, to enable children and young adults to use, appropriate, and, if need be, resist increasingly pervasive digital technologies in a reflective and competent manner, contemporary education has to convey knowledge about these technologies at all the levels introduced above in addition to providing users skills and access to particular devices. Initially, however, a few words need to be said about current advances toward digital technologies in educational research.

Education and the Matter of Digital Technologies

In a critical analysis of key Norwegian policy documents and national curricula from 1980 to 2006, Haugsbakk (2011) identifies a series of discursive operations in the field of education that reflect a fundamental change in pedagogical principles and relations to new technologies. He highlights changes in the rhetoric of the documents with a marked shift toward what he terms a form of techno-determinism from the mid 1990s onward that, according to him, increasingly sidelines pedagogical expertise and transforms teachers from responsible educators to recipients of ready-made technological solutions.

Arguing from a similar vantage point, Beck (2011) has warned against the increasing pace of public debates and political decision-making regarding the inclusion of ICTs in education that threatens to disregard evident pitfalls of, and the underlying power structures driving and fuelling, these processes, while Missomelius (2014) points to ambivalences in technologies such as MOOCs and OER that under certain circumstances can facilitate learning and teaching, but that also afford an outsourcing of responsibilities and activities from educational institutions to learners (pp. 7-8).

Taking note of this important strain of criticism, the present contribution will, nevertheless, turn focus away from debates about the inclusion of particular technological solutions into educational practices. Rather, I direct attention to the inherently ambivalent affordances and effects of digital technologies, and embed these in economic, societal, cultural, and ecological contexts. This way, I hope to support approaches to digital/media literacy and competence that aim at teaching about these technologies as well as improving user skills and educational practices.

Critical approaches to ICTs’ shifting roles and functions in societal contexts have already had some impact on pedagogical and didactic debates. Several scholars have developed frameworks that take into account the inherently ambivalent aspects of new technologies and have adjusted key terminologies accordingly. Erstad (2010: 67-69), for instance, introduces five conceptual dimensions that can serve as a viable matrix for endeavours to include critical approaches to digital technologies into syllabi and

educational practices. He argues for the use of the overarching concept of media literacy that enables attention to both analogue and digital technologies, incorporates a historical dimension of technological change, and “relates to broader aspects of living in media saturated societies, and not only skills in operating applications or information handling” (p. 58).

Erstad distinguishes his extended understanding of media literacy into the following subdomains: 1) basic user skills, 2) media technologies as objects of knowledge, 3) the changing technical conditions of knowledge dissemination in specific educational subjects, 4) impacts on learning strategies, and 5) digital ‘Bildung’ as a new form of overarching cultural competence. In particular Erstad’s dimension 2: ‘Media technologies as objects of analysis’ and dimension 5: ‘Digital Bildung/cultural competence’ can be productively informed by the critical research highlighted in the present article.

Another useful template is introduced by Beck and Øgrim (2009) who distinguish between three interconnected layers forming what they term contemporary digital competences: 1) user skills, 2) technological expertise, and 3) knowledge about technology’s role in culture and society. In their case, in particular layer 2 and 3 would be well suited to productively address such issues as technological infrastructure, surveillance and privacy, economic and ecological contexts and costs, information management, and the modulation and commodification of human attention that will be raised in the following sections.

In sum, media literacy, digital literacy, or digital competence are today understood as encompassing more than merely instrumental skills to increase the efficiency of uses of digital (and other) technologies in classrooms and beyond. Rather, as for instance Buckingham (2006: 267-268) has argued, these terms refer to the formation of multiple capacities in and through educational practices. According to him, these include the capacity to critically assess information sources and representational conventions, to understand the inherent situatedness of processes of production and reception, and to acquire technological meta-skills as well as user skills.

From Participatory Networks to a Digital Enclosure: The Ambivalent Affordances and Effects of Contemporary ICTs

According to Pimple (2014), an omnipresence of networked computational devices that are “embedded in just about anything” and the multiple functions and effects of which often remain “undetected by the casual observer” (p. 2) pose reason for “major concerns” (p. 3). The present article will address the material infrastructure, political economy, environmental impacts, and epistemological as well embodied effects of current digital technologies. In directing attention to issues of dataveillance and privacy, questions of ownership and the exploitation of immaterial labour, the growing ecological footprints of digital technologies, as well as questions of information and attention management, I hope to productively inform on-going debates about digital competencies and literacies.

Technological Infrastructure: Surveillance and the End of Privacy

Today, each computer or smart phone not only receives but also constantly emits information. Continuously disseminated data packages contain updates on location, direction

of movement, search and browse history, as well as social networks, lists of friends, their interests and locations. The significance of practices of mining of such “big data” for targeted advertising and state surveillance is today apparent (Andrejevic 2007, 2013; Morozov 2013; Fuchs 2014; Pötzsch 2015a&b). Andrejevic (2007), for instance, has warned that an increasing ubiquity of sensors in responsive technical environments is creating a “digital enclosure [...] an interactive realm wherein every action and transaction generates information about itself” (p. 2) that is captured, stored, and mined for business- and security-related purposes. As such, new participatory media ecologies not only afford empowerment and liberation (Mitra & Watts 2002) or facilitate political mobilisation (Barassi & Treré 2012), but also entail new practices of management and control (Morozov 2011; Andrejevic 2007).

