Implementation as a constitutive entanglement: Framing sociomaterial pedagogical practices emerging from the implementation of a learning management system
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Abstract
Are there concealed ways of using a learning management system (LMS) among educators in higher education? This paper argues that it is the case, and uses a sociomaterial bottom-up perspective to understand how a group of educators used a new LMS that was implemented at a Nordic university. Understanding an implementation as a constitutive entanglement, a sociomaterial research lens is applied to explain that in an implementation current technology usage evokes previous knowledge and assumptions about technologies and shapes the engagement with new technologies. This study found that when educators engaged with a new LMS, they viewed it as complex and needed to perform strategies that reduced technology complexities into practices that they knew. This engagement formed three sociomaterial pedagogical practices. A sociomaterial perspective might cast new light on how we understand the outcomes of technology implementation processes in educational contexts.

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Introduction
Educational research on LMS is massive, and often employ rational top-down perspectives to track the various phases of a technology implementation process. Meta studies of educational use of LMS establishes that researchers use technology adoption perspectives to explain that students have positive user experiences and that educators struggle with adoption (Araka, et al., 2020; Turnbull, et al., 2021a). That said, the mentioned research represents an opportunity for introducing an alternative approach to study technology implementation processes in educational contexts. This can be found in sociomateriality. It is a practice lens that can be applied as a bottom-up perspective to grasp an implementation as a constitutive
entanglement, and thereby enhance our understanding of the unexpected, unpredictable, and conflicting practices that can happened in an implementation.

Thus, a sociomaterial perspective was employed to analyze how a group of educators used a new LMS implemented at a Nordic university. This study aimed to demonstrate that engaging with a new LMS is demanding; it is perceived as a complex technology which challenged educators to perform strategies that reduced technological complexity into practices that they could master. In many cases, educators turned to past technology and pedagogical experiences in order to use a new LMS. In the process, they enacted sociomaterial pedagogical practices that shared similarities to known pedagogical practices, including course organization, assessment, and communication with students.

Therefore, this paper asks the following research question (RQ): *In what ways can there be concealed patterns for organizing pedagogical practices when using LMS?* To answer the RQ, the paper performs an analysis over four parts. The first part outlines the theoretical perspective and establishes an understanding of sociomateriality as outlined in educational research. The second part accounts for this study’s qualitative research design. Also, the background for the study is accounted for. The third part performs a data analysis and shows three sociomaterial pedagogical practices. Finally, the fourth part discusses the study, while the last part provides a summary and conclusion.

## Part I: A sociomaterial practice lens on education

Sociomateriality is a research agenda inspired by actor network theory (ANT) (Latour, 2005; Law, 1992) which has been substantially developed in information system and organizational research (Orlikowski, 2010, 2007; Orlikowski and Scott, 2008). The emergence of sociomateriality is connected to the ‘material turn’ a call from researchers claiming that studies of technology is overlooked in the social sciences and humanities and needs to be examined (Kallinikos, et al., 2012).

Sociomateriality has no set definition but challenges our understanding of what technology “is” or might be. Fenwick (2014) argued that traditional technology perspectives tended to approach technology and people as separate and self-contained entities, meaning that they were separated by clear-cut forms, properties, and boundaries that with deterministic effect shaped each other. By contrast, sociomateriality acknowledges another view; it is a practice lens that grasps technology and people as relational and symmetrical, and as entangled in immaterial and material activities and relations (Orlikowski and Scott, 2008). Sociomateriality recognizes that the material and the immaterial as equal, meaning that *relationality* has emphasis.

When researchers rethink the meaning of technology, sociomateriality becomes extensively theorized and makes certain core assumptions. For example, the material and the immaterial are understood as inherently interrelated and mutually constitutive and are based on a relational ontology being a ‘constitutive entanglement’ [1]. All materials are assumed to be dynamic and grasped as ‘intrinsic to everyday activities and relations’ [2]. Objects are perceived as heterogeneous assemblages, implying that objects are embedded with a preceding history that can be evoked when performed into practice as part of temporary and situated events (Orlikowski and Scott, 2008). Researchers acknowledge that the material and the immaterial are effects of connections and activities being part of a web of relations making sense when performed into existence (Fenwick, 2014).

Over time, theorizing has contributed to the development of key directions which dispute the ontology and agency capabilities of human and non-human actors. An *agential realist view* (Barad, 2006, 2003) assumes a relational ontology, and contends that ‘the social and the material are inherently inseparable’ [3], implying that technology and humans are so neatly stitched together that they continuously affect each other (Orlikowski, 2010, 2007). A *posthuman perspective* (Barad, 2006, 2003) argues that materialities are
somewhat ‘substance free’ and can be the outcome of the emergence of intra-activity enacted as a phenomena through material discourses. A substantialist perspective (Leonardi, 2013) puts emphasis on the material and perceives the material and the immaterial as mutually independent, meaning that substances can be self-contained entities that have agency capabilities independently of time and space.

The material turn crosses over to educational research. It appears as the process of developing a separate sociomaterial research lens, connecting technology and pedagogy in new ways (e.g., Bhatt and De Roock, 2013; Fenwick, 2014; Han and Ellis, 2019; Hannon, 2013; Lundtofte, et al., 2019; Smythe, 2018; Wilson, et al., 2017; Zukas and Malcolm, 2017). This research stream combines agential realist and posthuman perspectives. Fenwick (2014) explained that a clearer emphasis on understanding practice contributes to a shift from individual subjects to larger sociomaterial collectives. The research focus is not on emphasizing a few forms, boundaries, and properties, all in the zone of close proximity to students, but understanding the larger effects of an ongoing relationship between technologies and pedagogy.

