

**Unraveling the Fabric of Learning: A critical Examination of Sociomaterial
Perspectives on Learning.**

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Abstract

In this article I attempt to critically reflect on the theoretical merits of the sociomaterial approaches to learning. Through offering an array of theoretical concepts, in addition to what are considered social effects, these perspectives argue for an active character of materials in what constitutes reality. To this end, humans and materials are considered equally, and inherently entangled and this paradigm attempts to examine in what way this produces effects. To understand this, the theoretical concepts used by the sociomaterial perspectives are carefully considered in this paper. Therefore, I lay out an entangled conception of reality that forwards a consideration of both agency and participation to move beyond their traditional notions that are exclusive to humans. Additionally, through empirical applications of these concepts, I forward valuable insights of the sociomaterial perspectives on learning in terms of different forms of knowledge and the distinction of authority in the classroom. Lastly, upon critically reflecting, I postulate a sociomaterial perspective on educational policies by drawing on scholars who apply sociomaterial vocabulary in their research.

Keywords: sociomaterial, learning, theoretical assumptions, critical reflection, ontology, epistemology

Unraveling the sociomaterial: A critical examination of sociomaterial perspectives on education.

Education has always been deeply intertwined with materials. Despite this fact, throughout the history of the academic understanding of learning, material artifacts mainly went unnoticed (Sørensen, 2009). Nevertheless, in the past decades, the rising ubiquity of technology in education has steered the interest within educational research more towards these material artifacts (Fenwick & Edwards, 2010). Nowadays, students and teachers engage with both technological hardware (e.g. iPads and laptops) and software (e.g. PowerPoint, digital examination programs) in complicated ways of interaction. This evident digitalization of classrooms, from elementary schools to university lecture halls, has mixed technology with traditional educational practices. The fusion of digital technology with education has sparked a range of theoretical paradigms that aim to decipher any effects materials might have on learning.

Among the more influential resulting theoretical paradigms are the sociomaterial perspectives. These approaches address previously unquestioned conceptualizations of learning. They offer a framework that seeks to holistically understand the fusion of the social dynamics of learning and the tangible technological artifacts that are becoming increasingly integrated into educational practices (Sørensen, 2009). This framework highlights the trajectory of technology in gaining a more prominent role of analysis within educational research, moving from a less anthropocentric to a more balanced view of education that includes a consideration of technological artifacts (Fox, 2005). The theoretical assumptions of the sociomaterial perspectives are of primary concern within this paper.

As will become apparent, sociomaterial perspectives have their roots in a heterogeneous body of theories. First, the sociomaterial approaches draw significantly from Actor-Network Theory (ANT) (Sørensen, 2007, p. 16). ANT assumes entanglement of social

and material phenomena and allows for a networked consideration of all aspects of education (Latour, 2005; Orlikowski, 2009). Fenwick and Edwards (2010) furthermore acknowledge this heterogeneity by mentioning the ongoing relevance of post-structuralism, the sociology of science and technology, human–computer interaction, and feminism within sociomaterial perspectives. Therefore, according to Decuypere and Simons (2016), sociomaterial studies use a varying range of theoretical concepts that could be designated under the sociomaterial umbrella. This has made the influence of sociomaterial perspectives in educational research rather diffuse. What is important is that these approaches share an analytical refusal of boundaries between social and material phenomena in everyday life and instead try to study social and material phenomena in their entanglement (Decuypere & Simons, 2016). More specifically, they propose that everyday practices are constituted through continuous interaction and redefinition of social and material aspects. This results in a dynamical construction of objects, knowledge, and events through interwoven relationships (Sørensen, 2009).

The emergence of the sociomaterial perspectives in education represent a significant change in how learning environments and processes are understood. As a result of some important changes in this field over the last decades, the sociomaterial approaches emerged. From a predominance of cognitive conceptualizations, showing a tendency to overlook the role of the environment, critiques that tried to illuminate the social nature of education started emerging during the late 20th century. For example, there emerged analytical approaches to education that were inspired by Dewey's (1970, as cited in Fox, 2005) critique on education which argued against an educational model that presupposes essence and views knowledge as being passively transferred from teacher to learner. According to Dewey (1970, as cited in Fox, 2005) this essentialist conceptualization leads to a clear-cut distinction in authority between teachers and learners, limiting freedom to learn. To reinstate this freedom, this

critique was furthered through the development of the research paradigm of communities of practice in the 1990s (Lave & Wenger, 1991) which attempted to embed the classroom into the community. This historical development highlights the shift to more sociocultural conceptualizations of learning.