As the classified files leaked by former NSA operative Edward Snowden have revealed, mass surveillance and control, rather than emancipation and freedom, are today the most prominent features of global networked communication.³ In this particular case of clandestine state surveillance, the very material infrastructure of global networks – fibre optic cables, server parks, mobile phone towers etc. – plays a crucial role.

According to Galloway (2004) and Galloway and Thacker (2007), contemporary digital networking technologies exhibit a “twofold dynamic” (Galloway & Thacker 2007: 41) regarding emancipation and control. With regard to the Internet, the authors detail that code-based transmission protocols such as IP and TCP distribute agency across a vast array of nodes, while a physical infrastructural layer enables a system of centralized management and control. This two-fold architecture, they argue, makes for instance the Internet both a distributed rhizomatic network where every connected node, in principle, can directly interact with any other (the basis of an alleged liberating potential of this technology), and a rigid structure of control that channels all traffic through certain pivotal hubs such as root servers, key fibre-optic cables, or mobile phone towers (enabling control and surveillance).

Gellman and Soltani (2013, 2014) and Gallagher (2013) have described the technological applications through which the NSA’s PRISM programme successfully tapped into precisely these material networks underlying communication via the contemporary Internet. This was achieved by either gaining access to the physical infrastructure mentioned above, or by compromising the security and encryption tools of major communication operators and Internet service providers such as Microsoft, Google, Facebook, Yahoo, and others.

The amount of data that is extracted from global communication networks by state and non-state actors exceeds the capacity of human interpretation and analysis, and demands an automated form of assessment by means of algorithm-driven data mining applications. Andrejevic (2013) for instance details how tools for web analytics, predictive analytics, as well as sentiment and behavioural analysis routinely sift through sets of globally acquired big data and automatically identify patterns and deviations that lead to concrete policy recommendations or commercially motivated measures. Such tools for the reading and analysis of big data also create certain expectations in various scientific circles regarding an improved capacity to work with otherwise unmanageable datasets.

One problem connected to these developments is the decreased significance of human reasoning in analytical processes. As Andrejevic (2013) argues, in a “post-comprehension era of information processing” (p. 35), understanding of individual cases

is increasingly replaced by algorithmically identified patterns in abstracted sets of big data that highlight correlations, but are unable to place individual cases in their proper contexts. As such, uses of big data are ridden with certain sets of implicit assumptions that can compromise their applicability and might lead to unintended consequences. According to boyd and Crawford (2012: 665-674), among the problems connected to big data-driven analytics are a new digital divide between those with and those without the capacity to productively use this data, a tacit demise of contextual knowledge, a misled belief that big data necessarily is whole data and not a peculiar subset, and “apophenia” – a practice that identifies patterns “where none actually exist” (p. 668). As Johnson (2014) argues, raising awareness for such potential pitfalls in algorithm-based analytics is of great significance for debates regarding the use of web-based analytics as potential assessment tools also in educational contexts.

Without losing sight of the multiple beneficial uses of big data analytics, social media, and digital networking technologies in educational practice and society at large, the examples provided above indicate the necessity of particular competencies that are required by contemporary citizens to responsibly and productively navigate new technologically saturated environments. These competencies include 1) technical expertise of how digital networks as material structures operate, 2) a critical understanding of the multiple functions of ICTs as both facilitators of communication and exchange, and as means for economic, political, peer-to-peer, and self-surveillance, 3) basic legal knowledge regarding privacy rights and copyright regulations, 4) basic programming skills, as well as 5) mathematical skills that sensitize young adults for potential benefits, frauds, and flaws connected to algorithm-driven forms of automated analysis and prediction.

Political Economy: Who Owns the Cloud, and Why does it Matter?

In their historically inflected approach to interactive technologies, Kline, Dyer-Witford, and de Peuter (2003) criticize a “myopia” (p. 6) of techno-determinist discourses that selectively isolate a single aspect of complex life worlds – technology – and overstate its significance for socio-political, cultural, and economic developments. Questioning ideas of radical ruptures between so-called analogue and digital eras, they identify processes of production and consumption as a key continuity linking rather than separating the two eras. As such, they argue, “the paradox that is lost in [...] visions of digital progress is that genuinely new technocultural innovations [...] are being shaped, contained, controlled, and channelled within the long-standing logic of a commercial marketplace dedicated to the profit-maximizing scale of cultural and technological commodities” (p. 21)⁴. As such, it seems that in a digital age of participatory media, cloud computing, and virtual worlds, ownership of the means of communication, and financial as well as political control over global networks still matters. This implies that the political economy underlying digital ICTs emerges as a key field of critical research and education.

Today, apparently ephemeral digital data stored in the virtual, global cloud still exists somewhere as a material configuration in, for instance, a particular server. This server, together with the building around it, the fiber-optic cables interconnecting it, and the electric grid powering it, is owned and controlled by someone who has access to, can exploit, or simply disconnect the stored data. These underlying conditions become particularly sali-

ent in cases of conflict between interests of owners and those of a general public. Zajacz (2013) for instance has shown how the whistle-blower site Wikileaks, after it had released classified US military and diplomatic cables, was exposed to multi-platform attacks by US authorities that were not only directed at undermining the anonymity of Wikileaks' sources, but also targeted the site's material infrastructure and economic basis. US agencies pressured important Internet Service Providers, such as Amazon and Yahoo, to ban Wikileaks from their servers and forced PayPal to freeze assets and return donations. This action again triggered a retribution from the side of the digitally networked movement *Anonymous* that directed distributed denial of service attacks at various involved actors and platforms (Fuchs 2015: 89). The case of Wikileaks, as such, illustrates well the ambivalent affordances and capacities of participatory media ecologies that can both facilitate oppressive state measures and aid collective action at a grass root level.