This analytical focus means that technology and pedagogy become constituted, contextualizing technology and pedagogy as part of larger sociocultural contexts, where these contexts affect practices. This perspective contributes to a re-examination of pedagogical concepts and practices in a new light, a point noted in recent studies. For example, Bhatt and De Roock (2013) applied an agential realist perspective and aimed at understanding digital literacies among students in a classroom context. A normal approach would ask a student to perform a digital test, a type of test design allowing researchers to measure reading and writing skills as isolated entities. Alternatively, from a relational approach, analyzing practices as part of a sociocultural context, digital skills can be performed as part of a teaching activity. Bhatt and de Roock (2013) demonstrated that when students read and wrote in a classroom, different modalities, previous technological experiences, and social interaction with other students in a classroom, all played a fundamental role in what digital literacies meant in practice.

Smythe (2018) applied a substantialist perspective to provide another understanding of what adult literacy can mean when constituted in practice. Smythe demonstrated that this scenario changes when adults interacted with technologies in real-life contexts. Smythe noted that organizations increasingly change the way in which they communicate. For example, government agencies transform into ‘digital governments’, adopting artificial intelligence (AI) and automated tracking systems to an effort to become ‘effective’ and employ rational frameworks to handle inquiries from citizens. In the process, citizens do not encounter a public servant, but a non-human actor, a robot. The robot processes inquiries according to a behaviorist approach which is highly relational, endlessly providing feedback. In fact, it so effective that it directly responds and corrects mistakes. Empirically, adult literacy in practice requires cognitive labor, developing and advancing skills in order to interact with complex IT systems. Smythe’s participants reported that they endlessly uploaded and checked e-mail messages, with some robots rejecting applications because of spelling and grammatical errors along with missing keywords.

Educational researchers also use posthuman perspectives for examining technologies and humans as object-centered and material discourses that can be enacted in sociocultural contexts (Fenwick, 2014; Zukas and Malcolm, 2017). Lundtofte, et al. (2019) provided an alternative view on the role of technology when children play. They showed how children’s use of tablets required the development of a conceptual spectrum to distinguish sociomaterial practices of various play moods, ranging from absorbent to utensilent. The conceptual spectrum allows researchers to place technology and humanity in the foreground or the background in empirical analysis, reflecting how involved children were in play.

However, educational research on LMS that applies sociomateriality is rare, except for a few contributions such as Han and Ellis (2019); Hannon, (2013); Quimno, et al. (2013), and Wilson, et al. (2017). If used, educators are seldom the subject studied; instead the focus appears to be technical staff managing implementation at the meso-level at universities. Criticism raised in these papers is that behaviorist technology frameworks ineffectively capture relational complexities between technologies, people, and contexts. Top-down implementation models have been argued to be unsuitable in grasping institutional contexts and bottom-up experiences. Quimno, et al. (2013) claimed that frameworks and technologies used
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to implement e-learning technologies in developing countries were understood according to rational choice models such as utilization, acceptance, and adoption perspectives, acting as benchmarking standards. However they unsuccessfully captured changing and cultural contexts for e-learning.

The challenges associated with implementation is discussed in LMS research (e.g., Turnbull, et al., 2021b). Usability, accessibility, and learnability studies evaluate if students and educators understand user interfaces and their key features (Judge and Murray, 2017). For example, students were asked to compare accessibility and learnability of two LMS (Ahmad, et al., 2018). Students were asked if it was challenging to navigate and if the labels used to display key features were difficult to interpret.

To avoid failure, bench-marking practices were suggested, formulated on strategic (Sallum, 2008) and end-user levels (Dehinbo and Odunaike, 2010). Some researchers claimed that if learning technologies were not used at all, it could be assessed as useless. Frameworks or intervention strategies were needed to map the needs of all stakeholders in a given implementation (Botha, et al., 2018; Ekuase-Anwansedo, et al., 2018). Some researchers were rather blunt in that they claimed that there were grave mismatches between LMS learning design architecture and institutional realities (Gwamba, et al., 2018). To reduce these gaps, technology designers needed to better integrate institutional and bottom-up perspectives.

Few research contributions have used sociomateriality to grasp the outcomes of implementing an LMS in higher education. However, Hannon (2013) was inspired by an agential realist perspective where the emphasis was on grasping “minute sociomaterial connections” between technology and pedagogy (Fenwick, 2011). Hannon did not establish a bottom-up perspective or examine the experiences of students or educators. Instead, the focus of the study was learning technologists who managed implementations at the meso-level of a university. Learning technologists work with organizing learning object repositories (LOR), used in LMS to make learning resources searchable and reusable. A key theme in the study was describing the dilemmas, conflicting practices, and new challenges that learning technologists faced on a daily level. They experienced ambivalence when they had to make decisions on which learning contents were shareable. For example, a learning technologist might have to determine the pedagogical value of a learning video. Hannon demonstrated that learning technologists were not comfortable and avoided making pedagogical evaluations; they focused on technology rather than pedagogy. Thus, a sociomaterial research lens demonstrated that actors who were close to an implementation continuously negotiated between the demands of a learning technology system and teaching and learning needs.

This allows us to clarify how sociomateriality is applied in this study. It is used to frame a technology implementation process as a constitutive entanglement (Orlikowski, 2010). A simplified way to grasp it is to look at what an implementation can mean, defined as a process of putting recent technology into effect. But using a technical definition as a premise would exclude the many contradictory, conflating, and conflicting practices happening in an implementation. In fact, an implementation is a complex event or process that can be difficult to administer even though implementors plan well ahead. Many unexpected things can happen when people use new technologies. For example, end users can use it in unexpected ways, meaning that new user patterns can emerge as an outcome of an implementation. In fact, it can be meaningful to say that in an implementation, past and current technology experiences and uses will most likely amalgamate with different goals, strategies, intentions, interpretations, uses, expectations, and assumptions. When we add such factors together, it is perhaps more meaningful to address an implementation as most of us will experience it to be, an entanglement. In other words, it is a series of complicated relations or situations where technologies are used in a context.

