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# HUMAN/MACHINE LEARNING: BECOMING RESPONSIBLE FOR LEARNING CULTURES OF DIGITAL TECHNOLOGIES.

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## ABSTRACT

This paper centrally asks for the ways in which ubiquitous, ever new digital technologies of 'our' everyday lives transform learning at the digital human-machine interface from the perspective of feminist science and technology studies. How to account for emerging forms of interwoven human and machine learning? Suggesting the term of learning cultures in approaching this question, the paper emphasizes an understanding of learning not as a proficiency of an entity embodying either natural or artificial intelligence, but rather as a culturally situated and materially enacted process. In so doing, the paper brings together recent impulses that suggest a re-conceptualization of learning, e.g. through the notion of "machine learners" (Mackenzie 2017) or that of "posthuman learning (Hasse 2018)". Reading these insights together, I will finally suggest an account of becoming responsible for learning cultures of digital technologies through a reconsidered notion of interwoven human/machine learning.

## KEYWORDS

Learning; Digital Human-Machine Relations; Feminist STS

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# 1 INTRODUCTION

*There is no consensus on the relevance of digitisation for culture and society.*
*Gertraud Koch, 2017*

Ubiquitous, ever new digital technologies seem to become of increasing importance to‘our’ everyday lives, ranging from the apparently long-established smart phone, robot lawn mowner and vacuum cleaner to smart home assistants, all distributed by the leading technology companies of the Global North. The core technology of what can be framed as constituting “the internet of things” (Greengard, 2015) are smart miniaturized computers. The IoT then stands for a technologization of ‘our’ human existence that is characterized by the massive evolution of computing capacity that allows connecting things and persons, or connecting to others in new ways.

This paper is interested in the human-machine interfaces emerging through technologies of the IoT. Even though there might not exist a consensus on the relevance of digitization, it argues that digital interfaces are not only constitutive of new forms of how humans and ‘smart things’ relate. Rather, from these new relations also evolve new forms of learning between humans and those digital technologies of connecting. Therefore, it suggests to research digitization as a ressource for reconsidering how humans learn. By acknowledging the impact of emerging digital human-machine interfaces on ‘our’ learning processes, this paper moreover suggests to reconsider the conceptual foundations of the very notion of learning itself from the perspective of first feminist learning theory and second feminist studies of science and technology (FSTS). Background for this reconsideration is a notion of learning that understands the latter not as a purely cognitive capacity, but rather as the result of experience and as closely tight to ‘our’ being-in-the world (cf. Meyer-Drawe 2012 [2008]).

From such a phenomenological perspective, digital devices in their infrastructural dimensions also require posing the following questions: How to account for emerging forms of interwoven human and machine learning? And: How does such an account of interwoven learning challenge the notion of responsibility?

In the following sections, the paper will first present its approach to such a conceptual reconsideration of learning at the interface between humans and digital technologies to then bring insights of critical FSTS scholarship on digital learning together with (post-)phenomenological learnig theory in order to establish the notion of human/machine learning. Finally, this will serve as a point of departure to generate impulses for re-adjusting what it means to become responsible for human-machine relations of interwoven digital learning.

# 2 THE IOT: CONCEPTUAL CLARIFICATIONS

The IoT appears at the same time ubiquitous as intangible. It might figure in a device like the smart home assistant, but it also encompasses the very infrastructure that makes it possible to connect. Therefore, it seems to be important to first enhance the graspability of the phenomenon ‘IoT’. I suggest doing so by reconstructing a selected historical aspect of this complex phenomenon. This, as I will continue to argue in the following subsections, means to trace a trajectory of miniaturized computers that suppsosedly blend in to ‘our’ everyday environments. Mapping aspects of this trajectory then becomes the point of departure to make the quality of connection of digital devices more tangible and therefore also the seemingly diffuse nature of human-machine relations that the IoT implements. Through this, I will also begin to tackle the question of learning at the emerging interfaces.