Criticizing a continued concentration of media and technology companies in the hands of a few major global businesses, Wood (2009) has argued that terms such as participatory media, web 2.0, or social media, often function as a "commercial gloss" (p. 170) that has a tendency of de-emphasizing issues of ownership, influence, and control. "MySpace is of course owned by Rupert Murdoch" as she elegantly puts it (p. 170). From a similar point of view, Olsson (2010) has asked whether "contemporary media ecology [...] should be understood as an ecology in which various forms of user participation are in fact produced – or even manufactured – by organized interests?" (p. 102). Addressing such underlying economic conditions of ICTs not only enables a critical perspective on contemporary media-saturated societies, but also provides useful tools for an analysis of the economic and political force-fields within which demands for an inclusion of ever new technologies into virtually all areas of public services, including education, emerge.

In spite of the many economic and social benefits of participatory technologies, it seems that McChesney (2013) is right, when he identifies an underlying logic of ownership, capital accumulation, and surveillance "as the elephant in the room" of Internet studies (p. 13). The logic through which global capitalism "dominates social life [and] defines our times" (McChesney 2013: 13), however, becomes palpable not only in issues of ownership and control of material infrastructure, but also in the exploitation of immaterial labour through the monetization of user data and crowd-sourced products.

Andrejevic (2007, 2013), Morozov (2011, 2013), and Fuchs (2012) have shown that both businesses and state agencies automatically assemble and exploit user data on a massive scale. The very business models of companies such as Google, Facebook, Microsoft, or Yahoo are based on the extraction, refining, and subsequent sale of user data, including profiles, behavioural patterns, and consumption habits (Andrejevic 2011, 2013; Fuchs 2012).

In addition to this, users of online applications make significant contributions to the global economy by creating genuinely commons-based solutions (Sandoval 2015), or by improving devices or games they use through practices of beta-testing, modding, or fan fiction (Jenkins, Ford, and Green 2013). However, often users are not sufficiently rewarded for their labour in economic terms (Fuchs 2014: 103-121). In "informational capitalism" (Fuchs 2010), the inherently passive consumer of media content is transformed into an active prosumer who continuously makes tacit contributions to a global value creation chain. In the context of this development, Fuchs (2012) has denounced

the “exploitation of the internet prosumer commodity” (p. 139) through the increased “collection, storage, assessment, and commodification of personal data, usage behaviour, and user-generated data” (p. 155).

These forms of exploitation of immaterial labour are afforded by what Schäfer (2011) refers to as a form of “implicit participation” (p. 105) in the digital production process. Implicit participation unfolds not as a conscious and voluntary contribution, but as the result of a “default design feature” (p. 105) of information systems that exploit user activities by for instance commodifying online traces, or by taking possession of tacit improvements to software application made by users. As a result of this, argues Sandoval (2015), a clearer distinction between commercial and genuinely common-based applications and solutions becomes necessary.

Knowledge regarding the *modus operandi* of contemporary information-based economies and critical awareness of the advantages and pitfalls of practices of crowd-sourcing and user-profiling, should not only inform debates about digital competencies and literacies, but should also become part of discussions regarding the possible inclusion of digital technologies into classrooms and other educational settings. Here in particular a distinction between genuinely commons-based media and commercial products has to be further highlighted.

Ecology: The Material Footprint of Digital Technologies

Another material dimension of contemporary digital ICTs that should be subjected to critical scrutiny in research, politics, and teaching is their growing ecological impact. An often-assumed environmental benefit of digital communication compared to its analogue counterpart has long been treated as a self-evident truth informing both public discourse and political decision-making. The notion that reading a newspaper online rather than receiving the paper version by mail, or that using email instead of physical letters to communicate with others, entail considerable benefits for the environment is still held by many and constitutes an effective apologetic frame that somewhat disables critical attention to the growing environmental and societal costs connected to the production, powering, as well as the increasingly rapid disposal of digital devices that has been highlighted by scholars such as Carli (2010a&b), Gombiner (2011), Maxwell and Miller (2012), and Lager Vestberg, Maxwell, and Raundalen (2014).

The energy required to power the Internet is augmenting considerably (Gombiner 2011). A huge amount of the electricity consumed by server parks and datacentres are used to cool down ever more powerful machinery. According to Maxwell and Miller (2012: 29) the average energy required to power data centres has risen from 750-1000 watts per square meter in the mid 1990s to 1500-2000 watts by the end of the 2010s. In addition to these increases in average energy costs comes an explosion in the number of datacentres and server parks worldwide (Maxwell & Miller 2012: 29). As a result of these developments, writes Gombiner (2011: 120), in 2010 the combined ICT industries accounted for approximately 2 percent of global greenhouse gas emissions – roughly the same as the aviation industry.

