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Research Article

# Theorising sociomateriality in online learning: cutting through the complexity

Malcolm Garbutt , Carolien van den Berg

Department of Information Systems, University of the Western Cape, South Africa

**ABSTRACT**
The COVID-19 pandemic has intensified the need to develop theory and practice in digital education. In this position paper, we expand on the research conducted in information systems (IS) on sociomateriality by applying it to online learning. The aim was to provide a theoretical underpinning for guidelines to reduce the complexity of social and material combinations in digital education. An overview of sociomateriality within IS research is provided, distinguishing between two sociomaterial perspectives to situate the research. A high-level review of student learning as the social and online learning as the material is applied to a four-quadrant model to unbundle the complexities within this space. Our perspectives are supported by feedback from a third-year information systems course that confirmed the merit of the model and broadened research in online learning. The model is further refined with a philosophical underpinning of Ackoff's four pursuits of humankind to provide recommendations for future interventions.

**Keywords:** Affordances, critical realism, entanglement, imbrication, information systems education, online learning, theorising sociomateriality

**Categories:** • *Applied Computing* ∼ *Education, e-Learning*

**Email:**
Malcolm Garbutt mgarbutt@uwc.ac.za (CORRESPONDING),
Carolien van den Berg cvandenberg@uwc.ac.za

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## 1 INTRODUCTION

The COVID-19 pandemic lockdown forced traditional face-to-face higher education institutions to adapt to online learning abruptly. Online learning combines social (i.e., learning) and material (i.e., internet and communications technology) components to produce technology-mediated education. Although traditional learning combines social and material, online learning involves the advanced use of technology while separating social actors and physical materials by time and space (Niemimaa, 2016). This separation changes the learning profile by modifying the relationships between social and material. For example, Vladova et al. (2021) suggest three adjustment categories to online learning: time flexibility, learning flexibility, and

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social isolation. In developing countries, social separation may be increased through material inequality, extending the existing digital divides (Singh et al., 2021).

In the shift to fully online teaching, we observed these impacts on learning to varying degrees. Noting that engagement ranged from committed students to non-committed students, from preferring to work at home to working on campus, we encountered students for whom the shift to online learning was easy and others who found it complex. Simultaneously, we observed students for whom technology was taken for granted and others who only used technology because they were required to do so. The same was observed for other material aspects, such as learning spaces. This led us to consider how we can generically address issues with class sizes of 300, 400, 500, and 600 students.

In the information systems (IS) space, a substantial amount of research has explored the relationship between social and material under the banner of sociomateriality (Bratteteig & Verne, 2012a, 2012b; Cecez-Kecmanovic et al., 2014; Leonardi & Barley, 2008; Niemimaa, 2016; Orlikowski, 2007). In this positional paper, we expand on this work and apply it to higher education to provide guidelines for reducing the complexity of social and material combinations in online learning. We took a retrospective-prospective pragmatic approach to review our understandings of online teaching brought about by the pandemic, which may be applied in the anticipated increased use of blended learning (Hrastinski, 2019; Rasheed et al., 2020) as the pandemic reduces and lockdowns are eased. Furthermore, technology-supported learning is expected to be increasingly used to overcome the high cost and low scalability of traditional learning methods and meet the long-term needs of lifelong learning and the growing demand for technological skills in employment (Eltahir, 2019).

Central to the sociomaterial aspect of learning is the differentiation of physical and virtual spaces, which have become entanglements in online learning. Learning spaces are often indistinguishable due to the embedding of online learning in daily surroundings (Singh et al., 2021), particularly in poor communities where living space is severely restricted. Focus on “virtual”, “online”, “digital”, and “technology” for the most part ignores the physical surroundings, which reinforces a binary approach through idealizing technology as not being bound to time and space. As the pandemic-forced move to online learning has shown, the lines have blurred between the virtual and physical (Singh et al., 2021). In addition to the primary responsibility of doing their university work, students had responsibilities in their home environments, such as cooking, cleaning, and other chores, which negatively affected many students (Abujarour et al., 2021). While students created virtual learning spaces in these often crowded living spaces, they struggled with a lack of social interaction for lessons, tutorials, workshops, and practical lessons (Adnan & Anwar, 2020). The situation was exacerbated by digital divides resulting in limited access to technology (Iyer & Chapman, 2021; Singh et al., 2021). recommend creating enabling conditions to mitigate learning space challenges. These enablers include academic institution digital upgrades, redesigned curricula, and digital content development.