Orlikowski and Gash (1994) developed a research lens which was based on researching the implementation of a new technology in a large organization, examining technological frames. Based in cognitive theory, technological frames is defined as: “that subset of members’ organizational frames that concern the assumptions, expectations, and knowledge they use to understand technology in organizations. This includes not only the nature and role of the technology itself, but the specific conditions, applications, and consequences of that technology in particular contexts” [4]. Technological frames enabled Orlikowski and Gash to address a nuanced approach on what role past technology experiences might have on current use.
They formulated three technological domains — (1) Technology-in-use, which refers to how a person has used and currently uses a technology; (2) Technology strategy, which points to what a person’s technology use might be in the future; and, (3) Technology nature, which means what a person actually knows about a particular technology.

These technological domains were applied to explain how two groups (top managers and consultants) in a consultancy had different expectations and assumptions of groupware, Notes. Top management had optimistic expectations and envisioned that Notes could improve and change work culture, from an individual level to a collaborative one, by introducing a technology designed for collaboration. The technological frames of top managers for Notes was based on strategizing and rationalizing that consultants would easily adopt and learn a new technology. Based on that, a hasty implementation was executed. When Orlikowski and Gash interviewed consultants, they discovered that consultants had different technological frames. They had challenges in understanding the purpose of the technology and how to effectively use it. Consultants did not use Notes for collaboration but instead opted to perform individual tasks such as sending e-mail messages to colleagues. Orlikowski and Gash demonstrated that a technology meant for changing work practice brought little change. Past and current technological experiences played a critical role in how a new technology was finally used in practice.

Technological frames permitted Orlikowski and Gash to perform a snapshot analysis. They demonstrated that an implementation can be contradictory and complex. That being said, my application of sociomateriality has some overlap with technological frames. I used sociomateriality as a bottom-up research perspective to understand an implementation as a constitutive entanglement, a part of everyday practice, not a streamlined process directed by rational top-down perspectives. In an implementation, my main assumption was that a continuous stream of emerging practices and activities resulted in various conflicting and contradictory outcomes and effects on pedagogical practice. To capture and understand them required forging an agential realist perspective. According to my view, technology and pedagogy, or, the immaterial and the material, were acknowledged as relational, symmetrical, and equal and were constituted and enacted as pedagogical practice which took place in contexts. These contexts could in turn shape pedagogical practices.

But there are additional matters that I wish to address. I used sociomateriality as an interpretive research lens to show that when educators started using a new LMS, technology and pedagogical practice could be viewed as effects of connections and activities, part of a web of larger relations performed into existence (Fenwick, 2014). Central to my use of sociomateriality was the assumption that when educators started using a new LMS in an implementation event, previous technology experiences and pedagogical practices were evoked, meaning that the preceding history of objects, practices, activities, and relations played a fundamental role in how a learning technology was finally used currently. As a result, educators enacted particular sociomaterial pedagogical practices, a matter that will be demonstrated in the data analysis.

Part II: Background to the study and research strategies

Few studies have used sociomateriality to examine the outcomes of implementing an LMS in higher education, outside of Hannon (2013). Inspired by a grounded theory approach (Corbin and Strauss, 1998), Hannon employed qualitative methods and used personal accounts and experiences from participants which were collected from interviews, objects, and documents.

To an extent, a similar approach was used in this study. A qualitative research strategy was applied to collect data from the implementation of an LMS at a Nordic university, identified with the pseudonym ‘Alpha University’. In 2016, Alpha University procured a new LMS after a costly process. A data sample was gathered to examine user experiences of a group of educators who participated in the implementation’s pilot phase. The data sample consisted of 23 participants and included academics who taught across various
Implementation as a constitutive entanglement: Framing sociomaterial pedagogical practices emerging from the implementation of a learning management system disciplines. An overview of the participants and their academic fields are provided in Table 1. Interview data was collected as primary data. To devise RQs and a theoretical perspective, a research design was formulated, inspired by Tjora (2018), involving an inductive and in-depth investigation using an explorative qualitative research design in three parts.

In the first part, a set of RQs were operationalized into an interview guide. The interview guide explored topics like description of the participants’ backgrounds, previous LMS use, testing of particular features in the new LMS, and other queries. Selection criteria for recruitment of participants were also devised. They were selected from volunteers based on pre-established criteria to ensure that a range of disciplines from across the university were represented.

Table 1: Overview of participants and academic fields.

<table>
<thead>
<tr>
<th>Participant number</th>
<th>Academic field</th>
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<tbody>
<tr>
<td>P-1</td>
<td>Geography</td>
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<tr>
<td>P-2</td>
<td>Geography</td>
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<tr>
<td>P-3</td>
<td>Pedagogy</td>
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<td>P-4</td>
<td>Geographic information systems</td>
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<td>P-5</td>
<td>Radiography</td>
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<td>P-6</td>
<td>Information security management</td>
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<tr>
<td>P-7</td>
<td>Information forensics</td>
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<tr>
<td>P-8</td>
<td>Cyber and information security; Technology</td>
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<tr>
<td>P-9</td>
<td>Nurse studies</td>
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<tr>
<td>P-10</td>
<td>Logistics and supply chain</td>
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<td>P-11</td>
<td>Medical microbiology</td>
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<tr>
<td>P-12</td>
<td>Informatics and e-learning</td>
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<tr>
<td>P-13</td>
<td>Geomatics engineering</td>
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<tr>
<td>P-14</td>
<td>Special education</td>
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<tr>
<td>P-15</td>
<td>Sociology</td>
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<td>P-16</td>
<td>Psychology</td>
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<td>P-17</td>
<td>Health sciences</td>
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<tr>
<td>P-18</td>
<td>Economy and administration</td>
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<tr>
<td>P-19</td>
<td>Economy and administration</td>
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<tr>
<td>P-20</td>
<td>Teacher education</td>
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<tr>
<td>P-21</td>
<td>Chemistry and material technology</td>
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<tr>
<td>P-22</td>
<td>Teacher education</td>
</tr>
<tr>
<td>P-23</td>
<td>Informatics and e-learning</td>
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</tbody>
</table>
In the second part, data collection was carried out. Data was gathered through semi-structured qualitative interviews which were conducted between October 2016 and March 2017. Each participant was interviewed individually, with each interview lasting approximately 30 to 60 minutes in length. The interviews were recorded digitally. Participants signed an informed consent form. All in all, 23 research interviews were completed.