Further, I argue that the proposed approach means to *situate* the IoT, that is, approaching the IoT through the feminist epistemological lens of

"situated knowledges" (Haraway 1991). This includes to situate knowledge claims, e.g. through tracing aspects of the IoT's trajectories as well as the emerging technical infrastructure and devices within the complex and interwoven power and spatiotemporal relations as constitutive frame of the IoT. Situating the IoT, I will in the following subsections reconstruct briefly 1.) the historical aspect of ubiquitous computing and 2.) the discursive-material properties of the emerging digital interface to then 3.) generate an understanding of the nature of connecting implemented by the IoT and ask how this new mode of connecting also challenges 'our' concept of learning at the digital human-technology interface.

## 2.1 THE IOT AND UBICOMP – HISTORICAL INSIGHTS

The IoT can be regarded as pertaining to longstanding imaginations of a "calm technology which receeds into the background of our lives" (Weiser 1991) – an imagination which emerged from the effort to evolve personal computers into an ubiquitous, but calm machinery of our everyday lives. Mark Weiser popularly coined the term of ubiquitous computing (ubicomp). He envisioned computational futures by asserting that "personal computing had not gone far enough" (Dourish and Bell 2011, 2). Instead, he worked on making computational technologies the fabric of 'our' political, economical and social lives. As Paul Dourish and Genevieve Bell (2011) put it, Weiser's highly influential "technomyth" was based on his anticipation of "a world suffused with information technology, in which daily life might bring some people into contact with many, interconnected devices, large and small" (3). However, and as they also underline, the technomyth of ubicomp operates on the technical and imaginative level. That means to acknowledge the ways in which imaginations not only set the limits of how 'we' think about technologies, but also how 'we' develop technology – in short, which kind of technology can be, is and will be developed.

Ubicomp as a concept might have moved into the background of computational interests, however, the very principles of it that can be framed as realizing a suffuse of our world with information technology, have moved to the fore of contemporary technology development. Butwhat exactly does that mean? The IoT as pertaining to the larger category of calm technology is fundamentally based on realizing a world in which "every 'thing' either is a computer, has one attached to it, or at least in some way is connected to the Internet" (Kinder-Kurlanda and Boos 2017, 197).

In the following subsection, I will reconstruct the importance of situating the IoT within the context of ubicomp for grappling with the quality of connection between humans and digital technologies as well as its impact on human learning.

## 2.2 MAKING THE INFRASTRUCTURE & INTERFACE OF THE IOT TANGIBLE

Prerequisite to the ability to connect digitally is the capacity not only to compute, but importantly, to constantly collect (sensory) data. The latter allows "to identify and localise objects in time and space (ibd.). However, this also means that the person, using connected, digital devices, turns into the producer of a vast amount of data, e.g. data that tracks and monitors how I move to the city, what I eat and how I sleep. These aspects have been discussed, for instance, prominently by Deborah Lupton (2016) coining the term "the quantified self". Lupton provides an important figure for the analysis of digitization with which she maps the regulative aspects of monitoring and tracking that highlight the dimensions of control over as well as optimization of subjects implemented to the constant collection of data through digital, networked devices.

With this, Lupton not only provides an account of datasized self-embodiment and the concomitant concept of the self as regulated through quantifiable data, but also points towards the problem of ownership over data.

For the porpuse of this article, I underline that the aspect of an increasing datafication of 'our' lives and bodies inherent to the IoT makes palbable the ways in which digital connectivity is not an abstract phenomenon happening in the relam of numbers. Rather, it displays that digital connectivity is a socio-cultural and, importantly, material transformation of the very grounds of 'our' living. In turn, it requires to be analyzed through a perspective of FSTS which asks for the ways in which binary oppositions are reworked or redrawn through digital connectivity as world-making phenomenon.

