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Learning, digital technologies, and sociomaterial approaches: A critical reflection from the perspective of materialist dialectics

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Abstract

In this article, I attempt to critically reflect on sociomaterial approaches to learning, especially as it is conducted with digital technologies. By pursuing detailed ethnographic case studies, these approaches argue for the active character of digital technologies in the constitution of learning. More specifically, digital technologies are treated in this paradigm as co-participants—along with humans—in the formation of learning practices. Despite their invaluable empirical insights, I suggest that these approaches do not adequately emphasize the transformative potential of learners and do not conceptualize learning from the perspective of human development. In addition, I propose that, apart from empirically based research, which is the preferred mode of research of sociomaterial approaches, there is also a need for categorical thinking to conceptualize the mediation of learning by digital technologies. In my critical reflection, I draw on scholars working in the traditions of cultural-historical theory and activity theory, and on materialist dialectics more generally.

Keywords

dialectics, digital technologies, human transformative activity, learning, sociomaterial

Technoscience constitutes an integral dimension of the contemporary world, being ubiquitous in all settings and aspects of everyday life (Michael, 2006). Learning and education are no exception and, in the last decades, digital technologies have become part of education. These technologies are now considered important learning tools for both

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students and teachers, given that reading on a computer is a very common way of learning. Besides reading, the educational process as a whole has been affected significantly by new technologies. Indeed, almost all current lectures and teaching are conducted with the aid of digital technologies (e.g., computers, projectors, and PowerPoint), which, due to their reactive, symbolic, and internally complex character, sometimes appear to be intentional social objects, with which we can interact and communicate (Suchman, 2007, pp. 38–42). In addition, many course materials, especially at universities, are organized and accessed on specific Internet platforms. These platforms seem to operate like small communities, where students and teachers can interact and exchange ideas and questions. More and more university programs are also offered online, and students can participate in these programs remotely, without being physically present at lectures.

These are some of the consequences of the rapid and ever-increasing technoscientific innovations that have been introduced in education in the past few decades. These developments have radically changed the relationships between students and teachers, and created new potentials for learning, teaching, and participation in the educational process. Therefore, many social scientists have extensively researched the impact of digital technologies on learning, teaching, and education, placing particular emphasis on how learning can be *enhanced* through these technologies (Derry, 2008). For example, the vast majority of scholars, influenced by the constructivist framework, have attempted to explore how digital technologies provide opportunities for more flexible, cooperative, and problem-based learning (see Resta & Laferrière, 2007).

In this article, I provide a critical overview of one recent and very influential perspective on learning with digital technologies—namely, sociomaterial approaches. To this end, I review their theoretical assumptions and some relevant empirical investigations. Based on the perspective of Marxist materialist dialectics, I argue that the symmetrical ontology of sociomaterial approaches underestimates human transformative activity and human development, which are important dimensions of the mediation of learning by digital technologies. I conclude the article by emphasizing the need for more dialogue among the approaches discussed.

Sociomaterial approaches: A definition

Sociomaterial approaches constitute a loose collection of ideas that have been inspired by various traditions of thought, such as post-structuralist philosophy, science and technology studies, actor–network theory, posthumanism, new feminist materialisms, and complexity theory (Fenwick, 2015; Sørensen, 2009, pp. 8–19). Even though sociomaterial approaches do not form a homogeneous paradigm, they do share some common premises. The central shared premise of these approaches, as several scholars have pointed out (e.g., Decuyper & Simons, 2016a; Fenwick, 2015; Landri, 2018, p. 19), is that the social and material dimensions of life are always entangled in everyday practices. This means that neither the *social* nor the *material* has a preexisting essence, but they are emerging and performed within heterogeneous networks of relations (or *assemblages*).¹ From this perspective, all “phenomena are ontologically primitive relations—relations without preexisting *relata*” (Barad, 2003, p. 815). Individual things and entities (i.e., *relata*) are understood to be the effect of such relations; they are the product of what

Barad (2003) terms *intra-actions*. Therefore, these approaches propose that it is not possible to impose any a priori ontological distinction or boundary between phenomena and entities.² What humans and nonhumans are, what counts as social and as material, can only be decided after we engage in the empirical effort of tracing their entanglement in specific, constantly emerging practices (see Latour, 1994, p. 35; Sørensen, 2013, p. 118).

This worldview entails a relational and dynamic understanding of materiality (Law & Mol, 1995), where materials and technologies are treated as processes of coevolution along with myriad other natural, material, technical, and social entities. All technologies, including digital ones, are considered to be deeply involved in the constitution of societies, and these perspectives often use the term *sociotechnical* to stress the inextricable relation between society and technology (Derksen et al., 2012, p. 142). Therefore, any claims of technologies as linear, stand-alone sources of change and necessity are vehemently rejected, while choice and contingency are emphasized (Winner, 1993, p. 367). Notwithstanding the emphasis on choice and contingency, in this view, material things and tools are not subordinated to human intentions, plans, and affects, as instrumental means to human ends. Instead, they are regarded as active participants in sociomaterial practices, with the latter being reconceptualized as more-than-human practices. In this respect, Sørensen (2009) has stated that “[i]nstead of beginning with the question of whether technology does what humans want it to do, we should ask how materials participate in practice and what is thereby performed” (p. 28).