This positional paper aimed to situate these practical recommendations within a philosophical model to guide the practical application from ontological, epistemological, and methodo-

logical perspectives using a sociomaterial view.

The paper proceeds as follows. In the next section, we review the two predominant sociomaterial views in IS research and how these views can be integrated with support from the model of Bratteteig and Verne (2012a). In the third section, we apply excerpts of feedback from a third-year higher education institution course to the model. The fourth section discusses the model's implications and findings, and we conclude the paper in section five with an overview, limitations, and further research.

## 2 SOCIOMATERIALITY BACKGROUND

During the last decade, a sociomateriality view of information systems has come to the fore (Orlikowski, 2007). Two ideas pervade understanding of the sociomaterial intertwining of the social and the material. On the one hand, the social-material imbroglio is considered a separable imbrication (Leonardi & Barley, 2008) and, on the other, an inseparable constitutive entanglement (Orlikowski & Scott, 2008). These views are based on critical realism and agential realism, respectively. Critical realism believes there is an absolute reality beyond human knowledge in which only events resulting from structurally-controlled interactions of material and non-material agents are visible (Bhaskar, 2008). Agential realism believes that reality is constructed from entangled interactions of human and non-human networks that exist in relation to their mutual constitution in the world (Barad, 2007). Agential realism recognises that only cross-sectional agential "cuts" can be analysed, whereas critical realism hypothesises mechanisms and structures that provide predictable events. Hence, the two views are incommensurate.

Orlikowski has been promoting a sociotechnical view of information systems for over three decades (Orlikowski & Baroudi, 1991) and has extended the technical view to include all forms of materiality emanating from the practice of agents. This is achieved from an integrated (or constitutive entanglement) view of humans and materiality (Orlikowski & Scott, 2008). According to Archer (2007), being human in the world necessitates interaction between humans and the world that can only be understood analytically. Archer's world constitutes a combination of nature and practice that resonates with the materiality of Orlikowski. In Orlikowski's understanding of sociomateriality, social and material are inseparable and ontologically based on Barad's agential reality (Orlikowski & Scott, 2008). However, inseparability has been criticised because the concept suggests distinct elements that are counterintuitively incapable of being separated (Kautz & Jensen, 2013). The morphogenetic approach proposed by Archer (2010) explains structure, culture, and agency as a stratified ontology capable of producing emergent and irreducible outcomes that range from reproductory to transformatory. As observed in the structural theories, structure and agency are considered intertwined but not inseparable (Archer, 2010). Inseparability causes the blurring of the boundaries between subjectivity and objectivity, reducing the ability to change circumstances (Archer, 2007) and making analysis of emergent properties difficult. From a systems approach, the separation of subject and object permits emergence resulting from combining the individual elements.

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Sociomaterial emergence is simplified in the imbrication notion described by Leonardi (2013). Imbrication is based on the Greco-Roman roof tiling system that uses two distinct forms of tile (tegulae and imbrices) to provide a waterproof covering. Tegulae are flanged tiles laid side by side with flanges covered by semicircular imbrices. While the tegulae may give some protection, thorough waterproofing is only realised through imbrication. The imbrices also have other uses; for example, inverted, they can be used for guttering. Although each part can be used separately, the amalgam exhibits emergent properties.

The philosophical basis for Leonardi's stance is associated with systems thinking, which Mingers (2004) associates with Bhaskar's critical realism.

## 2.1 Differentiating the Sociomateriality Frameworks

We consider emergence as the central precept to differentiate between the two sociomateriality views. Imbrication (Leonardi, 2011; Leonardi & Barley, 2008) is noted for emergent affordances of separable social and material agents. On the other hand, constitutive entanglements (Orlikowski & Scott, 2008) are signified by the inseparability of social and material agents producing emergent sociomaterial assemblages. Assemblages are not reducible to causal explanations, and the outcomes of the assemblage are only viewable from a temporal-spatial perspective. Agential cuts are used to separate the social from the material temporarily. Although this may assist in describing observed actions, it is unreliable for predicting outcomes in different time-space combinations.

Imbrications acknowledge boundaries when focusing on ways to understand the interaction between social and material. In contrast, constitutive entanglements deem sociomaterial issues to be caused by a lack of boundary between social and material (Archer, 2007; Niemimaa, 2016).