In the third part, an approach for sociomaterial mapping of data was devised. The data analysis started with first transcribing interviews which were later analyzed in NVivo. In NVivo, an open coding strategy was used which consisted of coding the participant answers into relevant categories which later developed into larger themes, a coding strategy resulting in a codebook. The focus was on finding emerging patterns which consisted of grouping and comparing the participant perceptions, user patterns, and experiences of using the LMS. During the data analysis phase, the researcher compared data to various theoretical lenses and used a data analysis strategy as outlined by Brinkmann and Kvale (2015). They suggested that a hermeneutical approach could be applied to connect emerging themes from data to theoretical perspectives, a strategy that allowed researchers to probe their data to various models.

<table>
<thead>
<tr>
<th>Citation from participants</th>
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<tbody>
<tr>
<td>“I don’t manage to understand what and where I’m going to click. I got a lot of IT expertise but I fail. I talked with a colleague the other week who said exactly the same thing. He’s frustrated and is unable to use the LMS in an easy way.”</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Codes</th>
<th>Categories</th>
<th>Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Navigation</td>
<td></td>
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<tr>
<td>User interface</td>
<td></td>
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<tr>
<td>Frustration</td>
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<tr>
<td>Technology complexity</td>
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</table>

| “I use the LMS to upload lecture” | |

Table 2: Example of coding strategy for theme 1.
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Notes. I have divided my course into folders, as I have always done.Folders for interesting resources, videos. I have a course homepage with a presentation of myself with contact info. I went to a conference in the Netherlands to learn about the LMS. There, I went to a workshop where a guy from a university explained how you could use the calendar feature. Under the calendar, he could add links to everything. So, when the students access the course, they have everything there, deadlines, links to lectures, what the students need to prepare, etc.

Features
- Uploading and stowing
- Lecture notes
- User features
- Pedagogical practice
- Inspiration
- Disappointment
- Inability
- Frustration

Prearranged course organization
Building blocks
Substitution
Course structuring misalignments
A dream scenario. Yes, I thought! Highly organized, a good overview! To achieve it with our LMS is not possible for the moment.”

“There was a lot of searching, I had a high level of frustration. I don’t know how many hours I sat in my office before I go help from a colleague. And then, as I said, we sat for two hours before we finally managed to find that the quiz feature. Then it took us a little over an hour to get the first quiz done, so we had to publish it so that it worked.”

Feature Quiz Search Help
Template Assessment Inflexibility

For example, I viewed data in relation to TAM and social capital theory. These were rejected because they could not adequately frame what happened in implementation. By contrast, a sociomaterial practice lens fulfilled that goal. In other words, sociomateriality was not set in the start of research but emerged in relevance. Sociomateriality was also used as it better conceptualized disparate perceptions, user patterns, and experiences of participants in order to establish a holistic picture of technology use, a matter that became
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evident in the development of the three themes making up sociomaterial pedagogical practices.

How were the themes developed? In data analysis, I established three emergent themes that suggested sociomaterial pedagogical practices. They emerged when I compared different codes, categories, and themes to general pedagogical principles used in learning design. For example, in the development of theme 1, ‘course structuring misalignments’ (coding strategy displayed in Table 2), this sociomaterial pedagogical practice shared similarities to a pedagogical principle that is important in teaching, structuring a coherent course.

Nilson and Goodson (2017) argued that explicit course organization should encompass an overview of learning goals, learning contents, learning outcomes, learning activities, assessment forms, and other factors. By contrast, in the interviews, participants were asked several questions about how they used particular features in the new LMS to support their teaching practices. Later, in the coding work, a clear pattern emerged. Participants were frustrated because they did not managed to understand the graphic user interface and were not able to upload learning material to create a coherent course. In other words, a complex LMS made it difficult to set up a basic course structure. Therefore, it then became meaningful to address a misalignment between technology and pedagogy. The data analysis strategy used to formulate theme 1 was also applied to develop the remaining sociomaterial practices.

Part III: Data analysis

<table>
<thead>
<tr>
<th>Number</th>
<th>Name of sociomaterial pedagogical practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Course structuring misalignments</td>
</tr>
<tr>
<td>2</td>
<td>Disruptive assessment</td>
</tr>
<tr>
<td>3</td>
<td>Social disconnectedness</td>
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</table>

We will examine how an implementation can be viewed as a constitutive entanglement. It will be exemplified by looking at outcomes of an implementation’s pilot phase at ‘Alpha University’. In so doing, it makes sense to bring up this paper’s RQ: In what ways can there be concealed patterns for organizing pedagogical practices when using LMS? To answer it, three sociomaterial pedagogical practices are presented (Table 3). The first one analyzes what types of educational models were used when setting up a course. The second outlines how the LMS was used for assessment. The third describes how educators communicated with their students.

**Sociomaterial pedagogical practice 1: Course structuring misalignments**

The first sociomaterial pedagogical practice identified from coding was called “course structuring misalignments”. If educators managed to use the LMS and its embedded features to prearrange for course organization, an educational practice used in planning of courses. The sociomaterial pedagogical practice denotes if we can trace a pattern where the educators can set up a coherent learning environment where technology and pedagogy relationally support each other.
Ideally, course organization emerges when an educator applies a learning design to structure an LMS pedagogy in a learning platform. For example, learning goals, learning materials, learning activities, and assessment forms are operationalized into a course by using a module set-up. In a module, the student follows a prearranged learning path and engages with interlinked learning activities. A module can start with an introduction page explaining learning goals and learning activities. Thereafter it follows a constructed arrangement of reading materials, videos, scheduled lectures, tasks, peer review assignments, quizzes with automated formative responses, a discussion forum, etc. To set up this learning environment, it requires deep knowledge of a subject’s taxonomy and how to make technology relationally support pedagogy.