However, and as I would like to emphsize, the latter is not exclusive to newly evolving forms of relation between humans and digital, networked devices and the concomitant digital infrastructure. Rather, it can be argued that the entanglement of the socio-cultural and material grounds of 'our' existence is a quality inherent to computational culture at large.

Kathrine N. Hayles (2012) describes in "How we think" the impact it has on her working when the computer breaks down or the Internet is disconnected: "I feel lost, disoriented, unable to work—in fact, I feel as if my hands have been amputated" (21). Being cut off from the Internet for several days just recently, I can only confirm Hayles' description – though I felt not like my hands have been amputated, it nevertheless had a tremendous effect on my ability to work as an academic. Hayles further continues that the inability to work, especially when thinking and writing is your work, is not only a psychological effect of the computer as a networked device. Rather, she points out the following:

"[R]esearch indicates that the small habitual actions associated with web interactions—clicking the mouse, moving a cursor, etc.—may be extraordinarily effective in retraining (or more accurately, repurposing) our neural circuitry, so that the changes are not only psychological but physical as well. Learning to read has been shown to result in significant changes in brain functioning; so has learning to read differently, for example by performing Google searches" (ibd.).

I regard Hayles argument as vital for making the IoT in its effects on our lives more tangible. If the calm technology is becoming a part of our existence, we will have to understand the ways in which connecting to the IoT is not only about producing data, but is also an embodied process that involves the capacity to alter 'our' physical structures. In addition, this also implies to take into account the ways in which learning is an embodied process and that acquiring a capacity such as reading is highly dependant on the medium we learn to read with. Learning to read a book or learning to read a google search on my computer or digital gadget thus make not only a difference in 'our' capacities to read, but also in 'our' embodiments of that capacity.

Furthermore, embodiment and physical contextualization appear to be key in realizing calm technology. This can be traced back to the fact that the idea of ubicomp evolved from "the perceived failure of the personal computer to deliver meaningful value to human beings" (Dourisch and Bell 2011, 10). Notably, Weiser and his colleagues were confronted with the critique of anthropoligsts such as Lucy Suchman, who were working at XEROX in Palo Alta around the time when Weiser (1991) began with his work on the "computer for the 21st century". As Dourish and Bell point out, the influence of the work of Suchman and others "critical of the traditional conceptions of computation, interaction, and practice embedded in computer system design" (ibd.) cannot be underestimated.

In consequence, calm technology that moves into the background can be regarded as an attempt to increase the value of computers for humans. This attempt involves embedding digital technologies in the already existing infrastructures of our everyday lives and thereby also making digital technology a part of our material

daily environments – in a manner that "moved away from the desktop and [...] was distributed across a range of devices, each specialized to particular sorts of tasks" (ibd., 11).

In what follows, I will turn to the question of learning with regard to the IoT from the perspective of one selected phenomenological feminist learning theory that I will bring into conversation with selected findings in (F)STS on human-machine relations of learning. My focus in this is to avoid an either technooptimistisc or technopessimistic perspective in grappling with the nature of connectivity provided by the IoT. Rather, I suggest to shift from a binary opposition between subject and digital technology towards a co-constitutive account of connectivity and its implications for learning in a phenomenological sense.

## 3 On Human Learning with digital devices

In which ways does embedded and distributed, digital technology impact processes of human learning? To address this question, it is necessary to briefly outline my understanding of human learning. Differentiating between specific educational practices and methods of learning on the one hand as well as on the other the question of how to understand the very nature of learning, I follow Meyer-Drawes (2012 [2008]) work on conceiving of the latter in terms of the capacity of being-in-the-world where learning is experience. This means to draw on a phenomenological account of learning that, in short, centrally focuses on (embodied) experience and thereby brings the sensual over the cognitive aspects of learning to the fore. A phenomenological account of learning understands the latter as my involvedness in the world and happens when I am confronted with the new that challenges me to act (differently). This, furthermore is thought of as a specific human capacity (cf. ibd.).