Through the acknowledgement of the social nature of learning, the notion of networked learning came to the foreground. This was paired with critiques on the role of the authoritarian teacher. The notion of networked learning reconceptualizes learning as emerging from a configuration, called a network (Sørensen, 2009). This, in turn, leads to a perception of the teacher as part of a larger network within learning groups (Scrimshaw, 2001 as cited in Fox, 2005). Thus, networked learning considers the teacher and learner as co-creating the educational space. Furthermore, according to Fox (2005), the increasing access to computers' online databases would diminish the authority of teachers, leading to more evenly distributed power across the network in educational settings. A substantial role of the internet in democratizing education becomes evident in this networked conceptualization of learning. This forces a more prominent consideration of materials. Therefore, these so-called sociocultural approaches have commonly been criticized in their place to turn away from the role of materials in education, seeing them as mere tools to advance human-centered educational performance (Sørensen, 2009).

Furthering the critique on the sociocultural approaches, the sociomaterial approaches started to gain shape through development of ANT at the end of the 20th century. ANT and, generally, the sociomaterial perspectives gained more traction around the turn to the 21st century, with Fox (2005, p. 102) reasoning that they 'provide insight into critiques of the idea of community in higher education and have implications for our understanding of networked learning'. To understand networked learning, the full network must be considered. What sociomaterial perspectives offer to education, in addition to sociocultural approaches, is the

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view that social and material components (curricula, students, teachers, blackboards, classrooms, etc.) are intrinsically intertwined and should thus be analytically considered equal and in terms of networks and their processes (Decuyper & Simons, 2016). These insights add the material understanding of learning to the more exclusively social understanding of the outlined sociocultural approaches.

The understanding of learning from the sociomaterial perspectives forces us to depart from an alternative onto-epistemological starting point in comparison to what is common in most research paradigms that tackle education. As mentioned, all aspects of education are to be considered equally potent actors within a learning network (Sørensen, 2009). Therefore, sociomaterial perspectives consider an inherent entanglement of both observer and observed, instead of a conception of reality that departs from a prior distinction between the two (Barad, 2003). This leads to a leveled ontology. Furthering this assumption, reality then emerges from intra-actions; the dynamic interplay between the heterogeneous elements of everyday life (Barad, 2003). Applying these conceptions allow learning to be understood as an effect of a sociomaterial network instead of a mental process. Therefore, sociomaterial perspectives argue for a performative account of knowledge (Sørensen, 2009), that is, learning is considered as a performance of relations within networks that extend participation to non-human objects (Sørensen, 2007). This theoretical approach focuses on the transformative potential carried by all parts of the process of learning.

Whereas this sociomaterial theoretical understanding has seen widespread educational research applications in terms of empirical studies that consider different material aspects present in education (e.g. Aagaard, 2017; Luke, 2022; Meyer, 2015), the existing body of literature shows little critical consideration of the underlying theoretical concepts of the sociomaterial approaches applied to learning. What this shows is a general academic tendency to immediately apply sociomaterial perspectives to real world situations, which is in

line with the view of Fenwick and Edwards (2010, p. 1) that sociomaterial perspectives are ‘a way of intervening in educational issues to reframe how we might enact and engage with them’. This paper however, instead of hastily diving into empirical application, attempts to take a step back. For us to sensibly apply these approaches and intervene, we must first understand them deeply. Therefore, I critically embark into the theoretical backdrop of sociomaterial perspectives and, from their conceptualization of the entanglement of social and material aspects in everyday practices, try to arrive at an understanding of how this entanglement shapes learning.

To achieve this in a coherent manner, this thesis attempts to answer the following question: What are the core theoretical assumptions underlying sociomaterial approaches to learning? Throughout this paper, the main theoretical assumptions of the sociomaterial perspectives are discussed. As will become apparent, these assumptions challenge traditional distinctions between social and material phenomena, and humans and non-humans. After concisely elaborating these theoretical concepts, I arrive at a discussion of their implications for learning before concluding with a more general discussion of possible futures within educational policies. Given the already mentioned heterogeneity of the sociomaterial approaches, specific terminology naturally differs across papers (Decuypere & Simons, 2016), dependent upon the individual preferences and goals of the researchers. Thus, doing justice to the conceptual subtleties across the existing body of academic research is beyond the scope of this paper. Furthermore, considering the complex nature of the sociomaterial perspectives, this paper mainly argues in favor of the sociomaterial perspectives to foster a comprehensive understanding. Adding to this is that these perspectives are still being developed, therefore this paper may serve as an encouragement to further ongoing endeavors.