By contrast, data shows that the implementation appears as a constitutive entanglement, as the educators rarely set up their courses in the manner described earlier. When educators engaged with the LMS, they perceived it as a complex technology which challenged them to perform strategies to reduce technological complexity. In many cases, educators relied on past technological and pedagogical experiences to navigate and use the new LMS. Educators selected a few features which become part of a core work environment, meaning that many features were never tested. In interviews, educators frequently referred to difficulties with the graphic user interface of the LMS and its many embedded features. One educator explained that the implementation failed to motivate changes given the abundance of options: ‘It’s like here you have a bunch of things, see what you can build! We fall back to the same way we’ve always worked’.

Technological complexity had layers of expressions, generating contradictory effects on setting up a course. Simplest expressions were frustration, uncertainty, and difficulties in using the new LMS in an easy way. When one did not manage it, the LMS was described as ‘inflexible’, or ‘a bad Web site from the 90s’. In practice, the educators reported that it was difficult to navigate; it required a lot of clicking; features were non-self-explanatory. An ICT professor noted that:

I don’t manage to understand what and where I’m going to click. I got a lot of IT expertise but I fail. I talked with a colleague who said exactly the same thing. He’s frustrated and is unable to use the LMS easily. (P-12)

The LMS had a default graphic user interface commonly seen in learning technologies. It could be best described as a large folder system. The user interface design had a centered right work surface and a left-centered menu list containing many key features that facilitated learning activities and student administration. If a user clicked on a feature, one was directed to its designated work space that contained many options. In other words, educators had several options to create interesting learning opportunities for their students. But when an educator started building a course against a “file explorer” set up, another pattern surfaced. Educators selected a couple of key features that they assessed as relevant, which meant ‘course content’, ‘grade center’, and ‘quiz’. These were employed as part of a simplified work surface, serving as a primary foundation to enact two types of prearranged course organizations which could perhaps be better described as educational models.

The first educational model was a substitutional approach to course organization, representing a weak relationality where technology and pedagogy stood somewhat apart. Educators who enacted this course organization made a clear distinction; pedagogy occurs in the lecture hall and at seminars where the LMS stores learning materials, provides information, and allows for the submission of assignments. This model can be better understood through the educators’ description of the LMS: “an administrative tool” or an “electronic ring binder”. An educator described it as ‘a submission and feedback platform for student assignments’. To make practice of it, a minimum course set-up was enacted, and was based on educators’ past LMS use. The LMS became a storage site, containing little learning activities that were designed for active learning by students. This aspect meant that technology was seldom employed to support and augment pedagogical practices. Typically, an educator created a main course page with basic course information, containing folders for reading assignments, employing core features meant for limited student communication and assessment of assignments.
But setting up a minimum course to be a storage and management space was not always easy, showing a pattern of course structuring misalignments. Educators reported that structuring and visualizing fundamental ‘building blocks’ of their courses was difficult. For example, using key features to position images, creating navigation that led students directly to reading material, was difficult because of a complex graphic user interface. Educators could not easily customize and visualize a storage and management space as they had done in the past. Frustration emerged:

> I use the LMS to upload lecture notes. I have divided my course into folders, as I have always done. Folders for interesting resources, videos. I have a course homepage with a presentation of myself with contact info. I went to a conference in the Netherlands to learn about the new LMS. There, I went to a workshop where a guy from a university explained how you could use the calendar feature. So, when the students accessed the course, they have everything there, deadlines, links to lectures, what the students needed to prepare, etc. A dream scenario. Yes, I thought! Highly organized, a good overview! To achieve it with our LMS is very difficult. (P-9)

The second enacted educational model was an augmented approach for pre-arranging course organization, reflecting a stronger relationality where technology could be employed to support pedagogical practices. Educators who enacted it also used past technological and pedagogical experiences. However, they argued that the LMS ‘must be something more than just a system for only student administration’. Normally, educators blended technology and pedagogy to enact hybrid education which combined campus pedagogy and online educational approaches. For example, they were inspired by the notion of a flipped classroom. Educators structured their courses with prearranged learning resources such as videos, combined with learning activities such as quizzes or student peer review features. In this way, pedagogical principles, such as formative feedback and active and collaborative learning, were integrated into the educational model.

But the pilot phase displayed cases where technology did not support pedagogy, especially when some educators attempted to enact a flipped classroom. For example, an educator in geography had for years developed a flipped classroom lesson design, consisting of short videos that he had recorded for years. The educator wished to redesign his teaching practice by adding a student peer review feature, which could provide more clues to the utility of learning materials. The educator was optimistic about the implementation and hoped that it would be a possibility to enact a hybrid learning design. Later, he found out that the exact feature he wanted to test was not included in the ‘total package’ that ‘Alpha University’ had acquired:

> I thought the new LMS would be excellent. The students could give feedback to each other. To organize the peer review, we could use rubrics. What we actually experienced, was that Alpha University only bought half the package. The LMS didn’t have the features we wanted. The LMS provider used a sub-contractor that supplied the student peer review feature, and Alpha University had not made a deal to include it. (P-2)