## 2.2 Philosophical Separation

Fundamental similarities and differences between the sociomateriality views may be better understood by examining their philosophical stances regarding action and activities. Orlikowki's agential realism combines historical and future views of the social and material as co-developing (Orlikowski & Baroudi, 1991). These views are observable through their "constitutively entangled" interactions and are not readily separable (Orlikowski, 2007, p. 1437). On the other hand, Leonardi (2013) takes the critical realist view of social and material as pre-existing and only knowable through the limited observable events generated by them (Mingers, 2004). This view resonates with the Habermasian third world, where social and material (subjective and objective) worlds combine to produce activities (Mingers & Willcocks, 2014). Both philosophies recognise activities and communication (practice and discourse) as fundamental outcomes (Mingers & Willcocks, 2014; Orlikowski & Scott, 2015). Similarly, practice and discourse are essential to social discourse that produces materiality. Laclau and Mouffe (cited by Al-Amoudi and Willmott (2011, p. 28)) describe discourse as a "structured system of differ-

ential positions that has a material character and confers meaning to its elements". Practice and discourse are at the heart of activity theory, with the subject performing meaningful actions on a work object towards an outcome through communication (Taxén, 2009).

From an Orlikowskian sociomateriality interpretation (Orlikowski & Scott, 2008), constitutive entanglements focus on the activities between the social and material. However, this view fails to explain consistent transitions between the material and social agents and thus provides less opportunity for action and change (Bratteteig & Verne, 2012a). A system of agential cuts may separate the social and material but fails to provide a stable longitudinal understanding. However, shifting focus from interactions to discourse over time may help understand changes in practice (Orlikowski & Scott, 2015). Transformatory discourse, meanwhile, retains the essence of the Leonardian perspective. Although Leonardi's critical realist approach perceives the materiality of online learning and components as a priori, his social view includes activities that cause interaction between materiality and discourse (Leonardi, 2013).

Leonardi's acceptance of social and material as distinct entities permits the analysis of the effects of emergence from the union of the social and the material. This embraces the potential for taking action and bringing about change through transformations in either the social, the material, or both (Bratteteig & Verne, 2012a). The ontological critical realist view underpinning imbrication accepts that social and material are only knowable through their actions across time and space (Leonardi, 2013). Space is where events exist while time flows evenly between and during events (Niemimaa, 2015) Conversely, neither the social nor the material can be individually understood by the enquirer since this forms part of the upper stratification of the critical realist view of the world. The mechanisms in the upper real domain cause events to occur in the domain of the actual, some of which may be observed in the domain of the empirical (Mingers et al., 2013). Agential or relational realism, which underpins constitutive entanglements, views social and material as a complex mangle of practice (Pickering, 1993), limiting the potential for action beyond the immediate entanglement (Orlikowski & Scott, 2008). The inability to understand the entanglement's internal (and temporary) stabilisers resembles the actual domain of critical realism. The effects may be observed in the empirical but cannot be transformed there.

Critical realism takes a longitudinal view toward understanding how experiences are produced from events generated by objectively real structures and mechanisms (Wynn & Williams, 2012). Enactment of mechanisms characteristically results in morphogenesis and morphostasis, whereby social structures are changed and stabilised. Morphogenesis and morphostasis are hypothetical explanations of the events that lead to observed experiences. Critical realism is more concerned with transformation (morphogenesis) than reproduction (the outcome of morphostasis), and consequently, routinised action is largely ignored (Archer, 2007). Thus critical realism focuses on transformation and change from a deep ontology perspective, as evidenced in the stratification of the domains of the real, the actual, and the empirical (Mingers & Willcocks, 2014).

In contrast, the form of sociomateriality espoused by Orlikowski and Scott (2008) is onto-

logically flat (Mingers & Willcocks, 2014) and concerned to a greater extent with stabilisation and reproduction. Similarly, flat ontology is noticeable in Latour's actor-network theory that is entwined with Orlikowskian sociomateriality (Wynn & Williams, 2012), where the social is neither above nor below a bounded arrangement of practices and structures (Schatzki, 2011).

According to critical realism, experiences observed in the empirical domain are caused by underlying mechanisms in the actual domain. Experiences can be empirically tested and understood through retroduction (Wynn & Williams, 2012), which is a creative process (Wynn & Williams, 2008). Retroduction seeks to propose a hypothetical mechanism that may cause a particular phenomenon (Leonardi, 2011). Being hypothetical signifies that the mechanism may not exist. The mechanism pre-exists in Orlikowski's sociomateriality, but its outcome/phenomenon may differ across time and space. In contrast, the critical realist view does not preclude different phenomena arising from the same hypothetical mechanisms in another time and space.