Analysis

Reality Through a Sociomaterial Lens

The sociomaterial perspectives make fundamentally different assumptions about the world. Sociomaterial perspectives offer a shift of paradigm that challenges the conventional separation of objects from their representations, signaling a move away from representationalism (Hamilton & Friesen, 2013). They depart from an inherent entanglement of material and social phenomena instead (Decuypere & Simons, 2016). This entanglement entails a relational conception of reality, which is central in Barad's (2003) agential realist ontology. Barad (2003) derives this ontology from Bohr's contributions to quantum theory, taking relations as the primary ontological and epistemological unit. This ontology posits that entities come into being through intra-actions, instead of interactions, getting rid of any prior distinction or relation (Barad, 2003). Through these intra-actions, boundaries emerge and allow for an entity to have meaning in relation to others (Sørensen, 2009). Within this framework, reality itself is a tapestry of phenomena in the continuous state of being weaved by these intra-actions, blurring the lines of classic distinctions between human and non-human actors. Relating this to learning, it raises the question of how we could view technologies and other materials in education differently.

The agential realist ontology reconceptualizes the traditional notion of causality. To explain this, Barad (2003) introduces the concept of agential separability. Agential separability is a concept which redefines objectivity as an inevitable entanglement of the observer and the observed, challenging the classic objective stance that assumes an evident distinction between the two (Barad, 2003). Thus, everything is inherently drawn together in its responsibility for an emerging reality. Each object carries with it a connotation, a 'script' as Latour (1994, p. 30) puts it, 'that can force passersby to play a role in its story'. This ontological position reshapes our understanding of entities from static to dynamic participants in a reality that emerges through relationships, instead of viewing them as separated. These relationships are symmetrically mediating one another, in that they significantly shape each

other (instead of one being shaped by the other); a form of mediation which Latour (1994) calls translation.

This dynamic conceptualization blurs classical distinctions like human/non-human and social/material. To this end, the sociomaterial perspectives apply the concept of symmetry. Symmetry refers to the equal analytical treatment of humans and non-humans (Sørensen, 2013). Considering the way causality is redefined in terms of inherent relations, that inevitably blur prior distinctions between subject and object, symmetry is a necessary concept. Symmetrical consideration is further justified by the mentioned principles of intra-actions and agential separability. More specifically, the notion of intra-actions implies this through denying pre-existence of essence, by highlighting the emergent nature of reality (Barad, 2003). Since relations then become the primary unit of analysis, we must equally consider humans and non-humans. Agential separability further underlines this through the insistence on interdependence between observers and observed (Barad, 2003). A well put illustration is given by Latour (1994, p. 32) in describing the symmetrical change in the coming together of a social and a material entity: ‘You are different with a gun in hand; the gun is different with you holding it.’ In this example we can imagine a reality emerging from the converging of two entities, innately dissolving the well-defined distinction between subject and object, since they can no longer be separately considered. The concept of symmetry allows sociomaterial researchers in education to analytically deconstruct the traditional classroom in a manner that challenges previously held assumptions.

The equal consideration of humans and non-humans furthermore broadens the traditional affordance of agency. More specifically, sociomaterial perspectives do not limit the notion of agency to humans but also afford agency to non-humans (Sørensen, 2013). Non-humans are then considered important agents that possess the capacity to co-produce reality. Consistent with the entangled notion of reality (Barad, 2003), sociomaterial perspectives

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define agency as a capacity that emerges from this interrelatedness (Latour, 2005; Orlikowski, 2009). However, because of its human connotations, the term agent is suggested to be replaced by the term actant (Latour, 1994, 2005). Actants may be human but are no longer human by necessity (Law & Mol, 1995). The sociomaterial perspectives thus arrive at a view of agency as being situated in how actants emerge through their entanglement, viewing both social and material phenomena as being formative of reality (Decuyper & Simons, 2016). This redefinition of agency also redefines the term mediation in terms of a network, since interconnectedness is assumed, actants inevitably influence each other and their action then becomes an emergent part of the network (Latour, 1994). The analytical application of these concepts would allow us to turn previously overlooked objects in education into actants, fostering a sensitivity to the effects they may have on learning. To further disentangle the relational nature of reality, the sociomaterial perspectives use the term assemblage or network. An assemblage can be defined as a complex web of heterogeneous actants (human and non-human), capable of producing effects (Sørensen, 2009). Actants consequently emerge as an effect from the inherent interactions within a specific assemblage (Sørensen, 2009). In other words, the network they are part of actively shapes the capabilities, goals and identities of the actants (Luke, 2022), making the assemblage more than a mere collection of actants (Latour, 1994). Returning to Latour's (1994) gun example, the goal of both the human and the gun (gunman) emerges through their relationship within an assemblage. Where the goal of the human may first have been to just hurt the target, in the assemblage with a gun, a goal to kill may emerge. Thus, assemblages are characterized by a dynamic state of becoming (Sørensen, 2009). The concept assemblage therefore underscores that entities interactively acquire meaning and agency, challenging traditional views of social and technological configurations.