For these reasons, the proponents of sociomaterial ideas encourage researchers to study sociality and materiality symmetrically, by using the same analytical terms and vocabulary. As Orlikowski (2007) has put it, these approaches are characterized by an “insistence on speaking of the social and the material in the same register” (p. 1437). At the same time, sociomaterial researchers are careful to point out that such an analytical sensitivity does not imply that humans and nonhumans are the same; they just have to be treated as equal co-participants in everyday practices (Decuyper & Simons, 2016a, p. 33; Waltz, 2006, p. 58), “as comrades, colleagues, partners, accomplices or associates in the weaving of social life” (Latour, 1996, p. 235).

Thus, sociomaterial approaches try to avoid both essentialist and instrumentalist explanations of the relationship between the social and the material, between humans and nonhumans (Hamilton & Friesen, 2013). According to Aagaard (2017), both technological determinism and instrumentalism, albeit mutually exclusive frameworks, have managed to coexist in “an uneasy armistice” in the field of educational technology (pp. 1128). Instead, sociomaterial scholars are committed to treating the relationship between humans and technologies as one of mutual constitution and coevolution. The relationship between humans and technologies, in turn, does not take place in a vacuum, but in the midst of numerous other social and material forces that enact and are enacted by the messy, heterogeneous practices of everyday life (Højgaard & Søndergaard, 2011).

The rise of sociomaterial approaches in learning studies

Sociomaterial frameworks have developed within many different disciplinary fields—most notably, sociology (e.g., Latour, 2005), anthropology (e.g., Hutchins, 1995), and philosophy (e.g., Mol, 2002). Within these fields, the dynamics of science and technology, as well as of work and organizational practices, have traditionally formed their main

interests. Over the last two decades, several learning sciences scholars have increasingly adopted an interest in these approaches (Fenwick & Landri, 2012, p. 1). This interest, which has culminated during the past decade, has not emerged incidentally. In particular, it has been preceded by—and is connected to—a broader turn toward situated, sociocultural approaches in learning studies (Kontopodis & Perret-Clermont, 2016). Sociocultural approaches, like sociomaterial approaches, do not provide a coherent framework but rather an umbrella term for theories that focus on the internal connection of learning with the sociocultural and material world. These approaches have been notable for critiquing cognitivist perspectives for their one-sided preoccupation with the internal properties of the mind and their understanding of learning as a passive transfer of knowledge from an experienced possessor to an inexperienced individual. From a sociocultural perspective, “learning is an integral and inseparable aspect of social practice” (Lave & Wenger, 1991, p. 31), whereby individuals strive to participate more fully in social practice (pp. 36–37), and develop their identities according to their roles and positions in that practice (p. 53).

While agreeing with sociocultural approaches—that the mind, learning, and knowledge are always situated, embodied, and distributed—sociomaterial scholars provide, however, an alternative framework for studying learning. First, they do not limit the notion of participation to human beings, as in sociocultural approaches, but they use it to include material objects as well (Sørensen, 2007, p. 16; 2009, p. 18). In this respect, they have criticized sociocultural approaches for often accepting a conceptualization of objects as passive means to human ends, as mere intermediaries of human intentions that lie in the background and “do not act other than in the hands of humans” (Fox, 2002, p. 83). As noted above, sociomaterial researchers argue that we have to understand objects as equal participants in practices, as mediators that “perform relations and thus contribute to the outcome of situations” (Schlauch, 2020, p. 160).³ In this view, objects are not only embedded in the workings and history of “communities of practice” (Lave & Wenger, 1991), but are also “social actors” (Waltz, 2006, pp. 52–53) that actively constitute sociomaterial practices.

Furthermore, the very definition of learning is cast differently through a sociomaterial lens. Even though learning is still treated as always situated in practices, what is meant by the terms *situated* and *practices* differs here, and this difference has significant implications for the conceptualization of learning. More specifically, inspired by the “multiple spatial topologies” framework developed by Annemarie Mol and John Law (1994), sociomaterial scholars argue that practices are situated in multiple ways, depending on the specific spatial patterns of relations that the assembled elements configure. The various spatial patterns of relations, in turn, perform different forms of knowledge and learning, as well as different methods and criteria for the validation of knowledge and learning (Sørensen, 2009, p. 134). Therefore, the objects of knowledge and learning (e.g., a mathematical concept, a historical event) are not conceived as existing separately from the patterns of relations they are embedded in, but are understood to “become distinct and purified in practice” (Fenwick & Edwards, 2010, p. 36). As Fenwick and Edwards (2010) have pointed out,

an object of knowledge—whether it is a mathematical concept to be taught to sixth graders, a new evidence-based medical protocol to be implemented through continuing education, or an academic monograph—is held together by a network of connections that must be continually performed to make the knowledge visible and alive. (p. 24)

Rather than referring to well-bounded social practices within which learning is situated, then, sociomaterial scholars argue that there are multiple patterns of situatedness, along with accompanying learning processes. Hence, they emphasize that it is important to understand knowledge and learning in a performative way: based on the spatial patterns of relations within which they arise, knowledge and learning can perform as either individual/abstract/representational or social/situated/nonrepresentational (for a detailed discussion and definition of the various forms of knowledge and learning, see Sørensen, 2009, pp. 130–136). However, because these multiple patterns “co-exist rather than replac[e] one another” (Sørensen, 2009, p. 69), it is possible for knowledge to be *transferred* and generalized, or, as sociomaterial scholars put it, *translated* across them (Schlauch, 2020, pp. 161–165; Sørensen, 2009, p. 181).