Niemimaa (2016) depicts the two frameworks for sociomateriality research as a duality. In Figure 1, imbrication occurs through affordances of the social and material. On the other hand, agential cuts of constitutive entanglements reveal possibilities of existing and future entanglements.

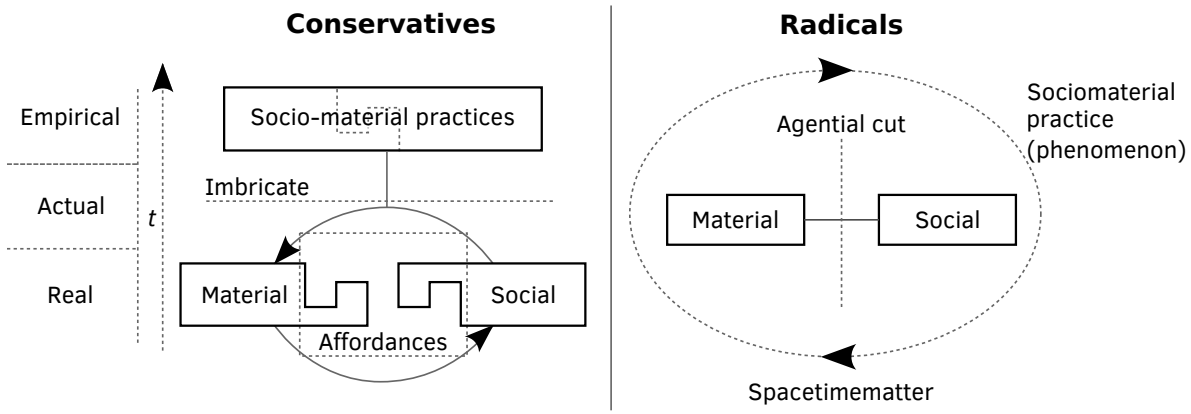


Figure 1: Frameworks for Sociomateriality Research (Niemimaa, 2016).

Emergent affordances are the relationships between material qualities and the social perception of action based on those qualities (Leonardi, 2011; Volkoff & Strong, 2013). According to Gibson (2014), affordances are the potential for action offered or provided by an object to someone or something. Affordances are more regularly considered for an item than its properties such as colour, shape, size, texture, mass, or mobility. The material's affordances are regulated by mental images held by the social agent from past interactions with similar materials. Conversely, the material agency's affordances alter the social agent's capacity for action (Niemimaa, 2016). Affordances are considered mechanisms in the critical realist stratum of the real (Volkoff & Strong, 2013) and can be identified through regular interactions between the social and material over time and analysed longitudinally (Leonardi, 2011). A material

agent may have multiple affordances for social agents with diverse outcomes (Leonardi, 2011). Thus, affordances are "materially and historically conditioned space[s] of action" (Leonardi & Barley, 2008, p. 51).

Niemimaa (2016) associates affordances with imbrication but not constitutive entanglements. For the latter, Niemimaa used the term possibilities. Later, Niemimaa (2018) linked affordances to agential realism (the philosophy underpinning constitutive entanglements), warning that these affordances are not emergent properties of material agents but possibilities for networks between the material and social agents. We agree with this view. However, for clarity and longitudinal stability, we consider (emergent) affordances as a property of imbrication and possibilities as reconfiguration of relationships between social and material agents for constitutive entanglements. Volkoff and Strong (2013, p. 823) observe that affordances simplify understanding sociomaterial problems, but researchers must uncover "the immediate concrete outcomes the actors experienced or expected to experience" to identify the affordances.

Emergent affordances from imbrication can be reduced to the relationship between the social and material based on retroduced mechanisms. However, entanglement outcomes are not easily identified over time and space. Hence to analyse the entangled sociomaterial effect, there is a need to simplify the complexities that give rise to entanglements.