This dynamic state of assemblages does not exclude the possibility of it reaching stability through the influence each component of the network has on another (Latour, 2005). However, before adding to our understanding of assemblages, the notion of possible stability needs elaboration. As a clarifying concept in this regard, Latour (1994, p. 37) utilizes the term blackboxing. Blackboxing is explained by Latour (1994) as the converging of an assemblage into a stable entity, concealing the roles of specific actants in a network. However, the interconnected roles and influences of actants in these assemblages are described as unpredictable, making the stability of objects relationally constructed (Law & Mol, 1995). This would mean that stability is conditional upon the continuance of relationships within an assemblage (Latour, 1994). Therefore, Decuypere and Simons (2016) argue in favor of a more in-depth assessment of how each component of an assemblage influences and is influenced by the others. This allows researchers to focus their attention on the role conventionally overlooked actants play in certain assemblages within education.

To illustrate the above-mentioned ideas, Latour's (1994) example of a speed bump on a campus can be relevant. In any intuitive observation, a speedbump would be blackboxed and viewed as a stable object that forces passersby to slow down without necessarily considering what brought it into being. However, when applying a sociomaterial lens, we can open the blackbox and see the speedbump in terms of the network that it is part of (Decuypere & Simons, 2016). This allows us to see that a campus has policies regarding safety, which can be harmed by any traffic that passes by above a certain speed. The safety goals are then reached by employing people that engineer a speedbump on the campus, creating a dynamic assemblage. This assemblage is afforded stability through ontologically transforming the shape of the surrounding actants as being present within the speedbump, making it effect campus policies (Latour, 1994). However, the apparently stable effect of the speedbump is still conditional in its nature. For example, it is dependent upon the continued

existence of the campus policies. The sociomaterial perspectives afford a deeper insight into how assemblages may operate to co-create reality.

As can be derived from the previous paragraphs, the ontological considerations that are apparent throughout sociomaterial perspectives can seamlessly be integrated with epistemological considerations. ‘Things are woven into the social fabric’ and thus can hardly be disentangled from one another (Waltz 2006, p. 53). The constitution of reality in this dynamic perspective can therefore not be seen separately from what is to be known. This results in ‘ontogenesis (concerning the way things come to be)’, a symbiotic relationship between being and knowing (Decuyper & Simons, 2016, p. 32). Such relational thinking concerns the question of how the configuration of both humans and things alike, affects (and effects) their becoming as well as humans’ ability to know reality (Sørensen, 2009).

To further conceptualize this symbiotic relationship between being and knowing sociomaterial researchers use the concepts of participation and performance. Participation conceptually allows both social and material actants to, instead of merely being present, be critically involved in the creation of reality. Sørensen (2007) elaborates this by extending the classical anthropocentric notion of participation (Dreier, 1990 as cited in Sørensen, 2009), affording participation to non-humans as well through the acknowledgement of their active role in creating knowledge. Performance, or performativity, integrates the interrelated social and material elements of an assemblage, acknowledging their co-production of specific effects (Sørensen, 2009). This notion of performativity heterogeneously conveys an active role of both humans and non-humans in emerging reality, inherently implementing the extended notion of participation by emphasizing that both the social and material planes do something to create reality. Sørensen (2009, p. 15), furthermore builds on Verran (1998) in saying that performativity is an ‘enacting mode of knowing’, in that it is inherently connected

to the practical context it is performed in. This enacting mode of knowing can point to different forms of knowledge across different contexts when applied to education.

Educational research that applies a sociomaterial lens attempts to provide a sufficient description of the setting which it tries to explain. This description entails a mapping of the apparent relations of an assemblage, the actants in it, and the effects that are apparent in the researched situations (Decuyper & Simons, 2016). According to Decuyper and Simons (2016, p. 39), the research then ‘always implies an act of gathering’ which would point to the relationality of educational settings. Through these descriptions, educational settings that are taken for granted (blackboxed) can come to be seen in a new light.

Implications for learning

Having arrived at a conceptual understanding of the core theoretical assumptions of the sociomaterial perspectives, I will now delve into their implications for learning in specific. As Schlauch (2020, p. 166) notes, there are at least four ways in which sociomaterial perspectives can be useful in furthering an understanding of learning:

The participation of materials in educative practices can be discussed.

This participation facilitates a consideration of the contribution of these material elements in educational processes.

Learning can be situated in a relational process of the emergence of knowledge.

Multiple forms of knowledge can be considered according to different spatial settings, focusing less on teachers.

Considering applications of the discussed theoretical framework, several sociomaterial contributions to education will come to be illuminated. As will become apparent, the mentioned concepts will naturally intertwine in their application.