Finally, the subject of learning is redefined in these perspectives, given that “[t]he learner here is neither an individual nor a community of practice necessarily, but could be any component part of the network and/or the network as a whole” (Fox, 2002, p. 85). From this point of view, humans are not the only ones who learn: nonhumans, as well as whole networks, can be viewed as learners—namely, as performing learning, which essentially “is an aspect of the process through which new networks are knitted together” (Fox, 2002, p. 88).

Inevitably, these ontological and epistemological assumptions have important methodological implications for the study of learning with (digital) technologies. Adhering to the principle that “technologies have different impacts in different contexts” (Verbeek, 2000/2005, p. 5), and based on empirical, pragmatic, and constructivist perspectives of science and technology, sociomaterial approaches emphasize the significance of studying concrete artifacts within concrete practices (Michael, 2006, pp. 4–5). Indeed, scholars who embrace these approaches investigate technologies and learning in practice, at the micro level, by pursuing detailed ethnographic studies of various educational contexts. Johri (2011) considers precisely this focus on practice as the power of sociomaterial approaches (p. 209). However, it should be mentioned that, in contrast to traditional educational ethnographies, this strand of ethnographies does not approach material objects and technologies as “semiotic carriers of meaning,” but as actors that have profound effects on all educational processes (Roehl, 2012, p. 112). Furthermore, despite the fact that research attention is centered on the micro level, the analytical potential of sociomaterial approaches extends beyond the local level because these approaches attempt to show empirically how the force of local actors is shaped by actors that are distant in place and time (Hannon, 2009, p. 18)—local networks are deemed as always being in a process of negotiation with distant networks.

Digital technologies and learning: Sociomaterial critiques

Before examining how this framework has been applied in the empirical practice of learning with digital technologies, it is important to provide an overview of some sociomaterial critiques of prevalent concepts in the educational technology literature. This is necessary in order to gain an understanding of some of the theoretical discussions that have been advanced from this perspective in the field of learning with digital technologies. Beginning with the term *affordance*, which is usually employed in educational technology research to denote that technologies carry with them specific learning possibilities

(e.g., more collaboration, easier access to information), Oliver (2011) has argued that “[a]ffordance neatly illustrates the concept of technological determinism” (p. 374). According to Oliver, the term affordance is inscribed in a causal understanding of technology, depicting the latter as a force with very specific effects. Thus, in his view, the term encourages a focus on some abstracted and decontextualized properties of technology, without doing justice to the social practices within which technology is always embedded (p. 375; see also Hembre & Warth, 2020). Similarly, Wright and Parchoma (2011) have critiqued the term for “its positivistic origin, unclear usage and logical inconsistencies” (p. 249), and have argued that the concept promotes a simplistic conceptualization of digital technologies as devices whose only role is to support the enactment of constructivist pedagogies (p. 250).

Along these lines, Bayne (2015) has criticized the discourse in the UK around the term *technology-enhanced learning*. According to Bayne, the rhetoric of technology-enhanced learning serves to “black-box” the multiplicity of technology and its intrinsic entanglement with society, presenting technology as only being “in service” to learning and teaching (p. 9).⁴ Furthermore, this rhetoric prevents any critical engagement with current educational practices because these are treated as only amenable to further improvement by the correct use of digital technologies (p. 10). Bayne has argued that such conceptualizations provide an oversimplified, conservative, and reductive picture of technology, and she has urged researchers to be more careful when engaging with concepts to describe their field.

With regard to another popular concept in the literature of educational technologies, that of *networked learning*, Fox (2002, 2005) has suggested that many researchers in the field have understood it very narrowly. In particular, Fox has mentioned that many scholars have used this term to simply foreground the affordances of the Internet as a new technological medium for more participatory and interactive learning. For Fox (2005), networked learning “is a part of wider techno-social networks building contemporary ideas of community” (pp. 101–102), and the Internet should be conceived as a sociomaterial network that cultivates a new communal space in comparison to that created by print media. This new communal space entails new ways of informal and formal learning, as well as new identities, imaginations, and political contestations, which all should become the subject of rigorous study.

In addition, the term *mobile learning* has been subjected to scrutiny by sociomaterial approaches. Most often, Enriquez (2011) has noted, scholars conceptualize mobile learning as learning that is being “enhanced” by mobile technologies, and attempt to study it in strictly designed and defined contexts (pp. 40–41). Moreover, they pay attention only to human-to-human interactions without attending to nonhuman actors. Enriquez has argued that mobile learning could be understood as learning by “being mobile,” in both a literal and metaphorical sense, which emphasizes “the corporeal travel and sedentary practices of users’ lived bodies” (p. 41). In her view, mobility, spatiality, and embodiment are neglected and crucial aspects of mobile learning research, which should be conducted in nondesigned contexts, and explore both human and nonhuman entities as they circulate in sociomaterial networks.

Finally, Gourlay (2021) has recently made a critique of the term *virtual learning*. Gourlay suggests that this term provides an immaterial and disembodied picture

of learning with digital technologies, which are assumed to be nonphysical and totally distinct from analog technologies. As a result of the dominance of the term, the focus remains one-sidedly on what happens on-screen (p. 60). Contrary to this, Gourlay submits that learning, however mediated by digital technologies, is always sociomaterially and bodily grounded. Gourlay also notes that this term is problematic because it promotes a neoliberal and humanist agenda, whereby the capacities of human beings “are imagined to be extended or even transcended via digital technologies” (p. 60).