The point here is not to unduly criticise for instance Google for offering the important services they do. It is, however, a sobering fact that the main increase in energy-intensive online activities is the result of spare time occupations in industrialized

countries, such as streaming videos or playing online games. As such, activities carried out over the Internet not necessarily replace ecologically more damaging actions that previously had been conducted offline, but are often comprised of new pursuits that cause additional energy demands rather than reducing environmental impacts caused by established activities.

As a consequence, optimistic forecasts regarding the beneficial impact of digital communication technologies on the environment have to be critically reassessed. For instance, estimates indicating a reduction in paper production due to emails as well as digital books and documents that were expected to lead to the emergence of paper-free offices did not materialize (Cali 2010a). As Maxwell and Miller (2012: 61) show, in spite of the introduction of digital technologies on a massive scale, paper production for office work rose by 44 per cent between 1990 and 2008. Neither did the predicted decrease in business-related travel or transportation of goods by air or land occur.

In another strain of criticism, Orisakwe and Frazzoli (2010) assert that, today, e-waste is “the fastest-growing component of the solid-waste stream” (44) and “one of the largest known sources of heavy metals, toxic materials and organic pollutants” (43). Consumption patterns in industrialized nations are responsible for most of the electronic debris. Still, more than 80 per cent of it is dumped or processed under often avert working and safety conditions and with devastating ecological and health-related effects, in the Global South (Maxwell and Miller 2012: 101-108). Only fractions of this garbage are reused or enter a recycling system, while the vast majority disappears in global “hidden flows” (Cobbing 2008: 5).

The production and disposal of digital technologies is seldom the subject of public debate, yet causes increasing societal and ecological costs. Mills (2013: 3), for instance, states that by 2013 the combined activities of the ICT industry – including resource extraction, production, powering, and disposal – consume almost 10 per cent of global electricity production, twice the energy consumption of global aviation.⁵ Knowledge about these issues emerges as an important element of contemporary digital literacy and competence. In particular the fact that the costs and unintended consequences mentioned above often remain underemphasized in public discourse relating to digital technologies places a key responsibility on educational institutions to convey such data to foster a critical and competent citizenry, and to seriously entertain the question of how many technical devices really are necessary in schools to teach about digital technologies and their potential benefits and drawbacks.

Information Management

In his book *iSpy*, Andrejevic (2007) points out that the “hip, tricky little ‘i’” (p. 4) signifies the ambiguities of the interactive revolution in that it implies both “solipsistic customization” and the “democratic [...] ability to talk back” (p. 5). As the present section will show, the “solipsistic customization” identified by Andrejevic not only applies to targeted advertising and customisations of online solutions, but to a growing extent also refers to a tacit individualisation and tailoring of the information users can access via digital networks. As such, the processes highlighted by Andrejevic acquire immediate saliency for issues related to information and media literacy in particular in educational contexts.

Graham, Schroeder, and Taylor (2013) have recently argued that “[b]y shaping both what we know and how we know it, search engines – and those who design and control them – are able to wield an immense amount of social power” (p. 1368). Search engines and news services function as both gatekeepers and intermediaries between rapidly growing online content and users. In these processes, the “perennial question” (p. 1368) emerges of how the veracity of, for instance, search results can be validated given the secrecy surrounding search algorithms combined with the significant economic incentives of private enterprises “to orient the results page in self-serving ways” (Rieder and Sire 2014: 195), and coupled with the welcome option provided to state actors to “architecturally alter” search engines “to serve political regimes” (Jiang 2014: 212).⁶

The introduction of a certain bias in search results, however, matters not only in relation to clandestine advertising or state propaganda, but has an even more significant epistemological dimension. Focusing on underlying processes of information selection, Pariser (2011) and Bucher (2012) have shown how page and edge rank algorithms deployed by Google and Facebook customize search results and news feed updates. They explain that factors such as users’ browser histories, past and present location, social networks, past purchases, and online interactions with others, influence the paradigm of results delivered back to users. This development makes Google’s search engine increasingly “reflect [users’] own interests” (Pariser 2011: 3), while an “algorithmic editorial voice” predisposes the appearance of content on Facebook (Bucher 2012: 1167). In both cases, allegedly unbiased sources of information exhibit an in-built tendency to put forth results that are in correspondence with traced individual preferences.

Page and edge rank algorithms have been introduced with the objective to improve the perceived relevance of search results. However, the way through which such filters tacitly predispose which information becomes available, and which remains hidden, have led Miller and Record (2013) and Mager (2014) to warn of possible implications for the formation of individual and collective beliefs. According to Miller and Record (2013), the tendencies afforded by these technologies might facilitate the formation of echo chambers where users are increasingly exposed to viewpoints and attitudes similar to their own, rather than exchanging arguments with fundamentally opposed positions. As such, rather than including previously excluded voices into a public conversation, the techniques of customization of social media and search engines might, in the long run, further fragment public discourse and contribute to an undermining of shared processes of political deliberation in democratic societies.

Such questions of information management are often duly covered in traditional approaches to media literacy in general and digital literacies in particular. Nevertheless, the specific affordances of algorithm-driven filters and sorting mechanisms predisposing the paradigm of information made available via widely used online applications, deserves special attention. As such, knowledge regarding the underlying economic incentives, possibilities for political instrumentalisation, and algorithmic modi of operation, as well as an awareness for the availability of alternative tools for finding and sorting content on the net, constitute crucial elements in a set of relevant 21st century digital competencies and skills.