Following the structure of the previous section, I will commence with an application of the concept of symmetry to learning. Symmetry is a concept which Sørensen (2009)

illustrates in practice, in her research with an online learning environment. This research elucidates the intricate connection between the social and the material by showing how they can be equally considered. To this end, Sørensen (2009) elegantly illustrates an application of the interconnected concepts of agential separability and intra-actions. First, agential separability is outlined by arguing that ‘theory participated in performing the technology’ (Sørensen, 2009, p. 59), showing a mediating relationship of theory in the construction of reality that entangles observer and observed. This challenges the traditional conception of objectivity that assumes an a priori distinction, instead departing from an assumed entanglement between the two. Intra-actions are furthermore displayed through the argument that ‘technologies become’ (Sørensen, 2009, p. 59), showing a process view of technologies that achieve stability. An online learning environment can thus not be assumed to have a pre-defined essence but is rather performed into being through application in the classroom. The interrelated view on objectivity and the participation of technology in shaping (and being shaped by) education equalizes analytical planes, illustrating the conceptual use of symmetry in relation to learning.

The concept of symmetry furthermore allows sociomaterial researchers to analytically deconstruct the traditional classroom in a manner that has little prior assumptions. For example, Sørensen (2007, p. 22-23) describes the influence of technology in the classroom on authority, by comparing two contexts: a traditional classroom with analogue technologies and a computer lab with a 3D learning environment. The traditional setting reinforces the commonly accepted student-teacher relationship through the performance of the blackboard that creates a ‘regional distinction’, directing attention and enforcing a divide between authority (teacher) and subjects (pupils). In addition, this ‘one-to-many’ relationship is maintained through the stable workbooks of the students that allow the teacher to maintain awareness of what all the pupils are working on. However, with online learning

environments, this static nature of materials fades together with the authoritarian regional distinction which the blackboard performs into being (Sørensen, 2007). Through the individually employed learning environment of the pupils, tasks are no longer homogeneously dispersed. This leads to an allowance of one-on-one relationships between teacher and learner, which in turn diminishes the traditional distinction in authority. Sociomaterial perspectives can dissect traditional conceptions of the classroom, illuminating the transformative capacity (digital) materials have on authority and teacher-learner relationships.

Moreover, materials participate in the construction of knowledge. As Schlauch (2020, p. 166) argues, it is impossible to view knowledge as separate from ‘who or what is performing it’. Knowledge, then, is continuously performed within a range of educational practices (Sørensen, 2009). In line with Verran’s (1998 as cited in Sørensen, 2009) view that knowledge is inherently embedded, Fenwick and Edwards (2010, p. 36) additionally argue on the integration of ‘objects of knowledge’ into the assemblages of sociomaterial perspectives, diminishing their traditional distinction from humans. These objects inherently contain information which then can be performed in an assemblage, these performances then emerge as knowledge (Fenwick & Edwards, 2010). What follows from this is the notion that the educational encounters change when the setting changes, since the objects of knowledge will inevitably change with it (Fenwick & Edwards, 2010). As forwarded in the example on authority, contrasting the blackboard with an online learning environment, the realization of teaching and learning changes through different material settings because the inherent interrelations between them change (Sørensen, 2009). Thus, participation and performativity are connected in this embodied view of knowledge which turns learning into a dynamic process of embeddedness (Schlauch, 2020).

Consequently, through the possible differences in material and social configurations across situations, different forms of knowledge can be performed. Learning, defined as ‘growth in knowledge’ (Sørensen, 2009, p. 136), is performed differently depending upon the educational configuration. Thus, Sørensen (2007, p. 21) distinguishes between representational knowledge and liquid knowledge. Whereas the performance of representational knowledge requires a stable set of materials that can accurately represent reality (a ruler, conveying a measurement unit that is generally accepted), liquid knowledge is more procedural in nature in that it emerges through an interaction with the specific educational assemblage (Sørensen, 2007). Liquid knowledge highlights the relationship between the learner and their dynamic (online) environment (Sørensen, 2007). In terms of learning, liquid knowledge can then be valued when a learner effectively deals with, or transfers knowledge to the sociomaterial assemblage that is specific for the learning situation.

An illustration of how representational and liquid knowledge are enacted in education is offered by Luke (2022). This research, with a focus on role of the pause/play button when studying lecture recordings, highlights that knowledge emerges from a network of social and material actants. Traditionally, as seen in the example with the blackboard, representational knowledge is viewed as being passively transferred from authority to subject. However, Luke (2022) illustrates that representational knowledge is strongly mediated by the pause/play button in that that it allows stable materials to come together in an assemblage, affording a dynamically structured learning situation. For example, through the pausing and playing of the lecture at will of the student, consolidation of information is allowed at a personalized pace.