## 2.3 A Sociomaterial Disentanglement Framework

In their study of a tax call centre, Bratteteig and Verne (2012a) suggest that aspects of sociomaterial assemblages may be likened to imbrications and accordingly disentangled into social and material agencies. Concerns of call centre users for whom the tax rules are entangled may be addressed by human agents at the call centre who "translate the problem from an entanglement to an imbrication" (Bratteteig & Verne, 2012a, p. 18). This enables entangled problems to be addressed and a course of action prescribed for the call centre user. With the understanding that sociomaterial entanglements are epistemological and not ontological, Bratteteig and Verne (2012a) developed a four-quadrant model to explain the potential for disentanglement. The first axis represents structure (tax rules), and the second is the social context, ranging from simplistic to complex.

The social context of Bratteteig and Verne (2012a) is straightforward and referred to in the framework as social in Figure 2. The structural contexts (tax rules) are synonymous with materiality, referring to both nature and the outcomes of practices of human beings in the world (Archer, 2007). Consequently, the structural context is entitled material in the figure. Tax rules represent materiality in the social context.

The model holds potential for assessing online learning. For example, Rasheed et al. (2020) show combinations of easy and complex sociomaterial challenges in online learning. Sociomaterial challenges are presented in three categories, students, teachers, and institutions. Student challenges include self-regulation challenges, technological literacy and competency challenges, student isolation challenges, technological sufficiency challenges, and technological complexity challenges. Teacher challenges include teachers' technological literacy and

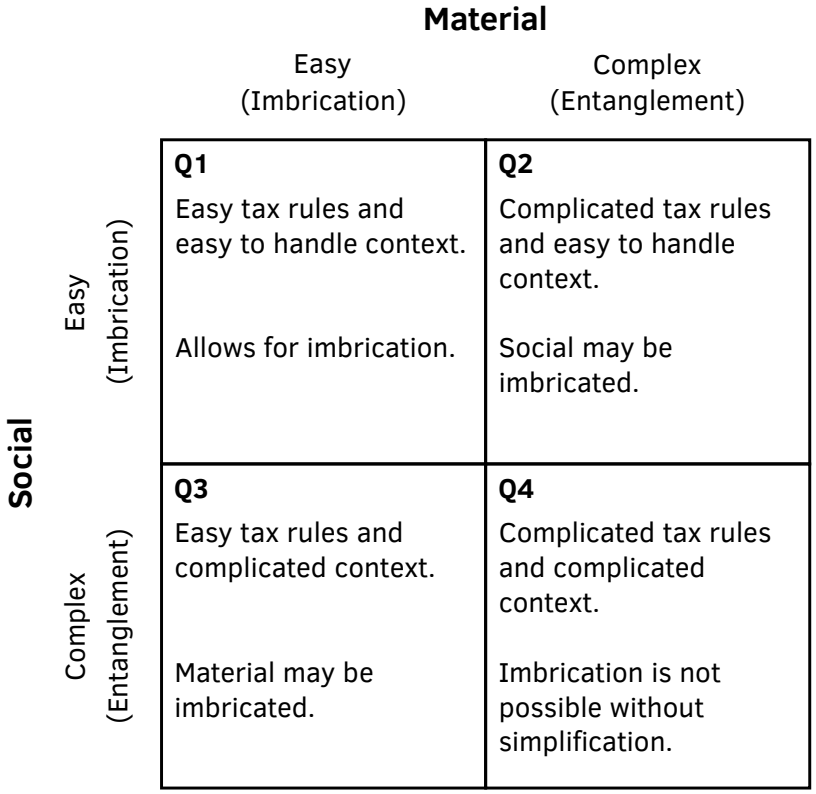


Figure 2: Sociomaterial Disentanglement (Bratteteig & Verne, 2012a).

competency challenges, online video challenges, technological operational challenges, and teachers' belief challenges. Education institution challenges include technological provision challenges, teachers' training challenges, and lack of technicians. These observations show online learning as combinations of social and material ranging from simple to complex. Placing Rasheed et al.'s (2020) findings into the model of Bratteteig and Verne (2012a) can provide insight into the aspects of online learning that need to be simplified to be researched and addressed.

The question yet to be answered is how to adapt to the simplified imbrication and identified affordances. One method is found in early Greek philosophy, reviewed in the next section.