This research is indicative of an emergent trend in sociomaterial studies of learning with digital technologies, which attempts to deconstruct dominant assumptions and principles in the field. However, the main focus of sociomaterial approaches is on building alternative insights on the subject and, foremost, on providing different ways of intervening in pedagogical practices (Fenwick & Edwards, 2010, pp. 1–23). For this reason, it is now crucial to explore their empirical endeavors.

What digital technologies do in the learning process: Empirical investigations

The vast majority of sociomaterial studies of learning with digital technologies have focused on formal educational contexts. In these contexts, the role and contribution of various technologies have been analyzed. For example, recent studies that have been conducted from this perspective have explored the workings of personal laptops and portable tablets (Aagaard, 2017; Alirezabeigi et al., 2020; Hembre & Warth, 2020), the screen (Decuyper & Simons, 2016b), online learning platforms and the Internet (Bolldén, 2016; Pischetola et al., 2021; Sørensen, 2009), computer software (Knox, 2014), a lecture capture system (Luke, 2022), the practice of videoconferencing (Meyer, 2015), and so forth. The goal of such studies has not been to advance causal explanations of the relationship between learning and digital technologies, but to develop empirically detailed insights regarding the intermingling of humans and technologies in the learning process, and the enactments of this intermingling.

A central question that has been addressed by these studies is *how* and *what* learning practices and experiences come into existence through the interplay between humans and digital technologies. As an example, Pischetola et al. (2021) reported a case study of a 3-hour online class in a Brazilian university at the beginning of the COVID-19 pandemic. Their main argument was that the pandemic, by bringing to the fore a new assemblage between humans and digital technologies (i.e., online classes), made salient the active character of digital technologies in the learning process. For instance, the impersonal design of the online platform of the course, along with frequent Internet problems, significantly affected the learning experience of students, who often felt physically and mentally distressed. It is also interesting that “the usual flow of teacher–learner dialogue was deeply compromised in these situations” (p. 398), while pervasive social inequalities already existent in the Brazilian context were amplified because underprivileged students with unstable Internet connections were not able to engage in the class as actively as their more privileged peers. In this study, in sum, digital technologies were not treated as neutral tools for conducting the classes, but as active constituents of the learning process.

Likewise, Alirezabeigi et al. (2020), during a 5-month ethnographic study in a “Bring Your Own Device” school in Belgium, focused on the invisible doings of digital devices. By adopting a methodology that was sensitive to the disruptions and anomalies (i.e., breakdowns) in the infrastructural basis and use of digital devices in the school, they developed some relevant insights. First, they showed empirically that digital devices instigate patterned embodied actions on the part of students because these devices carry with them material that “keeps the gaze captured” (p. 197)—namely, material of personal importance to students. Such embodied actions include constantly holding a phone “or keeping the laptop’s screen light on” (p. 198), and drastically interfere with the learning process by causing distraction and restlessness. Second, they argued that digital devices are prone to adopt multiple functions in educational contexts according to the *scripts* they are subscribed to—that is, according to the contexts and purposes of use (see also Akrich, 1992). In fact, they noticed that many of these functions are in contrast to learning purposes (e.g., promoting navigation on news websites during class; Alirezabeigi et al., 2020, p. 199).

In general, the *multiplicity* of the performance of digital technologies has been of great concern for these approaches: How do different configurations between humans and nonhumans enact various performances of the same digital technologies? Meyer (2015), for instance, examined the practice of videoconferencing among three rural schools in Denmark in different configurations, such as peer-to-peer discussions, lectures, and the sharing of student-produced videos during synchronous meetings. Meyer observed that the specific enactments of videoconferencing were heavily dependent on organizational and educational matters. For example, even though the peer-to-peer videoconferences took place in the students’ regular classrooms and via students’ tablets—occasions that are generally fruitful for the creation of engaging and intimate learning experiences—the learning experiences that were enacted were as disengaged as those of videoconferences in large technologically equipped classrooms. According to Meyer, this happened because the educational plan designed for peer-to-peer discussions through tablets was not satisfactory and the collaboration between the schools involved in the videoconferencing was not robust.

In addition, and closely related to the interest in the multiple performances of digital technologies, sociomaterial research in education has significantly focused on the *ambivalent* character of digital technologies. For example, Aagaard (2017) pursued ethnographic analysis at a “Bring Your Own Device” school in Denmark and remarked that digital technologies operate as “gateways” to the world that have radically extended the spatial boundaries of the classroom. This extension of classroom boundaries affords immediate access to vast amounts of global, multimodal information in the classroom, but simultaneously entails new modes of distraction, given that it encourages off-task activities. Therefore, on the one hand, the introduction of digital technologies in education “allows students to ‘check up’ on the teacher and challenges the traditional educational power structure in which the teacher is the sole gatekeeper of knowledge in the classroom” (p. 1135); on the other hand, it “enacts an antagonistic student–teacher relationship in which the teacher becomes a watchful eye from whom students must conceal their activities” (p. 1139). Pischetola et al. (2021) have made similar observations regarding the contradictory performances of digital technologies. Specifically, they reported

that online classes, despite the fact that they allowed the participant students to continue with their course in the midst of the COVID-19 pandemic, also caused stress, high expectations, and a sense of surveillance, among other things (p. 398).