In an online environment with its dynamic characteristics, liquid knowledge is more apparent (Sørensen, 2007). As Luke (2022) continues, liquid knowledge can be illuminated by the switching across platforms and relevant webpages done by students, which is allowed

by the enactments of the pause/play button. This switching itself is an adaptive skill that is enabled through the presence of the pause/play button within the network. Through the pause/play button, students are afforded the option to switch to additional sources at their will or balance their information intake and this assemblage ‘would fall apart if the button itself was absent’ (Luke, 2022, p. 1022). These different forms of learning are in line with the position of sociomaterial approaches that learning is ‘a network effect’ (Fenwick & Edwards, 2010). The effects that are produced from an assemblage namely depend on the persistence of these existing relationships. Through the theoretical sensitivity the sociomaterial perspectives offer, the traditional conception of knowledge can be challenged, allowing us to question what forms of knowledge should be taught, and how they should be assessed in the educational sphere.

Concomitantly, sociomaterial perspectives challenge traditional conceptions of agency and action as exclusively attributed to learners. Empirically this can again be seen in Luke's (2022) study, where the pause/play button in lecture settings is acknowledged to be an actant with the agency to affect the learning environment and effect different forms of learning. The actions it performs in relation to students as an emergent aspect of a network of actants practically extends the notion of agency to non-sentient beings (Latour, 2005). The pause/play button, through its performance, actively enrolls different actants into the assemblage (Luke, 2022). Through the performance of the pause/play button, students can physically detach themselves from a lecture room by doing the same studying they would do in a lecture hall in a moving vehicle or a coffee place instead. In a more disrupting fashion, students can seamlessly switch to a humorous video or chat with a friend through the same action of the pause/play button. The pause/play button thus can have a positive effect on learning in allowing students to study in different physical settings but can also invite in disrupting actants such as social media (Luke, 2022). A paradoxical function of technology

thus arises that both facilitates and inhibits learning, illustrating the agency it has in influencing the network effects. Both educators and learners within the sphere of education can then begin to be sensitive towards the effects materials have on learning (Fenwick, 2015).

In conclusion, sociomaterial perspectives challenge traditional, static views of social and material entities in education through the network metaphor, by emphasizing that entities emerge and gain meaning and agency through their relational ties. As Luke's (2022) research illustrated, the pause/play button is a dynamic actant within an assemblage. Thus, the term actant emphasizes the performative and relational nature of all entities involved in a network. According to Fenwick and Edwards (2010), this perspective is significant in educational settings where the performativity of knowledge and its implications for learning are deeply influenced by the material conditions. This is supported by the different notions of knowledge outlined by Sørensen (2007) that can emerge dependent upon the sociomaterial configuration of the educational setting. Thus, teaching and learning are in a constant state of being co-produced by the dynamic interrelations of an assemblage (Fenwick & Edwards, 2010) and can be critically considered through the theoretical concepts the sociomaterial perspectives offer.

Discussion

The description of the core theoretical concepts of the sociomaterial approaches in relation to learning reveal that they open the possibility of renewing the existing understanding of different concepts within education. They allow us to view different educational settings in terms of a heterogeneous assemblage, leveling prior distinctions of authority and enacting different forms of learning through technological implementations. In this last section, I will revisit the initial questions of what the core theoretical concepts of the sociomaterial approaches are in relation to learning. I will rest my gaze upon the different sociomaterial concepts again, summarize their implications, and continue to provide a more

practical exploration in the direction of educational policies, while ending with a possible limitation of these perspectives.

Throughout this paper it has become clear that the sociomaterial perspectives embrace an inherent entanglement of material and social phenomena, challenging the traditional views of representationalism (Hamilton & Friesen, 2013; Decuypere & Simons, 2016). To highlight this, the perspectives integrate ontological and epistemological considerations in an emergent conceptualization of reality. Barad's (2003) agential realist ontology emerges as central to understand the sociomaterial perspectives. This ontology emphasizes inherent relationality over an inherent distinction by redefining causality, allowing entities to relationally emerge through intra-actions (Barad, 2003). This renewed conceptualization then blurs the classic distinction between humans and non-humans, instead indicating a dynamic participation in the construction of reality by the scripts objects inherently carry along (Latour, 1994). Together with symmetry and agency, participation and performance emerge as key concepts in the sociomaterial perspectives (Sørensen, 2007, 2009), affording the material plane in everyday practices a more active role in co-creating reality together with social actants, moving from a static to a dynamic conception of reality.

To explain what these theoretical concepts mean for learning in specific, I touched upon each of the four points mentioned before that Schlauch (2020) notes as the critical potential of the sociomaterial perspectives in the field of learning. Firstly, the participation and performativity of materials in educative practices in general can be discussed. As seen, the notion of participation within the sociomaterial perspectives has been extended beyond being exclusionary to humans by Sørensen (2007). Furthermore, performativity acknowledges co-production of effects by social and material actants together (Sørensen, 2009). These concepts are demonstrated Sørensen's (2009) comparison of the traditional and digital classroom, where the active participation and performativity is shown by how the shift

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in utilized materials actively transforms the relationship between teacher and student. What this shows is how the inherent entanglement of both social and material actants in education produce effects and shapes reality (Waltz, 2006), urging a participatory consideration of the material sphere in education.