Attention Management and Affective Design

Besides information management, also the ways by which digital media attract and administer human attention require critical scrutiny. Drawing on cognitive and neuroscientific approaches to attention, Hayles (2007, 2012) has identified a technologically facilitated “generational shift in cognitive styles that poses challenges to education at all levels” (2007: 187). She argues that the rapid spreading of digital devices to virtually all areas of life entails a shift away from “deep attention” that is characterized by long-term concentration on a single object under the exclusion of outside stimuli, to a modus of “hyper attention” that rapidly switches focus, thrives with multiple and simultaneous information streams, and requires constant stimulation and gratification (pp. 187-188). Avoiding the pitfalls of both apocalyptic and apologetic approaches, Hayles points to advantages in each mode of attention, yet maintains that ubiquitous digital technologies heavily privilege hyper attention. Given an inherent plasticity of the human brain, she argues, technology-saturated environments entail potential neuro-physiological long-term effects that, so far, are poorly understood (Hayles and Pötzsch 2014: 98-99).

Attention, however, is not only changed, but also administered and commodified in and through commercial digital technologies (Ash 2012; Andrejevic 2011; Faucher 2014; Rogers 2014). In an era characterized by information abundance, attention emerges as a critical resource and the target of various forms of commodification and exploitation. Micro-level affective design features amplify and modulate human engagement along a variety of technical applications and media forms and formats from online newspapers attempting to maximize the number of clicks and the time spent on their website for the sake of generating revenues, to apparently cost-free entertainment products that create affective links to particular products or services and maintain user attention through constant rewards and positive feedback (Andrejevic 2011, 2013). According to Rogers (2014), research should therefore critically address the various roles played by “technologies of attention, from the iPhone to Adderall [...] in establishing a more malleable subject” (p. 3).

Faucher (2014) has connected the design features of digital applications that afford practices such as profile management, celebrity emulation, and status enhancements to capitalist values of the entrepreneurial self, competitiveness, and conspicuous consumption. According to him, at the level of technical procedures and protocols, commercial social media applications contribute to a global process that “recode[s] the social as derivative of the economic” (p. 40) and, this way, often implicitly reproduces and strengthens capitalist values and subjectivities. As such, even though for instance dull mathematical exercises can be sweetened by rewards and shared ranking systems, the underlying processes still invite for a competitive mindset and focus on maximisation of individual rather than shared benefits (Missomelius 2014). Schrape (2014) issues a similar criticism when connecting techniques of gamification – the use of game mechanics in non-game contexts – to new ways of forming docile subjectivities, while Bogost (2011) warns that the logics of gamification and affective amplification imply a reduction of complex human beings to behaviouristic machineries that can be managed through simple stimulus-response cycles.

In spite of these critical assertions, in particular non-commercial social media applications such as wiki technologies, peer-to-peer networks, and open access or open code solutions clearly point to more inclusive, common-based usages of digital technologies (Jarvis 2011; Sandoval 2015; Handley 2013). Brox (2012) and Brox and

Jakobsen (2014), for instance, have shown how cost-free web 2.0 applications can be productively integrated in educational practices at various levels, while McGonigal (2011) has pointed to a variety of productive applications of games in such areas as education, health, and work.

In line with what has been said above, digital competence should on the one hand include knowledge about, and skills in the use of, genuinely common-based and non-commercial digital applications. On the other hand, however, this competence should also include a sound understanding of the *modus operandi*, and forms of address, of commercial digital applications and games. This knowledge should enable children and young adults to critically assess and productively counter forms of implicit and explicit moulding and management of their attentive potentials, and provide them with a critical distance to apparently ephemeral and ubiquitous technologies.

Conclusion

As the examples presented in the sections above indicate, digital technologies have mixed affordances and ambiguous impacts and effects. Digital applications such as Google, Facebook, or Twitter on the one hand facilitate social mobilisation and provide new opportunities to disseminate and receive information. On the other hand, however, the same technologies enable increased commercial and state surveillance, leading to new forms of commodification and control. In a similar manner, a tacit customisation of data flows increases the perceived relevance of search results and updates, yet at the same time tacitly limits what can be known and what information can be accessed by whom. While digital technologies on the one hand appear like energy-efficient replacements of analogue counterparts that enable new forms of communal interaction and co-production, a different perspective highlights their growing ecological and societal costs and draws attention to new forms of exploitation and exclusion.

Taking materialist approaches to media- and communications research as a point of departure, the present article introduced a series of studies that directed critical attention to precisely this mixed nature of digital technologies. In highlighting challenging aspects in such fields as technological infrastructure, economic conditions, environmental impacts, information management, and affective design, I suggested that these issue areas need to be addressed in contemporary pedagogical theory and practice to facilitate the development of children and young adults into competent, reflective, and critical citizens.