It is obvious that sociomaterial scholars have not looked for the abstract affordances of digital technologies, but have attempted to dig into their specific enactments in educational contexts. This attempt has been accompanied by an emphasis on the concrete materiality of digital technologies and how this materiality performs, along with other human and nonhuman participants, in learning practices. An exemplar of such an attitude can be found in Luke's (2022) study, which focused on the materiality of a lecture capture system and of its play-pause button. Luke considered these devices as "immutable mobiles," able to assemble both multiple nonhuman "actants" (software, video codecs, icons, text, audio, etc.) and diverse study practices (e.g., interacting with the capture system, navigating the Internet, note-taking) across various spatio-temporal dimensions.⁵ According to Luke, these specific spatio-temporal configurations would not have been possible without the concrete materiality of the capture system and of its play-pause button (p. 1022). However, the study revealed that the materiality and the workings of the lecture capture system were, in turn, embedded in the wider dynamics of the university: recorded video lectures did not afford more independent learning because the study practices related to it were significantly affected by the dictates of the curriculum and the university's examinations (p. 1016).

This emphasis on the concrete materiality of digital technologies has led some sociomaterial scholars of learning to conduct comparative analyses of the participation of various technologies, both digital and analog, in educational contexts. Sørensen (2009), in the most advanced ethnographic treatise on this question to date, compared the workings of a Danish fourth-grade class in the classroom and in a computer lab. In both cases, Sørensen observed how different technologies (like the blackboard or the 1-meter ruler in the classroom, and an educational 3D virtual environment in the computer lab) participated in learning processes. By embracing a spatial approach, Sørensen argued that the 3D virtual environment contributed to the formation of a fluid space of relations, with no distinct boundaries and with changing relationships among the constituent components, whereas the analog technologies of classroom practices participated in the formation of a regional space, which performed clear-cut boundaries between humans and materials. In the first case, the knowledge that was performed was characterized by Sørensen as liquid, which "created or invented something; it did not refer" (p. 126), and which was "part of the flow of the ongoing mutation" (p. 129). In the second case, the knowledge, according to Sørensen, was performed as representational, as being "in the head" of the students and "as referring to something somewhere else" (p. 98).

Overall, such sociomaterial studies have provided invaluable empirical insights regarding the active character of digital technologies in education, and created opportunities to pose new questions about the topic. Perhaps their most important contribution consists in their emphasis that technologies do follow trajectories that are to some extent independent from human intentions, while they can also resist or effect these intentions; objects are not only means to human ends (see also Schraube, 2009). At the same time, there seem to be some opportunities left unexamined in these approaches, which are related with that very contribution—namely, with the absolutization of the independence of technologies from

human intentions and activities. In fact, this absolutization appears to be in contrast with the main tenet of sociomaterial approaches—that is, the co-constitution of the *social* and the *material*.

Missed opportunities

From the above, it becomes evident that sociomaterial approaches deal with learning and related processes—like memory, attention, creativity, and so forth—as effects of heterogeneous assemblages. Because learning is conceived as an effect of the contingent and eclectic combination among heterogeneous human and nonhuman forces, any in-depth, systematic conceptualization of the relationship between learning and the history and structure of human activity is deliberately avoided. This methodological stance is based on sociomaterial approaches' flat, symmetrical ontology, which regards human activity and object action as equal forces in the constitution of the assemblage and of its various effects.

From my perspective, such a commitment underestimates the significance of human transformative activity for learning and subjectivity. As a result of this, it also loses sight of the internal relationship between human development and learning. These questions, as I will attempt to argue, have important implications for the conceptualization of learning in its mediation by digital technologies. My take on these questions is based on the approach of materialist dialectics, which emphasizes that psychological processes, including learning, have their historical origin in labor—that is, productive activities. In this approach, human labor, as a historically constituted and inherently societal process, is the driving force of human development and the transformation of the material world (for a detailed analysis, see Stetsenko, 2016). In psychology, this approach has developed more thoroughly in the traditions of cultural-historical theory and activity theory, and it is on representatives of those traditions that I draw here.

According to these traditions (especially activity theory), both subjects and objects are emerging in productive activities and their various historically developed manifestations, such as learning, play, and so forth (Leont'ev, 1975/1978). As such, the agency of objects is understood to be always embedded and to take its form in these activities. In this regard, Kaptelinin and Nardi (2006) have pointed out that “[m]aterial things are not inherently, essentially resistant (or empowering, or any other quality) . . . The particular properties of interest come to light in the whole context of an activity—which is oriented by a human-defined object” (pp. 240–241). This argument is based on the assumption that human activity is always object-oriented and goal-directed, given that its origins lie in the fulfillment of biological (and, later in human history, social) needs, which can be satisfied only through the use and creation of objects. In this approach, the boundaries between the subject and the object—and between nature and culture—are not blurred but develop historically in transformative, tool-mediated activities (Miettinen, 1999, pp. 176–178). Viewing these boundaries through a historical lens entails that material objects are conceived of not only as material, but also as cultural-historical objects, which are transformed throughout human history and embody/crystallize, as well as generalize, specific societal forms of activity (see the classic analysis of Ilyenkov, 1975/2012; see also Arievidtch, 2007, p. 53; Engeström, 1996, p. 263).⁶