Secondly, this participation facilitates a consideration of the contribution of these material elements in more specific educational processes. Applying a sociomaterial lens in educational research puts emphasis on the relationality of education, allowing us to question the roles materials may have on shaping taken-for-granted concepts (Decuypere & Simons, 2016). In doing this, agency is viewed as emerging from relations between actants (Latour, 1994, 2005). Illustratively, I touched upon the active, authority enforcing role of the blackboard in traditional classrooms (Sørensen, 2007). Whereas the presence of the blackboard enforces authority through a ‘one-to-many’ relationship in the traditional configuration, this relationship is leveled in an online environment to allow for a more equal and personal interaction between teacher and learner. In terms of personal attention and progress, this changes traditional educational trajectories of learners, again highlighting the performance of materials and their contribution to organizing authority and the emerging enactment of learning in the classroom (Verran, 1998, as cited in Sørensen, 2009). This reconsideration allows us to revisit notions of educational policies and how these translate into practice. The sociomaterial approaches allow us to reconsider these educational dynamics, affording an active, transforming role to all involved actants in the creation of knowledge (Sørensen, 2009).

The last two points are taken together, in that they have a significant amount of overlap. Namely, first, sociomaterial approaches allow for learning to be situated in a relational process of the emergence of knowledge, focusing less on teachers. Secondly, the sociomaterial approaches allow for multiple forms of knowledge to be considered according

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to different spatial settings. Both Schlauch (2020) and Fenwick and Edwards (2010) argue that different material configurations change educational encounters. To this end, the network metaphor and sociomaterial assemblages are forwarded as important theoretical concepts (Sørensen, 2009; Decuyper & Simons, 2016). Learning, then, is situated in a sociomaterial configuration and knowledge becomes an emergent property of relationally interacting actants (Sørensen, 2009; Luke, 2022). The assemblage effect of learning is illuminated by Luke (2022) in showing that the pause/play button in lecture capture systems plays an active role in the enactment of multiple forms of knowledge. It allows students the ability to enact both liquid and representational knowledge by affording the possibility to integrate a variety of resources and allowing them to control their pace, and place, of learning. This multiplicity of knowledge highlights the role of different networked configurations in the active enactment of knowledge (Sørensen, 2009), going beyond the traditional representational view that assumes knowledge as having an essence, considering its transfer as passive (Hamilton & Friesen, 2013). The sociomaterial perspectives elucidate the crucial role of materials in educational outcomes, showing how the emergent meaning and agency of different actants are intricately related to one another. As such, in a similar vein to the example on authority (Sørensen, 2007), the sociomaterial perspectives foster a move away from teacher-centered considerations of education and towards a more equal distribution within educational practice.

In addition, the concept of stability has implications for the educational sphere. Assemblages are comprised of a complex network of interrelated heterogeneous actants that together produce reality in a constant flux (Sørensen, 2009). Yet, however dynamic, an assemblage can reach stability that is dependent upon the relationships that are present within it (Law & Mol, 1995). Conceptions of education that are unconditionally static or anthropocentric are challenged by the sociomaterial perspectives in that they lay bare the

fluidity, materiality, and interrelatedness of these networks. In turn, this can foster a creation of new conceptual frameworks within educational practice that stimulate both teachers and learners to examine what shapes their learning take on (Fenwick, 2015). It allows them to explore the facilitating and inhibiting roles materials might have and concomitantly allows them to wonder about why certain practices gain stability in education (Fenwick, 2015; Luke, 2022).

Additionally, sociomaterial perspectives provide a valuable lens to understand the complex nature of educational policy. Landri (2015) criticizes educational policy for its neglect of materiality. An example of this neglect is offered in a consideration of the attempted educational convergence in Europe, which tends to resort to quantifiable indicators, such as reducing early school leavers or increasing graduates in certain fields of science (Landri, 2018). These policy statements show an educational tendency towards datafication (Landri, 2018). These data-driven policies are fueled by material infrastructures that mainly go unnoticed until interrupted, revealing the material enactments of educational policies through active contribution of these infrastructures (Landri, 2015). These material enactments can be traced by the theoretical sensitivity of the sociomaterial perspectives, revealing the underlying complexities of educational policies (Fenwick & Edwards, 2010). Here we can draw the parallel with Latour's (1994) example, where, through the same theoretical sensibilities, a speedbump can be seen as a network in which policy coincides with human actants to enforce itself. This complex heterogeneous network of interrelated actants then produces effects (Sørensen, 2009). Thus, even in terms of policy management, actants dynamically co-create each other's goals and functions, and are dependent upon each other to gain meaning.