Notes

1. See for instance the *Innovative Learning Environments* (ILE) project: <http://www.oecd.org/edu/ceri/innovativelearningenvironments.htm>
2. The Norwegian National Curriculum for Knowledge Promotion from 2006, for instance, includes digital competence into a set of basic competences along with writing, reading, or arithmetic.
3. The leaked documents can be accessed here: http://en.wikipedia.org/wiki/PRISM#The_Slides (accessed December 17, 2014). For an overview over the coverage of the scandal by *The Guardian* see <http://www.theguardian.com/world/the-nsa-files> (accessed January 31, 2015), and for an in-depth interview with Edward Snowden see https://archive.org/details/snowden_interview_en (accessed January, 28, 2015).
4. In spite of their critical stance, Kline, Dyer-Witthof, and de Peuter (2003) carefully avoid possible charges of technological dystopianism. They make explicit that “our argument is not that multimedia systems are intrinsically oppressive, vacuous, or malign. It is rather that their potential is being narrowed

and channelled in ways that betray their promise, even as that potential is promoted with the rhetoric of choice, interactivity, and empowerment” (p. 22).

5. These numbers do not stand unchallenged. Walsh (2013) has noted that Mills’s (2013) study “goes with the very high end” of estimates regarding the electricity demands of the ICT industry. Nevertheless, Walsh concludes that Mills’s work “still raises the alarm about the growing energy demand from cloud services”. As such, Walsh recommends, Mills’s conclusions should be taken seriously. Cartier (2013), on the other hand, has criticized Mills’s findings and connected his results to vested interests of the two “coal industry lobbying groups” that financed the study. Indeed, a certain influence by the fund-raising body on sentences such as this can hardly be denied: “Electricity fuels the infrastructure of the world’s ICT ecosystem the Internet, Big Data and the Cloud. Coal is the world’s largest single current and future source of electricity” (Mills 2013: 3). Cartier himself, however, writes for *MSN news* – Microsoft’s online news service. As such, vested interests of financing bodies taken for granted, this charge appears to go both ways.
6. For peer-to-peer-based alternatives to commercial search engines see for instance Handley (2013).

References

- Andrejevic, Mark (2014) ‘Surveillance in the Big Data Era’, pp. 55-70 in Pimple, Kenneth B. (ed.) *Emerging Pervasive Information and Communication Technologies (PICT): Ethical Challenges, Opportunities and Safeguards*. New York: Springer.
- Andrejevic, Mark (2013) *Infoglut: How Too Much Information Is Changing the Way We Think and Know*. London: Routledge.
- Andrejevic, Mark (2011) ‘The Work That Affective Economics Does’. *Cultural Studies*, 25(4-5): 604-620.
- Andrejevic, Mark (2007) *iSpy. Surveillance and Power in the Interactive Era*. Lawrence: University Press of Kansas.
- Ash, James (2012) ‘Attention, Videogames and the Retentional Economies of Affective Amplification’. *Theory, Culture & Society*, 29(6):3-26.
- Barassi, Veronica & Treré, Emiliano (2012) ‘Does Web 3.0 Come after Web 2.0? Deconstructing Theoretical Assumptions through Practice’. *New Media & Society*, 14(8): 1269-1285.
- Beck, Eevi (2011) ‘Computers in Education: What for?’. *Nordic Journal of Digital Literacy*, 6: 282-294.
- Beck, Eevi & Øgrim, Leikny (2009) ‘Bruke, forstå, forandre: Hva trenger elever å lære om IKT? [Use, Understand, Change: What Pupils Need to Learn About ICT]’, pp. 174-190 in Østerud, Svein (ed) *Enter: Veien mot en IKT-didaktikk*. Oslo: Gyldendal.
- Bogost, Ian (2011) ‘Persuasive Games: Exploitationware’. *Gamasutra* (May 3), http://www.gamasutra.com/view/feature/134735/persuasive_games_exploitationware.php
- boyd, danah & Crawford, Kate (2012) ‘Critical Questions for Big Data’. *Information, Communication & Society*, 15(5): 662-679.
- Brox, Hilde (2012) ‘The Elephant in the Room: A Place for Wikipedia in Higher Education?’. *Nordlit*, 30(2): 143-155.
- Brox, Hilde and Jakobsen, Ingrid (2014) ‘Wiki, tekster og arbeidsmåter i morgendagens engelskfag [Wikis, Texts, and Working Methods in Tomorrow’s English Education]’. *Acta Didactica Norge*, 8(2): 1-17.
- Bucher, Taina (2012) ‘Want to Be on Top? Algorithmic Power and the Threat of Invisibility on Facebook’. *New Media & Society*, 14(7): 1164-1180.
- Buckingham, David (2006) ‘Defining Digital Literacy: What Do Young People Need to Know About Digital Media?’. *Nordic Journal of Digital Literacy*, 1(4): 263-276.
- Carli, Don (2010a) ‘Going Paperless: Not as Green as You May Think’. *GreenBiz.com*, <http://www.greenbiz.com/print/34225>
- Carli, Don (2010b) *Print vs. Digital Media: False Dilemmas and Forced Choices*. New York: Institute for Sustainable Communication.
- Cartier, Curtis (2013) ‘Rumor: An iPhone Uses More Power Than a Refrigerator’. *MSN News* (August 19), <http://news.msn.com/rumors/rumor-an-iphone-uses-more-power-than-a-refrigerator>
- Cobbing, Madeleine (2008) *Toxic Tech: Not in Our Backyard. Uncovering the Hidden Flow of E-Waste*. Amsterdam: Greenpeace International.
- Erstad, Ola (2010) ‘Educating the Digital Generation: exploring Media Literacy for the 21st Century’. *Nordic Journal of Digital Literacy*, 5(1): 56-72.
- Faucher, Kane (2014) ‘Veblen 2.0: Neoliberal Games of Social Capital and the Attention Economy as Conspicuous Consumption’. *TripleC*, 12(1): 40-56.
- Ferrari, Anusca (2012) *Digital Competence in Practice: An Analysis of Frameworks*. European Commission Joint Research Centre: Institute for Prospective Technological Studies, <http://ftp.jrc.es/EURdoc/JRC68116.pdf>