Having been produced in a long historical process, and accompanying the phylogenesis and transformation of our species, these cultural-historical objects constitute our “inorganic body” (Marx, 1932/1988): the initiation into and internalization of these cultural-historical objects essentially provides the entry point for each individual to develop as a human being. The mediational and transformative potential of cultural-historical tools is traced precisely at this point (Kaptelinin & Nardi, 2006, p. 248). Of course, objects and tools not only bear an emancipatory potential; they also incarnate the contradictions of the specific mode of production. For example, in capitalist societies, they are imbued with the form of commodities, encompassing the numerous and dramatic contradictions of capitalism by being “contradictory unities of use value and exchange value” (Engeström, 1996, p. 263). Therefore, as Levant (2017) pointed out in his critical analysis of symmetrical ontology, without emphasizing sufficiently the importance of human, societal practices for the animation of the material world, we run the risk of fetishizing the “power” of material objects—that is, naturalizing the cultural-historical qualities of material objects (p. 258; see also Jovanović, 2021, p. 249).⁷

The underestimation of human, societal practices in the symmetrical ontology of sociomaterial approaches also leads to difficulties concerning the understanding of the developmental process, on both the phylogenetic and the ontogenetic levels. As Schraube (2009) has eloquently remarked in relation to actor–network theory, “[t]he systematic linguistic blurring of the dividing line between the actions of people and things also blurs the *origins* [emphasis added] of production processes in *human praxis* [emphasis added]” (p. 305). Similarly, Jovanović (2021) has recently stressed that a flat ontology “cannot explain developmental processes which necessarily imply structural differentiation between higher and lower stages, expressed also in differences between non-living matter and living matter and then differentiation among species of living matter” (p. 256). If we accept that development is at the core of learning processes, as cultural-historical theory and activity theory have demonstrated, then these difficulties in studying the dynamics of the developmental process can have significant implications for our investigation of learning with digital technologies.

Perhaps such misgivings about systematically theorizing the developmental process arise from the opposition of sociomaterial approaches “to the proposition that culture, history, learning or development can be understood in terms of one single order” (Kontopodis & Kumpulainen, 2020, p. 18), and their emphasis on the contingency and unpredictability of empirical, everyday practices. For example, in the field of educational technologies, Sørensen (2009) has criticized “humanist” researchers for starting their analyses with rigid conceptual understandings of human learning and development, and only after considering how technology could be integrated in educational contexts for achieving the desired, prearranged aims (p. 7). Rather, according to Sørensen, we should understand that the concrete, empirical reality of educational spaces, along with their numerous learning materials, is, in the first place, what makes us theorize human development and learning in the way we do. Therefore, in her book, *The Materiality of Learning*, she advances the argument that only through empirical investigations of the various spatial patterns of relations among human and nonhuman participants can researchers creatively theorize learning and its materiality.

From my perspective, empirical research is necessary but not adequate for studying such a complex topic (see also Schraube, 2003, p. 42). Along with empirical research, I propose that we also need metatheoretical, *categorical* thinking, which requires metatheoretical work on concepts. Unfortunately, sociomaterial approaches, due to their post-structuralist and pragmatist origins, are very hesitant in providing comprehensive categories. Despite the notable theoretical works mentioned above, they generally tend to engage in a loose way with concepts, and metaphors like *networks*, *assemblages*, *imaginaries*, *cyborgs*, and so forth are prevalent in sociomaterial analyses (see also Langemeyer, 2019). In these approaches, concepts are considered useful tools for intervening in the world, and not means for providing totalizing explanations of the world (Fenwick & Edwards, 2010, pp. 1–23; Fenwick & Landri, 2012, pp. 4–5; Sørensen, 2009, pp. 11–17).

Undoubtedly, empirical investigations and metaphorical thinking can be very fruitful, but, without engaging in categorical thinking, it seems difficult to develop a proper sensitivity toward the *societal mediations* of humans' relations with the material world. As Derry (2008) has explained, due to the accumulation of societal practices and the development of language in human history, our experience of and relation with the world is not directly affected by matter—as sociomaterial scholars claim—but is always socially and conceptually mediated. Therefore, it seems more plausible to suggest that “[i]t is not physics, but societal practices (including sciences) that reconfigure matter and thus the conditions of individual lives, which means that a number of mediating instances need to be taken into account” (Langemeyer, 2019, p. 311). This mediational relation with the world requires openness to the possibility of societal, economic, and cultural dynamics that are not evident in the immediacy of empirical reality (Winner, 1993, pp. 370–371). Indeed, metatheoretical reflection and categorical thinking may help researchers go beyond the immediate appearance of their objects of investigation, including learning and its mediation by digital technologies, and develop a more generalized perspective toward them (Schraube, 2013, p. 20).

In short, from the perspective of materialist dialectics, human transformative activity is not only a force among the many human and nonhuman forces of the assemblage, but is the organizing principle of human life. This implies that instead of assuming an equal relationship between human and object actions, it may be more fruitful to study the historical dynamics and the structure of human activity within which the dynamics of object actions unfold and, hence, could be disclosed.⁸ In such an approach, it also follows that humans are not simply participants in the world, as in posthumanist and new materialist approaches (e.g., Sørensen, 2013), but active, transformative beings. Here, psychological processes, like learning, can be viewed as instantiations or “moments” of societal, practical activities (Stetsenko, 2016, p. 159), which arise, develop, and are transformed in societal activities but at the same time—especially in mature levels of phylogenetic and ontogenetic development—reciprocally affect these activities (Stetsenko, 2016, pp. 181–182). This means that psychological processes are not an epiphenomenon or a direct effect of activities, assemblages, or intra-actions, but have their own history and structure, which is, however, always internally connected with the history and logic of societal activities. I suggest that this coupling of psychological processes, including learning, with societal activities may have important implications for the investigation of learning with digital technologies.