## 2.4 Potential Philosophy Underpinning the Four Quadrants

Ackoff (1978, p. 14) distilled millennia of philosophical thought on the pursuits of humankind into four categories:

1. Scientific -– the pursuit of truth
2. Political-economic -– the pursuit of power and plenty

3. Ethical-moral –- the pursuit of goodness and virtue

4. Aesthetic –- the pursuit of beauty

The scientific is socially and materially complex and resides in quadrant 4. The political-economic is materially complex and categorised in quadrant 2. The ethical-moral is socially complex and is classified into quadrant 3. The aesthetic and the pursuit of beauty are neither socially nor materially complex and are categorised into quadrant 1. Although defining and understanding beauty and its associated property quality is complex, everyone recognises beauty irrespective of subjectivity, and identifying material as aesthetic is not complex. Thus, affordances are evident for the pursuit of aesthetics, and imbrication is allowed.

Ackoff (1978) relates the philosophy of aesthetics to its Greek origins 2500 years ago to support the concept of problem-solving as an art. In essence, art has two foundational notions: creative from Plato; and recreative from Aristotle. Creativity is the inspiration to create an alternate future motivated by dissatisfaction with the present state. Recreative is palliative, relaxing, and fun and produces stability and contentment in the present. These concepts resemble the morphogenetic approach of morphogenesis (creative – inspiring) and morphostasis (recreative – fun).

We have adopted and adapted these concepts in this paper to address the art of online learning.

## 3 THE ART OF ONLINE LEARNING

Bratteteig and Verne (2012a, p. 19) recommend that under challenging situations, entanglements are disentangled into constituent agents to "*open a space for negotiation, choice, action, and change – and for autonomy.*" This recommendation translates as changing entanglements into imbrications and resonates with observations from a third-year student survey.

> I would like for tutors to assist with breaking down work which may be quite complex to understand, as some of us may struggle just because of the complexity of language in the content being taught whereas we have the capacity to understand if it is broken down into simpler wording. (Respondent 237)

The excerpt shows that the respondent considered learning easy, not complex. We use the term "easy" in deference to Bratteteig and Verne (2012a) but are not insinuating that learning is effortless or straightforward. We prefer to use the term less complex, where students are motivated and have the "capacity to understand." As an example, the following quote shows social ease with material complexity.

> I need … extra support material for learning all the contents done in the class. I know going to [the learning management system] … is important, but with so many modules it is kind of hard to keep track of the work that is due and I would

> appreciate it so much if we were reminded in our emails or in our WhatsApp group chat about the work that needs to be completed. (Respondent 127)

Affordances and possibilities provide the connective "glue" to link material and social agents be they technological or educational. We considered learners as social agents and online learning as material agents for this paper. We understand online learning as an emergent affordance of learning and technology (imbrication) and a possibility for constitutive entanglement. Likewise, learners are considered from two perspectives, students who find the course work less complex (imbrication) and students who find the course work complex (constitutive entanglement). This is depicted in Figure 3 in the four quadrants from Bratteteig and Verne (2012a)

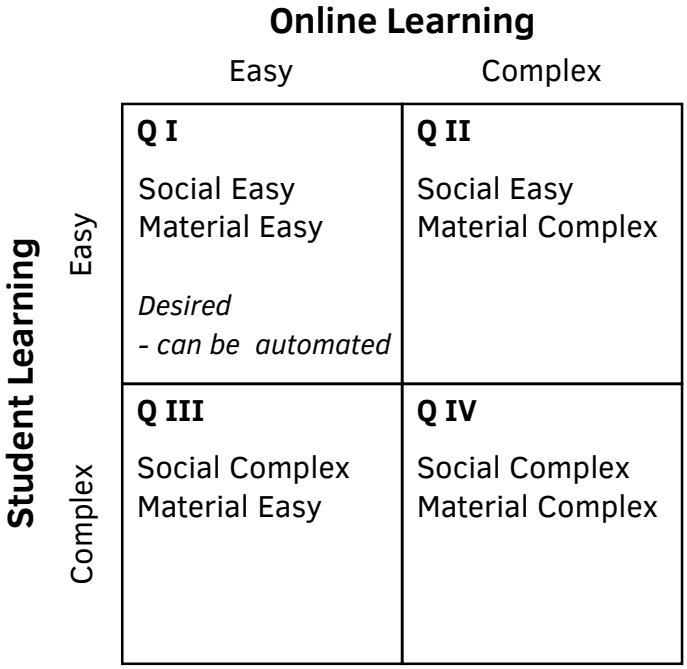


Figure 3: Sociomaterial Model for Online Learning

Quadrant I – Social Easy / Material Easy [Desired State – Disentangled to Imbrications]

In quadrant 1, social and material can be imbricated, and emergent affordances can be identified. Students (social) remarked on how accessible (easy) the learning was and how well the technology (material) worked.