- Fuchs, Christian (2015) 'Anonymous: Hacktivism and Contemporary Politics', pp. 88-106 in Trottier, Daniel and Fuchs, Christian (eds.) *Social Media, Politics, and the State*. London: Routledge.
- Fuchs, Christian (2014) *Social Media. A Critical Introduction*. London: Sage.
- Fuchs Christian (2012) 'The Political Economy of Privacy on Facebook'. *Television & New Media*, 13(2): 139-155.
- Fuchs, Christian (2010) 'Labor in Informational Capitalism and on the Internet'. *The Information Society*, 26(3): 179-196.
- Gallagher, Sean (2013) 'Your USB Cable, the Spy: Inside the NSA's Catalogue of Surveillance Magic'. *Ars Technica* (December 31), <http://arstechnica.com/information-technology/2013/12/inside-the-nsas-leaked-catalog-of-surveillance-magic/>
- Galloway, Alexander (2004) *Protocol. How Control Exists After Decentralization*. Cambridge: MIT Press.
- Galloway, Alexander & Thacker, Eugene (2007) *The Exploit. A Theory of Networks*. Minneapolis: University of Minnesota Press.
- Gellman, Barton & Soltani, Ashkan (2013) 'NSA tracking cellphone locations worldwide, Snowden documents show'. *The Washington Post* (December 4), http://www.washingtonpost.com/world/national-security/nsa-tracking-cellphone-locations-worldwide-snowden-documents-show/2013/12/04/5492873a-5cf2-11e3-bc56-c6ca94801fac_story.html
- Gellman, Barton & Soltani, Askan (2014) 'NSA surveillance program reaches 'into the past' to retrieve, replay phone calls'. *The Washington Post* (March 18), http://www.washingtonpost.com/world/national-security/nsa-surveillance-program-reaches-into-the-past-to-retrieve-replay-phone-calls/2014/03/18/226d2646-ade9-11e3-a49e-76adc9210f19_print.html
- Gombiner, Joel (2011) 'Carbon Footprinting the Internet'. *Consilience: The Journal of Sustainable Development*, 5(1): 119-124.
- Graham, Mark, Schroeder, Ralph & Taylor, Greg (2013) 'Re: Search'. *New Media & Society*, 15(8): 1366-1373.
- Handley, Tyler (2013) 'P2P searches as an Alternative to Google: Recapturing Network Value through Decentralized Search'. *Journal of Peer Production*, 3, <http://peerproduction.net/issues/issue-3-free-software-epistemics/peer-reviewed-papers/>
- Haugsbakk, Geir (2011) 'How Political Ambitions Replace Teacher Involvement: Some Critical Perspectives on the Introduction of ICT in Norwegian Schools'. *Nordic Journal of Digital Literacy*, 6(4): 239-257.
- Hayles, Katherine N. (2007) 'Hyper and Deep Attention: The Generational Divide in Cognitive Modes', *Profession* (2007): 187-199.
- Hayles, Katherine N. (2012) *How We Think. Digital Media and Contemporary Technogenesis*. Chicago: University of Chicago Press.
- Hayles, Katherine N. & Pötzsch, Holger (2014) 'Posthumanism, Technogenesis, and Digital Technologies: A Conversation with Katherine N. Hayles'. *The Fibreculture Journal*, 23: 95-107.
- Jarvis, Jeff (2011) *Public Parts. How Sharing in the Digital Age Improves the Way We Work and Live*. New York: Simon & Schuster.
- Jenkins, Henry, Ford, Sam & Green, Joshua (2013) *Spreadable Media. Creating Value and Meaning in a Networked Culture*. New York: New York UP.
- Jiang, Min (2014) 'The Business and Politics of Search Engines: A Comparative Study of Baidu and Google's Search Results of Internet Events in China'. *New Media & Society*, 16(2): 212-233.
- Johnson, Jeffrey A. (2014) 'The Ethics of Big Data in Higher Education'. *IRIE: International Review of Information Ethics*, 21: 3-10.
- Kline, Stephen, Dyer-Witthford, Nick & de Peuter, Greig (2003) *Digital Play: The Interaction of Technology, Culture, and Marketing*. Montreal: McGill-Queen's UP.
- Lager Vestberg, Nina, Raundalen, Jon & Maxwell, Richard (eds) (2014) *Media and the Ecological Crisis*. London: Routledge.
- Lund, Andreas, Furberg, Anniken, Bakken, Jonas & Lyngvåg Engelién, Kirsti (2014) 'What Does Professional Digital Competence Mean in Teacher Education?'. *Nordic Journal of Digital Literacy*, 9(4): 281-299.
- Mager, Astrid (2014) 'Defining Algorithmic Ideology: Using Ideology Critique to Scrutinize Corporate Search Engines'. *TripleC*, 12(1): 28-39.
- Maxwell, Richard & Miller, Toby (2012) *Greening the Media*. Oxford: Oxford UP.
- McChesney, Robert W. (2013) *Digital Disconnect. How Capitalism is Turning the Internet Against Democracy*. New York: The New Press.
- McGonigal, Jane (2011) *Reality is Broken: How Games Make Us Better and How They Can Change the World*. London: Jonathan Cape.
- Miller Boaz & Record, Isaac (2013) 'Justified Belief in a Digital Age: On the Epistemic Implications of Secret Internet Technologies'. *Episteme*, 10(2): 117-134.