Different perspectives, different questions

Adopting such an approach could help us pose different and, to some extent, complementary questions in relation to the subject. First, if we investigate learning in its internal connection with the history and structure of human activity, we may envision how digital technologies could fruitfully mediate and support the dynamics of human activity. An exemplary analysis on precisely this question was conducted by Arieivitch (2007), who approached learning as a stage-wise *internalization* of material activity and its associated, historically accumulated, cognitive tools (e.g., signs, measures).⁹ Based on the work of the Soviet psychologist P. Galperin (1902–1988), Arieivitch (2007) claimed that digital technologies should support this process of internalization and become an inextricable part of the meaningful and dynamic teaching–learning activity system in order for them to be transformed from mere information technologies to genuinely educational technologies (p. 63). Because this process of internalization does not take place automatically, but develops through various stages (from the stage of material activity to the stage of verbal activity, and from there to the stage of mental activity), Arieivitch also suggested that digital technologies should have different roles in different stages of the internalization of external activity and of cognitive tools (pp. 67–70).

Another opportunity that opens up with this perspective is related to a more systematic investigation of human subjectivity and learning, as these are constituted through their mediation by digital technologies. Instead of ending our analyses with empirical descriptions of the reconfigurations of the educational assemblage due to the introduction of new actors (i.e., various digital technologies), we could also focus on the systemic organization of psychological processes, as internally connected with the structure of human activity. According to Vygotsky (1930/1997b), “in the process of development, and in the historical development of behavior in particular, it is not so much the functions which change . . . What is changed and modified are rather the relationships, the links between the functions” (p. 92). Therefore, we could explore the way the systemic organization of higher mental functions (e.g., focused attention, deliberate memory, conceptual thinking)—and, as such, their very structure (see also Vygotsky, 1931/1997a)—changes with the pervasion of digital technologies in literally all spheres of everyday life, including, of course, learning and education.¹⁰ However, in order to engage in such an exploration, it is presupposed that we accept that higher mental functions are intrinsically connected with the structure of human activity and, hence, do indeed follow a systemic, hierarchical organization. This presupposition seems to come in contrast with the symmetrical ontology of sociomaterial approaches and their aversion to any structural perspective of the human mind.

A focus on the systemic organization of psychological processes also requires an explicit emphasis on human development because, as Vygotsky (1930/1997b) put it in the passage above, it is the change in the links of psychological processes that matters. Yet sociomaterial perspectives of learning do not examine the dynamics of human development. When developmental transformations of learning and activity are taken into account (e.g., Sørensen, 2009), the interest is centered not on human development, but on the development of the assemblage of the heterogeneous human and nonhuman elements that together produce learning. Such a systemic perspective is an important step in comparison with cognitivist approaches to learning, which are preoccupied with the individual learner.

However, from the perspective of cultural-historical theory and activity theory, learning can only be understood in its internal connection with the development of human personality and consciousness. As Dafermos (2018) has noted, Vygotsky's two core, interconnected, research projects concerned the study of consciousness and the problem of the cultural development of personality, and all the other aspects of his work, including learning, were connected to these two fundamental projects (p. 56).

Connecting learning, human development, and consciousness more directly could allow researchers to ask how human development is affected by the digitalization of learning and, more importantly, how human beings could reorganize and consciously transform their relationships with digital technologies, according to their needs and their prospects of development (see also Langemeyer, 2019, p. 319). These issues are of tremendous importance, and were especially so during the COVID-19 pandemic. Indeed, during the pandemic, the interconnection between learning and development became more apparent, given that online education affected the development of both students and teachers, while the impact of the lockdowns on human development reciprocally affected learning in a serious manner. These questions are also challenging in the context of the rapid automation of production and the increasing fragmentation of labor, where digital technologies play a significant role. Therefore, it becomes necessary to understand in more depth how humans have been experiencing these changes, what conflicts and contradictions they face in their learning processes with digital technologies, and what the potentials are for agentic action.

Some of the above-mentioned sociomaterial studies (e.g., Alirezabeigi et al., 2020; Pischetola et al., 2021) have emphasized the experiential dimension of learning with digital technologies, but this trend is not predominant in the sociomaterial paradigm, while the possibility of conscious transformation of human–technology relationships does not appear in the paradigm. In this framework, any discussion of conscious human transformation of our relationship with technologies is treated as *humanist* and as associated with the Enlightenment fallacies of human mastery over nature. However, in the tradition of materialist dialectics, the notions of consciousness and mastery of material tools and signs do not imply any such attitude. Rather, they denote that the development of humans is dependent on their internalization of material and socially shared activities, as well as the associated tools and signs (Arievitch, 2007). From this perspective, the notion of mastery is connected with an understanding of learning as a meaningful activity that engages humans in the appropriation and transformation of cultural–historically created tools and signs. In this way, in the dialectical tradition, learning and human emancipation are inextricably connected.