The focus of this paper is to understand the meaning of digital technologies of the IoT as co-constitutive for human learning conceived of as experience in such a phenomenological manner. Hayles (2012) understands the digital interface as constitutive of new forms of experience, when she writes:

"The more one works with digital technologies, the more one comes to appreciate the capacity of networked and programmable machines to carry out sophisticated cognitive tasks, and the more the keyboard comes to seem an extension of one's thoughts rather than an external device on which one types. Embodiment then takes the form of extended cognition, in which human agency and thought are enmeshed within larger networks that extend beyond the desktop computer into the environment" (23).

With Hayles, I consider distributed and embedded digital technologies to be constitutive of relations between humans and those technologies that are characterized by an embodied extended cognition. Especially the idea of the human becoming physically enmeshed within larger networks of distributed cognition appears promising for developping a notion of learning specific to the process of experiencing the IoT.[1]

In addition, Hayles makes palbale the ways in which digital connectivity means to become part of the embedded and embodied digital infrastructure – a status that challenges the division between human and technological entity, internal and external as well as human and technological (cognitive) capacities. This then, can be regarded as the point of departure to ask for the ways in which human learning as experience and machine learning as computational capacity also become enmeshed in new ways through, e.g., the IoT (1) and how 'we' could conceptualize the emerging forms of enmeshment.

1 There exists a large corpus on embodied cognition from varying disciplinary backgrounds with equally varying foci, discussing, e.g., how cognitive capacities are always interrelated to the physical and social world as well as how we have to understand them as öprocessual capacities. I have discussed aspects of this corpus with regard to digitl technologies elsewhere, see Treusch 2018 a, b and for an overview: Fingerhut et al. 2013

In what follows, I will present two recent approaches towards the interwovenness, but also differences between human and machine learning.

## 3.1 MACHINE LEARNERS

Adrian Mackenzie (2017) explores machine learning as a capacity of our contemporary digital devices that moves beyond 'pure programmability' of the machine. This means that 'our' devices start to learn – whereas learning here means a statistical process based on constantly collecting sensory data which is then quantified through classification. However, Mackenzie also contests an understanding of machine learning as purely based on statistical models of learning that can be reduced to amounting to a positivist, capitalist knowledge economy. Rather, he understands machine learning as a knowledge practice which assembles "accumulation of forms, techniques, practices, propositions, and referential relations" (30). With this, he expands the critical analytical toolkit for researching machine learning as the basical principle behind digitsation and quantification emerging from the digital connectivity of the IoT.

Nevertheless, he acknowledges that "machine learning is a convoluted but nevertheless concrete and historically specific form of calculation" (7) that constitutes a "form of knowledge production and a strategy of power" (9). In this way, knowledge production through machine learning can be understood as an execution of power in a Foucaudian sense (cf. ibid.). At the same time, Mackenzie also moves beyond a critical account of the (powerful) workings of machine learning "without preemptively ascribing potency to mathematics or algorithms" (ibd.).

Furthermore, he develops an account of data practice or the process of practicing data for researching machine learning. It allows to map the archeology of machine learning in terms of a foundational transformation of (human) knowledge production or in Mackenzie's words that of "'brainwork'" (13). This means to map the conditions and practices through which data practice becomes 'our' truth: "data practice […] reconfigures local centers of power and knowledge by redrawing human-machine relations" (9).

Mackenzie is specifically interested in machine learning's potential to challenge and change already established forms of data practice. This potential arises from the processes of reconfiguration implied to practicing data as the latter is exceeding "the coming together of algorithm, calculation, and technique" as a "coherent or complete" (17) process. The reconfigurative nature of data practice insists on the possibility to "articulate their diversity, loose couplings, and mutability" (ibid.). In short, Mackenzie argues for a close reading of data practice as a pre-requisite for enhancing the possibilities of non-hegemonic standardizations. This "would function as a mode of experimentation on operations" (209).