We found other examples where pedagogy and technology misaligned when educators wished to enact hybrid education models which included use of automated formative assessment features. An educator in nursing studies wanted to test a new quiz feature but experienced a situation where technological complexities prevented it. In her course, nursing students were required to document knowledge about basic medical frameworks. To reach the learning goal, the students were supposed to complete a knowledge test as part of their study requirements, which normally had be conducted by using a questionnaire (MS Word document) which was assessed by the educator. Such a learning activity could easily be replaced by
employing a quiz feature, but setting it up in the LMS proved difficult. The educator and a colleague spent hours searching for the quiz feature but could not find it in the piloted LMS. When swapping from a native language mode to the English version of the LMS, the quiz feature appeared. Setting up a quiz, with automated formative responses in a quiz feature with English as default language, proved very challenging:

There was a lot of searching. Also, there was a high level of frustration. I don’t know how many hours I sat in my office before I got help from a colleague. And then, we sat for two hours before we finally managed to find that quiz feature. Then it took us a little over an hour to get the first quiz done. We published it, and it worked. (P-9)

**Sociomaterial pedagogical practice 2: Disruptive assessment**

The second sociomaterial pedagogical practice to emerge from data coding was called “disruptive assessment”, mirroring constitutive entanglement. The sociomaterial pedagogical practice referred to ways that educators used the LMS to enact assessment processes which were crucial to the development of students.

The rationale for calling the socio-material pedagogical practice “disruptive assessment” meant that there was seldom seamless relationality between the technological default setup on assessing student work and how educators actually enacted assessment as part of their educational practices. They were very much misaligned. This was expressed in how the graphical user interface, and its embedded features, made it difficult to perform assessments. This was due in part to inherent complexity of the technology. Although many educators explained that they could assess, they expressed frustration when they tried to understand and effectively make use of the default setup for assessment in the new LMS. In order to understand the default setup, educators had to rely on past technological and pedagogical experiences.

Technological complexity had layers of expression where implementation could be seen as constitutive entanglement. Assessment was challenging for various reasons. The default feature setup for performing assessment was too complex to understand. Terminology describing the assessment feature was confusing. There were too many assessment feature options. One educator noted: “The grade center is complex, and it is very easy to make mistakes”. In this regard, disruptive assessment could be exemplified by how materialities impeded assessment, expressed in three distinct assessment activities.

The first assessment activity occurred when educators sought to enact formative assessment, a critical pedagogical practice involving the provision of ongoing feedback to support student learning. Data suggested that this was a high priority for all educators. For example, many educators required students to submit term papers for feedback before final exams. Disruptive assessment became evident as educators endeavored to reconcile their customary methods of providing feedback with the LMS’s distinct approach to assessment. This phenomenon was particularly evident in how educators attempted to organize and implement formative assessment through the technology:

Do you see what I see, inside the grade center? You have, for example, the option to create column, create calculated column. What does it mean? What is a calculated column? Manage, report? My subject has 37 students. If we are to see here, we have one, two, three, four, five, six, seven, eight columns. No, that’s a lot, under each title, next to each column there is a drop-down curtain, with different options. I am a person who wants things to be simple, not this messy setup. (P-11)

This excerpt serves as an example of how educators experienced the assessment feature. Its complex user interface design, numerous options, and embedded features made it time-consuming and difficult to learn,
Implementation as a constitutive entanglement: Framing sociomaterial pedagogical practices emerging from the implementation of a learning management system complicating its use. However, it was only when educators discovered that their feedback had not been received by students that they realized that they were dealing with a complex learning technology with distinct disruptive properties. This scenario was a recurring theme in this investigation, with many educators indicating that they had correctly checked all the assessment setup boxes, only to find that their students were not seeing comments. This situation highlighted the significant impact of disruptive assessment on educators and students alike and reinforced the need for more user-friendly and effective assessment technologies in education:

We did a round on student submissions. As we understood it, we’ve received the submissions and given feedback to the students. But it turned out not to be the case. In our overview [in the LMS] there was nothing to be assessed. But at the same time we hadn’t ticked off the correct boxes that enabled feedback. So, the students hadn’t received any comments. (P-3)

We also identified a pattern in which specific assessment features in the LMS disrupted the educators’ epistemic practices, particularly their understanding of formative assessment. For instance, assessment features could include options such as uploading assignments, creating rubrics to define assessment criteria, enabling student peer review, or using numbered scores to rate performance. When introduced, it challenged their existing beliefs and practices surrounding feedback:

It’s very unnatural for me to say that this [assignment] was 70 out of 100 points. That’s not the way we give feedback. I prefer to give it qualitatively. If I approve something, I want to point out what the student needs to do. (P-22)

The second assessment activity that formed a pattern of disruptive assessment was the attempt to enact summative assessment, or evaluating a student’s learning against pre-defined criteria or standards. Only a handful of educators tried to use the LMS’s quiz features to assess their students’ understanding of course material. As we noted earlier, setting up this type of assessment was challenging, while some recognized its potential benefits. These benefits could include increased efficiency in grading and providing feedback, enabling students to test themselves and identify areas for improvement, and facilitating the identification of knowledge gaps in course material. However, the disruptive nature of this type of assessment underscored the need for on-going professional development and support for educators to effectively integrate assessment technologies into their teaching practices:

We had lectures which were divided into modules which focused on an area or theme. In each module, there was a quiz. You needed to have 70 percent correct to pass, and you had many attempts. In this way, you are really forced to learn and work with the learning material. I think we should test the quiz feature in our subject. (P-1)

The third manifestation of disruptive assessment in our study emerged when educators attempted to enact collaborative activities into their assessment practices. This aspect was evident in at least two ways and were as follows.