- Mills, Mark P. (2013) *The Cloud Begins With Coal. Big Data, Big Networks, Big Infrastructure, Big Power*. Whitepaper by National Mining Association and American Coalition for Clean Coal Energy, http://www.tech-pundit.com/wp-content/uploads/2013/07/Cloud_Begins_With_Coal.pdf?c761ac
- Missomelius, Petra (2014) 'Digitale Bildungskulturen: Lernen in Zeiten der Netzwerkmedien [Digital Educational Cultures: Learning in Times of Networked Media]'. *Dichtung Digital*, 43, <http://www.dichtung-digital.de/en/journal/aktuelle-nummer/?postID=2240>
- Mitra, Aananda & Watts, Eric (2002) 'Theorizing Cyberspace. The Idea of Voice Applied to the Internet Discourse'. *New Media & Society*, 4(4): 479-498.
- Morozov Evgeny (2011) *The Net Delusion. How Not to Liberate the World*. London: Penguin Books.
- Morozov, Evgeny (2013) *To Save Everything Click Here. Technology, Solutionism and the Urge to Fix Problems That Don't Exist*. London: Allen Lane.
- Olsson, Tobias (2010) 'From the Ecology of Broadcasting to the Ecology of Participation'. *Nordicom Review*, 31 (special issue): 95-104.
- Orisakwe, Orish Ebere & Frazzoli, Chiara (2010) 'Electronic Revolution and Electronic Wasteland: The West/Waste Africa Experience'. *Journal of Natural and Environmental Sciences*, 1(1): 43-47.
- Ottestad, Geir, Kelentric, Marijana & Björk, Gréta Guðmundsdóttir (2014) 'Professional Digital Competence in Teacher Education'. *Nordic Journal of Digital Literacy*, 9(4):243-249.
- Packer, Jeremy & Crofts Wiley, Stephen B. (2012) 'Introduction: The Materiality of Communication', pp.3-16 in Packer, Jeremy & Crofts Wiley, Stephen B. (eds) *Communication Matters: Materialist Approaches to Media, Mobility, and Networks*. London: Routledge.
- Pariser, Eli (2011) *The Filter Bubble. What the Internet is Hiding from Us*. London: Penguin Books.
- Pimple, Kenneth (2014) 'Introduction: The Impacts, Benefits, and Hazards of PICT', pp. 1-12 in Pimple, Kenneth B. (ed.) *Emerging Pervasive Information and Communication Technologies (PICT): Ethical Challenges, Opportunities and Safeguards*. New York: Springer.
- Pötzsch, Holger (2015a) 'The Emergence of iWar: Changing Practices and Perceptions of Military Engagement in a Digital Era'. *New Media & Society*, 17(1):78-95.
- Pötzsch, Holger (2015b) 'The Emergence of iBorder: Bordering Bodies, Networks, and Machines'. *Environment & Planning D: Society & Space*, 33(1): 101-118.
- Rieder, Bernhard & Sire, Guillaume (2014) 'Conflicts of Interest and Incentives to Bias: A Microeconomic Critique of Google's Tangled Position on the Web'. *New Media & Society*, 16(2):195-211.
- Rogers, Kenneth (2014) *The Attention Complex. Media, Archeology, Method*. New York: Palgrave Macmillan.
- Sandoval, Marisol (2015). 'Participation (Un)Limited: Social Media and the Prospects of a Common Culture', pp. 66-76 in Miller, Toby (ed.), *The Routledge Companion to Global Popular Culture*. London: Routledge.
- Schäfer, Mirko Tobias (2011) *Bastard Culture! How User Participation Transforms Cultural Production*. Amsterdam: Amsterdam UP.
- Schrape, Niklas (2014) 'Gamification and Governmentality', pp. 21-45, in Fuchs, Matthias, Sonia Fizek, Paolo Ruffino, and Niklas Schrape (eds.) *Rethinking Gamification*. Lüneburg: Meson Press.
- Walsh, Bryan (2013) 'The Surprisingly Large Energy Footprint of the Digital Economy [Update]'. *Time: Science & Space* (August 14), <http://science.time.com/2013/08/14/power-drain-the-digital-cloud-is-using-more-energy-than-you-think/>
- Wood, Helen (2009) 'My Media Studies 0.0'. *Television & New Media*, 10(1): 169-172.
- Zajác, Rita (2013) 'WikiLeaks and the Problem of Anonymity: A Network Control Perspective'. *Media, Culture & Society*, 35(4): 489-505.