## 3.2 ON POSTHUMAN LEARNING

Cathrine Hasse (2018) differentiates between human, posthuman, and machine learning. With this, she basically problematizes 'the human' as a powerful modern figure: "the human is not a stand-alone individual engaging with a world of discrete objects, as has been the belief since the enlightenment, but a posthuman 'coming-into-being' with socio-cultural materiality" (1-2).

In this regard, she dismantles the idea of autonomy and agency as capacities of the 'human' subject in order to expand the human and human learning with an account of his or her constitutive embeddedness in a physical, socio-cultural environment. As Hasse emphasizes, "machine learning in AI builds on an outdated paradigm of the detached, rational human" (ibid.). In consequence, Hasse offers an account of learning as "becoming skillful in an evolving process of collective socio-cultural material epistemology" (ibid.).

The detached rational human is a figure of a computational culture that can be framed under the term of cognitivism. Through this vein, human cognitive capacities are described, e.g. as based on following fixed rules, or following a serial step-by-step path. Such conceptualizations have been analyzed as being Cartesian in nature, and thus, centrally perpetuating the mind/body split (e.g. Wheeler 2005). Though since the early 1990s new strands of an embodied and embedded AI (e.g. Brooks 1991) have been emerging, cognitive theories that are rooted in a Carteisan thinking appear to remain one of the bastions of AI (cg. Wheeler 2005). Against this backdrop, Hasse brings diverging strands of contemporary thinking that insists on the material nature of every aspect of 'our' existence. Based on that, she points out that "knowing is not reducible to a mental process; knowing is rather a physical practice of engagement" (4). Furthermore, she also emphasizes that this physical practice of engagement is a collective practice that "entangles humans and non-humans" (8). The term posthuman then marks the physical embeddedness and the entanglement of humans and non-humans – both as foundational for re-conceptualizing learning.

"Experience is thus not just subjective in an individualist way, but to some extent collectively shared through our socio-cultural learning processes that merge words, meanings and materials in ways that make social communication possible" (6). With this, Hasse proposes an account of posthuman learning as collective, socio-cultural experience that strongly differs from machine learning. She understands the latter as the context-free practice of, in short, manipulating numbers.

# 4 Reading Insights together: Impulses for becoming responsible for the IoT

In this paper, I situated the IoT by reconstructing briefly selected aspects of the historical lineage between ubicomp and the IoT. With this, I propose to make the the IoT graspable and work against the tendency that this ubiquitous phenomenon becomes intangible.

As a result, I argue that the IoT as embedded and distributed calm technology cannot be reduced to a purely abstract, number crunching means of collecting data through connecting things and persons. Rather, it can be situated within a critique on the computational culture from which the personal computer emerged. In addition, the impact on 'our' being-in-the-world are, with Hayles, of psychological as well as physiological nature. In short, calm technology conditions 'human experience', that is, learning.

How to grapple with learning at the age of the IoT? MachKenzie and Hasse both expand 'our' analytical framework for engaging with and conzeptualizing the transformations of learning. With Mackenzie, I furthermore suggest understanding the use of calm technology for controling and monitoring every aspect of human existence as not inherent to the idea and realization of distributed, but connected minituarized computers. Rather, the convergence of the IoT and (self-)quantification can be considered to be a historically specific configuration of human-machine relations – while reconfigurations are possible. With Hasse, I take learning as collective, sociomateiral, that is, posthuman experience as the point of departure for such reconfigurations.

Finally, I suggest an account of becoming responsible for digital connectivity at the age of the IoT that assesses at the possibility of, but maybe also the need for reconfigurations of the relation between human and technology. This

means to reconsider the relation between machine and posthuman learning – as interwoven forms of human/machine learning – while taking into account the power workings as much as the potential of data practice for either limiting or expanding 'our' posthuman capacity to experience.

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