> I appreciate the amount of effort put in by the lecturers and all those who work in the department. The level of effort put in is unmatched. The [learning management system] is very easy to navigate, and the layout makes it especially easy to track

> the work you have gone through each week. The addition of extra resources also makes learning easier. (Respondent 614)

### Quadrant II – Social Easy / Material Complex

In quadrant 2, student learning can be imbricated, but online learning must be simplified. Most students observed learning as easy in the presence of sufficient material. Limited reference was made to effort and placed the onus for their learning on their lecturers' explanations and teaching ability.

> I would like the lecturers to explain more about the weekly exercises because even though I consult with the tutors on what exactly is required. I still find it a bit challenging to fully understand the lecture slides as I'm not sure if we should only be reading to understand or remember exactly what we have read.
>
> (Respondent 283)

### Quadrant III – Social Complex / Material Easy

In quadrant 3, online learning can be imbricated, but student learning must be simplified. Social complexity often ignored material complexity rather than assuming it was easy.

> As a lecturer or a tutor, you must let your students know that you are there for them and that if they need help to reach out to you. Let them know that you are (I hope) in touch with counsellors or mental health experts that can help [students] should they need to speak to someone. (Respondent 48)

The following quote notes the potential for imbrication of material leading to inspiration (hence, Ackoff's creative).

> [I need w]ell organised assessments and well-structured content that is easily understandable. Lecturers and tutors should be more clear to what they lecture so that it gives students the desire to study. (Respondent 111)

Irrespective of the level of material complexity, social complexity was also observed in the contrasting views of some students. "*[A strength is the] content. The encouragements! The new way in which the lecturers brought outside or industry concepts into the curriculum.*" (Respondent 362). In contrast, Respondent 86 looked for more support "*in a manner that can be understood as well as by giving practical examples to bring the message across.*"

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Quadrant IV – Social Complex / Material Complex

Quadrant 4 shows the need for simplification as the entanglement of social and material complexity negates the potential for imbrication.

> When it comes to diagrams, I would like them to give enough explanations as to how to go about understanding the particular diagram. (Respondent 10)

> I need [e]laborated material through Powerpoint slides, videos and a recorded version of the lecture, exercises to practice weekly to test our understanding and if we can apply the knowledge, because application is important, feedback from tutors and lecturers from tests so we know where we went wrong.
>
> (Respondent 157)

Like social complexity, material complexity was observed in contrasting views of material agents. Some students wanted additional material, "*The lecturers should provide us with additional readings on the various topics and practical examples that could assist in our learning experience.*" (Respondent 172). Other students wanted less material, "*There are a lot of reading materials to be done in each week if the reading material can be minimised.*" (Respondent 176)

## 3.1 Imbrication Affordances for Online Learning

Following the creative/recreative pursuit of the aesthetic of Ackoff (1978), quadrant I requires inspiring and fun imbrications. This resonates with the student feedback.

> I would love to have the lecturers and tutors create a learning environment that reinforce[s] the view that students are able to master and excel at their respective academic subjects. (Respondent 217)

Respondent 19 recommended that the lecturers "*provide sufficient resources and make the module seem fun and enjoyable,*" while Respondent 81 required "*practical tasks like the game we had last semester. It was one of the best and most fun tasks [I have] done.*"

Some students showed insight into the connection between inspiration and fun. "*I would also require fun quizzes and discussion forums, For example, games that would help me understand my work and help me to want to learn more.*" (Respondent 166)

# 4 DISCUSSION

The Covid-19 lockdown provided unprecedented opportunities for theorising online learning. Although a significant volume of online learning literature existed before the pandemic, it has been dominated by voluntary use with limited scope. COVID-19 provided a base for research

on a topic that has been forced onto a large population. Online learning has several characteristics that make it possible to examine it from multiple viewpoints. Our interest was the nexus of social and material. We have taken a high-level view of student learning as the social and online learning as the material. Both forms extend along a continuum from easy to complex. Restricting student learning to social is insufficient as learning is not limited to students but includes lecturers in behaviour from easy to complex ways. For example, Cronjé (2022) suggests that blended learning combines behaviouristic and constructivist teaching. Whereas behaviouristic education depends on lecturers as teachers (i.e., constructive entanglements), constructivist teaching is scaffolded with more reliance on students as learners (i.e., imbrications). Online learning combines teaching and learning using information and communication technology to varying degrees (Rasheed et al., 2020; Singh et al., 2021; Vladova et al., 2021). Thus, online learning may be analysed as imbrication or constitutive entanglement.