Furthermore, sociomaterial perspectives open up the blackboxed consideration of educational practices. Educational policies and practices are often viewed as a static, taken

for granted entity (a matter of fact). Applying a sociomaterial perspective allows us to network these practices and examine how each component in this assemblage influences and is influenced by other actants within it (Decuyper & Simons, 2016). Diverse performances of the same policy, for example one of the objective quantifiable indicators for educational quality, are dependent upon the material and social configuration in which it is enacted (Landri, 2018). This datafication then inherently overlooks the complexity of educational practices (Landri, 2018). Dependent upon the location of a school and the demographics of its teachers and learners, the same policy can namely lead to very different practices (Fenwick & Edwards, 2010). As seen in the example of Luke (2022), materials can reconfigure the educational space by introducing and connecting actants within the assemblage, leading to either stabilizing or destabilizing effects that make policies more, or less stable and/or effective (Landri, 2015). By examining heterogeneous entanglements between humans and materials we can be sensitive to educational complexities and understand what constitutes the multiplicity of educational policy

To reimagine educational policy, research may benefit from rigorous sociomaterial analyses of how contemporary and past materials contribute to form educational practice (Sørensen, 2009). According to Sørensen (2009, p. 190), ‘literature on educational technology implicitly creates an image of school practices as having been devoid of technology until the arrival of the computer’. In line with this, Selwyn (2011) argues for an analytical focus on the actual implementation of technology in educational practice, instead of a continued focus on how it should be used. Through an analytic comparison of technologies in practice, both digital and analogue, different forms of knowledge become apparent (Sørensen, 2009). The question then comes to be about which forms of knowledge we want to be more apparent in education (Sørensen, 2009).

In more concrete terms, the sociomaterial perspectives can help, through continued effort in educational research, translating the understanding of educational policy to a more reflective and reflexive educational practice. This amounts to a responsibility of educators and policymakers to recognize and act upon material entanglements in education. According to Fenwick (2015), this would entail a sensitivity towards minor fluctuations and intra-actions of the dynamic emergence of reality with an examination of others' and one's own effects on that what is emerging. What is elucidated through the application of a sociomaterial lens, is the multiplicity of knowledge and learning. This multiplicity allows a redefinition of the physical arrangements in education in that they should connect the different forms of knowledge through translatable educational practices (Sørensen, 2009).

In a more contrasting vein, the heterogeneous nature of the sociomaterial perspectives may be problematic. This heterogeneity inherently means that the sociomaterial perspectives use a large array of different concepts (Decuyper & Simons, 2016), which can be conceptualized as theoretical technologies (Dewey, 1929, as cited in Sørensen, 2009). These theoretical technologies, within the framework of an agential realist ontology, then perform different intra-actions leading to different forms of knowledge (Barad, 2003). Thus, in this relationally emergent approach to reality knowledge is theoretically mediated, allowing different theoretical concepts to have an influence on the outcome. The apparent heterogeneity of the sociomaterial perspectives may therefore lead to different conclusions across the body of research that is being done under the sociomaterial flag, making their influence rather diffuse. An increased dialogue between theory and practice could therefore be useful to converge the evident heterogeneity within this paradigm, allowing for a more solidified influence of this paradigm. However, sociomaterial approaches are to be viewed as a sensibility and not as a totalizing theory of the world and its problems (Fenwick &

Edwards, 2010). This means that sociomaterial perspectives do not attempt to arrive at an undisputable truth but is rather used as a framework to question the reality we are used to.

Conclusions

Despite the heterogeneity that is apparent in the sociomaterial perspectives, in this paper I have attempted to capture their core theoretical assumptions in relation to learning. Through an outline of different concepts that are used by these perspectives, a dynamic consideration of reality emerges that considers materiality in an agential role. Applying these perspectives to the sphere of education revealed their capacity to reconsider terms that were previously taken for granted. This critical review may open doors to renewed practices within education, more dynamic practices through an awareness of the continuous emergence of the education. Whereas the sociomaterial perspectives have seen widespread empirical applications, their heterogeneous nature prevails throughout the body of research. To fully realize the potential of the sociomaterial perspectives, it is thus important that the dialogue between the fields of theory and practice is continued and encouraged, something which this paper attempted to engage itself in.

In conclusion, the sociomaterial perspectives offer a complex new lens through which learning can be viewed. The relational conception of reality challenges traditionally accepted beliefs (Barad, 2003), making it a time-consuming endeavor to fully grasp what these perspectives entail. However, once understood, the sociomaterial perspectives undeniably allow for important conceptual and practical developments with regards to learning. Their theoretical concepts democratize analytical considerations in this field (Schlauch, 2020). In the face of its heterogeneity, they urge a move away from anthropocentrism, towards a serious consideration of materials and their inherent entanglements with humans (Sørensen, 2009). A lasting influence in the field of learning is yet to be attained and it is the task of future researchers to solidify the influence of the sociomaterial perspectives.

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