In general, these questions concern the human side in the human–technology relation, which, in my opinion, tends to remain undertheorized by sociomaterial perspectives. These omissions have also been traced by scholars working in the tradition of (post-) phenomenology, who have mostly focused on the link between technologies and human existence and experience. For example, Verbeek (2000/2005), who is sympathetic to sociomaterial approaches and empirical studies of technology, argued that

in empirical technology studies the hermeneutic and existential questions posed by the classical philosophers of technology fall out of the picture: What is the role that technology plays in human existence and in the relation between human beings and reality? (p. 100)

In this light, we could ask: What does it mean for people to engage in learning with digital technologies? How do humans experience learning with computers and how does this experience differ, for instance, when learning with printed materials (books, notebooks, etc.)? How does humans' embodied, meaningful, and emotional involvement in learning change with digital technologies (Dreyfus, 2009)? Why do online classes tend to be generally less engaging than on-site classes? How have learning and educational activities and experiences changed with the rapid growth of information as a result of the development of digital technologies?

There is much room to explore such questions further, especially in the context of the COVID-19 pandemic, where our learning processes relied more than ever on digital technologies. Unfortunately, as Rückriem (2009) argued more than a decade ago, cultural-historical theory and activity theory have not engaged greatly with digital technologies, either theoretically or empirically (p. 88). However, there are some recent studies (e.g., Engeness & Nohr, 2020; Kumpulainen et al., 2019) that point to a more promising future in this regard.

Conclusions

The relationship between humans and technology is so intimate that neither humans nor technology can be conceived of outside this relationship (Schraube, 2013, p. 12). Learning, therefore, cannot be understood without an appreciation of its materiality and its technological mediation. Sociomaterial approaches have foregrounded the materiality of learning by locating learning processes in the complex, distributed, embodied, and heterogeneous entanglements of humans and nonhumans. Because cultural-historical theory and activity theory have also greatly appreciated the material, relational, and embodied qualities of learning, Fenwick et al. (2011) have suggested that these theories, albeit different in many respects, can also be treated as sociomaterial.

Despite some overlaps between sociomaterial approaches, on the one hand, and cultural-historical theory and activity theory, on the other, I have attempted in this article to argue for their significant ontological and epistemological differences, and to illustrate how these differences are reflected in distinct ways of investigating learning with digital technologies. In my opinion, these differences are so important that it is not possible to theorize cultural-historical theory and activity theory under the sociomaterial umbrella. Nevertheless, it is necessary to create possibilities for a more active and prolonged dialogue between the various perspectives that try to account for the materiality of learning. Such a dialogue could proceed on the basis of both empirical investigations and theoretical arguments. Given that empirical explorations of the topic are still in their infancy in the traditions of cultural-historical theory and activity theory, the focus of this article's argument has been on the metatheoretical plane. However, as theory can sometimes create new ways of engaging with empirical practice, the present endeavor has aimed to open up opportunities for further theoretical reflection and, possibly, for additional empirical interventions.

In conclusion, the mediation of learning by digital technologies is a very complex topic of research. Sociomaterial perspectives have developed invaluable empirical insights and have promoted practice-based research. By drawing inspiration from post-structuralist and (neo-)pragmatist philosophies, these perspectives "elegantly capture the

complex fluidity of processes that make up the world, yet they do not conceptualize social practices, human agency, and historicity of human communities in their effects on the world” (Stetsenko, 2016, p. 205). Dialectics, with its emphasis on the materiality and historicity of human life and, at the same time, human labor activities, could potentially encourage researchers to more systematically conceptualize human development, human mental functions, and human agency in the *drama* of learning with digital technologies in the 21st century (see also Dafermos, 2021).

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Notes

1. According to Sørensen (2009), the term *performance* “allows us to ask what is achieved through an arrangement of interrelating parts, of participations” (p. 28). As Mulcahy (2012) mentions, many disciplines, including education, have recently embraced this term (p. 14).
2. See, however, Bolldén (2016) for an exception to this tenet (p. 13).
3. In an early definition given by Latour (1991/1993), a mediator “creates what it translates as well as the entities between which it plays the mediating role” (p. 78).
4. Hamilton and Friesen (2013) give the following definition of *black-boxing*: “Black-boxing technology means taking for granted all the contingent decisions that accumulate behind artefacts and contribute to making them what they are” (p. 9).
5. “Immutable mobiles act at a distance and are easily transportable actors which maintain their identity or inherent characteristics between networks, allowing information flow from one actor-network to another” (Luke, 2022, p. 1013).
6. Sociomaterial scholars refute this argument as humanist and as cultivating the Enlightenment’s dreams, like essentialism, dualism, anthropocentrism, and so forth. In dialectical philosophy, these epistemological and pragmatic problems are not assigned to the Enlightenment tradition per se, but are contextualized within the dynamics of the capitalist mode of production (Levant, 2017), and the actual separation between humans and nature (Dafermos, 2018, p. 149).
7. Latour (1994) characterizes the process of transformation of humans and nature by labor as a myth (p. 35), and rejects the critiques of fetishism (p. 41).

8. For a classic activity-theory analysis regarding the history and structure of human activity, see Leont'ev (1975/1978). For a recent analysis of this issue, and in relation to information technologies, see Kaptelinin and Nardi (2006) and Rückriem (2009).
9. Because the term *internalization* has provoked heated debates in the history of philosophy and psychology, it is important to clarify that, in the tradition of materialist dialectics, the term usually refers to the transformation of material and socially shared activity into an individual's own cognitive activity (e.g., Arievidtch, 2007, p. 65).
10. I thank the anonymous reviewer for encouraging me to point this out in a more explicit way, by providing also a relevant reference to Vygotsky's (1931/1997a) original idea. Indeed, Vygotsky, in this work (and in most of his work generally), revealed the importance of sign and tool mediation for the development and reorganization of the structure of higher mental functions.

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