Whereas Niemimaa (2016) separates the two forms of sociomateriality of Orlikowski (2007) and Leonardi (2011), Bratteteig and Verne (2012a) offer a model that allows sociomaterial phenomena to be researched from multiple perspectives. Imbrications (Leonardi, 2011) are separable and can be analysed based on their emergent affordances. Constitutive entanglements are more complex and require agential cuts to analyse emergent assemblages. Emergent assemblages are more volatile than emergent affordances and consequently require the more stable imbrication of emergent affordances for longitudinal research. This means that the ideal quadrant for research is the social easy/material easy quadrant 1. Consequently, Bratteteig and Verne (2012a) suggest that complex aspects must be simplified to understand a sociomaterial phenomenon such as online learning.

We applied online learning to the Bratteteig and Verne (2012a) model to produce four quadrants of student learning and online learning tools. The four quadrants allow online learning to be viewed from four perspectives, social easy/material easy, social easy/material complex, social complex/material easy, and social complex/material complex. We supported our perspective with excerpts from feedback from a third-year information systems course. Our analysis shows that the Bratteteig and Verne (2012a) model is an adequate starting point for online learning research.

In answering the second question of how this would impact our teaching, we applied Ackoff's four pursuits of humankind (Ackoff, 1978) to the Bratteteig and Verne (2012a) model. Our target quadrant 1 correlated to the pursuit of art, which Ackoff determines to combine creative and recreative. Reifying creative and recreative to inspiring and fun (Ackoff, 1978), we observed that this resonates with the feedback from our student survey.

The Bratteteig and Verne (2012a) model teaches us that there has to be a simplification of the social and material in combination with the application of creation and recreation. We recommend that lecturers of online courses simplify student learning and online learning tools and then endeavour to make the coursework inspiring and fun. The caveat is that in the application of quadrant 1, inspiration and fun are the end of a process and not the start. As Ackoff (1978) shows, aesthetics is the fourth pursuit which begins with scientific (knowledge and truth with social and material complexity). It flows through the pursuit of power and

politics (material complexity) and the pursuit of ethics and morals (social complexity).

## 5 CONCLUSION

The purpose of this paper was to revisit theory to explore the complexities we have experienced in the forced move to online learning. Online learning has blurred the lines between the virtual and the physical, and the advanced use of technology further exacerbated digital divides. The aim was to explore practical recommendations within a philosophical model that guides the application from ontological, epistemological, and methodological perspectives. Applying a sociomaterial view makes it possible to contemplate the line between the social and the material.

The paper explored two sociomaterial views to interpret the intertwining of the social and the material in IS research based on critical realism (Leonardi, 2011) and agential realism (Orlikowski, 2007), respectively. In critical realism, the social and the material are considered a separable imbrication (Leonardi & Barley, 2008) and, therefore, can change through a social or material transformation. In agential realism, the sociomaterial entanglement is not readily separable, and only cross-sectional agential "cuts" can be analysed, providing less opportunity for action and change (Bratteteig & Verne, 2012a). Within the quest to demystify the complexities within the online space, applying a critical realism perspective opens up possibilities to interpret the mechanisms through which social interacts with material (the process of imbrication) as regulated by affordances for enactment (Niemimaa, 2016).

The application of the Bratteteig and Verne (2012a) model provides an opportunity to disentangle the social and material agencies to allow online learning to be viewed from four perspectives, social easy/material easy, social easy/material complex, social complex/material easy, and social complex/material complex. The proposed model was tested using excerpts of feedback from a third-year information systems course. Our analysis confirmed the merit of the model to broaden the research in online learning.

In order to find a philosophical underpinning to explore the impact of this model, the four pursuits of humankind (Ackoff, 1978) were applied to the four quadrants. This highlighted the possibilities of targeting quadrant 1 for learning interventions that are creative and recreative, interpreted as inspiring and fun which resonated with student feedback. The emphasis in quadrant 1 should be on inspiration and simplification.

The model verification was limited to anecdotal evidence from one university course module, and further testing and refinement are recommended. Interventions should focus on quadrant 1 of the model, with outcomes measured over time. More research on creative and recreative practices is required, particularly pertaining to networked learning.

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