First, the student peer assessment feature was introduced to educators; several attempted to use it. This feature involved students assessing each other’s assignments according to a set of predefined criteria. The goals of using it varied, such as teaching students how to assess the work of their peers, promoting meta-cognition skills, or reducing the workload of educators. Some educators realized the benefits of this feature as their workload could be reduced:
I have a lot of faith in student peer review as a principle because you get feedback from a student, who has individually read your report for half an hour. We have about 40 groups. If I did not have student peer review, I had to read all of them. I had to spend 80 hours and read them and that doesn’t happen. I think that there is something about the amount of feedback that is important. But there is another factor in the student peer review, that students get training in reading academic articles of varying quality. That in itself is a goal, to train yourself in doing that. The way we want to organize it is that we divide the curriculum into four sections. We have four themes that are related to the student term papers. Say, we have 100 students, we divide them into 25 students on each of these topics. We can call them group a, b, c, and d. The student who writes a paper on topic a gives feedback on topics b, c, and d, to fellow students. In this way, the students have now a greater incentive to read the curriculum. (P-2)

Second, we saw a pattern of disruptive assessment when educators tried to administer formative feedback with different types of student groups, a matter that also proved to be difficult in practice. It was difficult to use the new LMS to determine the exact study status of a student and accordingly cluster them into a relevant group that educators deemed fit, as applicable features were absent. For example, several educators had many campus and online students in their classes, and wished to employ a group feature with an assessment feature in order to have a more detailed overview of the status of each student. If in place, educators would have obtained a better overview, recognizing if students had completed compulsory work requirements on time. At the same time, students could monitor their own progress. In practice-oriented professional studies, such as nursing or teacher education, this disruptiveness was utterly on display. Here, students regularly rotated between theory and practice and spent time on campus before they turned to the practice to apply what they had learned. In such studies, it was common for students were divided into groups and received feedback from their teachers, implying that it is quintessential that LMS could support this grouping of students. In some of the most challenging incidents, an educator had to return to using a ring binder with a list of students in order to have an overview of which students had completed their compulsory work:

I worked at a school for continuing education. At that time, we had paper lists over what the students had done. In the last 10 years, I have worked in higher education and there has been no need for such tools. Now, I have a written paper on my desk. I use it to tick off for submitted and approved assignments. It gives me a complete overview. (P-9)

**Sociomaterial pedagogical practice 3: Social disconnectedness**

The third sociomaterial pedagogical practice to emerge from coding was called “social disconnectedness”, demonstrating how the implementation’s pilot phase was constitutive entanglement. The sociomaterial pedagogical practice touched upon an important learning principle in instructional design, the ability to create interactivity and establish lines of efficient communication between educator and student. In fact, most educators would certainly argue that effective communication is crucial when setting up a learning environment. Moreover, it is essential for any LMS to include user-friendly features that facilitates communication.

In contrast, our data suggests that material and immaterial factors were equally responsible for shaping social disconnectedness, resulting in a negotiated boundary that separated educators and students to some degree. This boundary impeded an ability to manage interpersonal relationships and educational practices
Implementation as a constitutive entanglement: Framing sociomaterial pedagogical practices emerging from the implementation of a learning management system efficiently. For example, educators lacked a dedicated messenger system, which made it difficult to communicate with students on a one-to-one basis. Instead, they had to rely on features designed for one-to-many or many-to-many communication, such as announcement systems and discussion forums. Additionally, the LMS did not offer features that supported group work effectively or provided a clear overview of students, which we discussed earlier. These limitations could be addressed by incorporating new features and tools into the LMS that enabled more direct communication between educators and students, as well as more efficient management of group activities and measures of student progress.

Social disconnectedness had varying effects on educators. In some cases, this had serious implications for professional disciplines that required a practice-oriented approach, such as nursing and teacher studies. As noted earlier, educators in these fields often had students moving between campus lectures and practical periods at hospitals and schools, where they were closely supervised, receiving feedback on assignments. This required a learning technology that could seamlessly connect educators and students. However, our research revealed that educators in these fields faced challenges in creating effective group overviews of their students. This was in contrast to other LMS that educators had used in the past, providing more comprehensive tracking and overview features. Moreover, social disconnectedness was also reflected in more subtle practices, such as ineffective communication that impeded organizing interpersonal relationships, practices, and activities. For example, educators reported uncertainty over whether important messages were being read by students. Instead, they observed that students created their own ‘shadow communication practices’ beyond the LMS, often using alternative channels like Facebook groups or Slack to administer the learning process among themselves. These challenges highlighted the need for learning technologies that not only facilitated direct communication between educators and students but also provided effective tools for tracking progress and managing group activities, to help bridge gaps between digital and physical learning environments.

That being said, our data also suggested that social disconnectedness was not only a phenomenon but also a pedagogical practice that was enacted by educators at two levels. The first level involved enacting different interpersonal communication practices that implied producing both informing and distancing techniques between the educator and student. For instance, some educators adopted a type of “pushing-and-informing-one-to-all” practice using the LMS’s announcement feature. While some educators found the announcement feature helpful, they acknowledged that its effectiveness relied directly on students monitoring their e-mail messages regularly. In addition, educators adopted a distancing technique or personal policy regarding how they communicated with students. They avoid full inboxes by relaying questions to a discussion forum, which functioned as an informal bulletin board to notify practical questions. One educator explained:

> If I get questions from students, I post them on the discussion forum right away. Simply because I would like to have the possibility to post and comment. (P-18)

The second level of expression was conveyed when educators attempted to use relevant key features to administer students into units and groups to fit their own needs. We observed how materialities shape immaterialities, having consequences on social disconnectedness. In an ideal use of an LMS, an educator should have a large degree of flexibility to administer their classes. For example, educators must be able to add and remove students, know a specific student’s status, and have the possibility to create separate student lists and group them according to activities and assignments. Instead, the data told another story which was far from the educational context in which the educators worked. The LMS was governed by a rigidity which hindered the use of the LMS to personalize effective student grouping. This aspect became clear when educators started using the LMS and compared features to previous LMS that they had used. For example, they were accustomed to personalizing student groups, as they were able to efficiently group and match students based on their own preferences and relate group organization of students to the structure of a particular study program. Some educators had off-campus students as part of their campus courses and wished that they could separate on-campus from online students, a trait that was difficult to achieve in practice.
A significant challenge was to add and divide students and co-teachers into separate and tailored groups. In professional studies, like nursing studies, flexible grouping of students was essential to conduct day-to-day administration of instruction. The students regularly circulated between campus teaching and practice, and groups were used to having an overview. Thus, an expectation was that such a feature would apply, but several participants could not create the groups as they wanted to, a matter that was later corrected during piloting. Educators recounted receiving long lists of students with no option to use a group feature:

I don’t think I got an overview of all the users. We got a list of everyone, but we have several types of groups and students. Some attend different study programs, some are campus students and online students, but then it doesn’t appear in the LMS, who’s in which group, who goes to which study program. (P-5)

Part IV: Discussion

To facilitate a discussion of this study’s implications, we will present arguments in three parts. First, we will summarize the main findings. Second, we will explore how a sociomaterial perspective can offer valuable insights into technological implementation processes. Finally, we will discuss the contributions of this research and limitations of this study.

First, to highlight the key findings of this study, let’s revisit the initial RQ posed at the beginning of the paper: ‘In what ways can hidden patterns emerge in the organization of pedagogical practices when using a Learning Management System (LMS)?’ In essence, our analysis revealed that educators primarily used the LMS as a site for storage, submission, assessment, and communication with students, representing a substitution of pedagogical practices. Although the new LMS offered numerous possibilities for enriching pedagogy, our data showed that the implementation challenged participants with a complex learning technology, resulting in a range of issues, as demonstrated in data analysis. This complexity manifested itself in different ways, such as a complex user interface, navigation problems, unclear feature purposes, and numerous steps required before features could be properly employed. Furthermore, the analysis demonstrated that technological complexity had relational implications on immaterial aspects, leading to materialities functioning as a kind of boundary to effective enactment of pedagogical practices. Data analysis illustrated several challenges, including difficulties in establishing effective communication and administration practices between educators and students, uncertainty about how the LMS supported assessment activities, and challenges in setting up a coherent course organization. In other words, the main findings suggest indeed that implementation’s pilot phase was an entanglement.

Second, it is important to make some initial remarks on applying a sociomaterial perspective. What advantages and disadvantages does sociomateriality provide an empirical analysis? On the one hand, some researchers contend that it is demanding and that they can become easily ‘lost’ in their data. They were repeatedly uncertain of what to look for and how to interpret data to create an analysis reflecting the spirit of sociomateriality, as it became challenging to grasp how material and immaterial components were relational and tidily interwoven (Leonardi, 2013). In other words, operationalizing sociomateriality into a coherent analysis was deemed as demanding. On the other hand, critics contend that sociomateriality, can, in fact, lead to the opposite of what it is supposed to do; instead of theorizing and providing new insights to the meaning of technologies and material practices, some researchers were ‘over-analyzed’ the social and downplayed the role of the material (Mutch, 2013). This trait has also wider implications. Sociomateriality is also criticized for being an insufficient term that can be used for analyzing complex constructs such as power relations and time in organizational contexts (Mutch, 2013).

Given these insights, a key question still arises: how does the concept of sociomateriality prompt us to
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To rethink technology implementation processes? To address this question, we can briefly challenge our preconceived notions about what an implementation entails. Typically, we associate implementation with a top-down, controlled process that can be managed and monitored effectively. It implies change and development, either in the organization itself or in how people work. Implementations are embedded with management rules and are often driven by larger objectives set by the organization. As such, investments or management processes must be developed to fulfill these goals. Organizations create plans, goals, and strategies, and assign specialized staff to manage these activities. This framework provides a sense of rationality and order, which helps contain any potential disorder (Weick, 2001).

An implementation is instead a complex undertaking that is difficult to predict and manage in practice, as Orlikowski (2000) noted. While frameworks and methods, such as agile coaching, Scrum, and Nexus, are commonly used to manage implementation, they can be undermined by unforeseen practices and activities that are bound to emerge. For example, people may choose not to use technologies as expected, which could pave the way for novel uses and practices. As a result, Leonardi and Barley (2010) argued that an implementation should be re-approached as an ongoing organizational process. This means that an implementation is not only a process in itself but also an event where phenomena can be constructed. To be more specific, there are different phases in an implementation, and a social phenomenon can be constructed in it, or there can be a separate process by which construction occurs. In other words, an implementation is not a streamlined, static, and rational process but rather an ongoing, changing, and dynamic organizational process with many potential outcomes and effects. This point led Leonardi and Barley to suggest five constructivist perspectives on how to understand an implementation: perception, interpretation, appropriation, enactment, and alignment perspectives. Each perspective has different approaches and assumptions, and each demonstrates that adoption and use of technology occurs in different phases of an implementation. Different types of social phenomena can also be constructed, including attitudes, beliefs, and values, schemes and frames, patterns of derivation and conformity, work practices, and roles and relationships. Additionally, an implementation can involve the construction of social influence, transfersences, intra- and inter-group interactions, and new ways to collaborate.

Throughout this paper, a sociomaterial lens has been used to argue that an implementation could be understood as a constitutive entanglement. From an agential realist perspective, an implementation is perhaps a complex and disorganizing event that cannot be reduced to a streamlined and rational process when viewed from the perspective of end users. Instead, the analysis demonstrated that the implementation of the LMS possesses multiple disruptive characteristics, which endowed materiality with strong agency capabilities. The participants were required to interact with non-human actors that posed challenges to established pedagogical practices. This resulted in contradictory outcomes, with materialities promoting conformity at the expense of fully exploring the LMS’s many potentialities. Participants perceived the LMS as containing barriers, leading them to develop strategies to navigate the technology’s ordering complexity by relying on past pedagogical and technological experiences. Thus, the implementation as a constitutive entanglement produced a substitution of pedagogical practice, resulting in little change. In essence, the implementation constructed particular attitudes and beliefs, treating the new LMS as a complex learning technology.

Third, research contributions and research limitations must be addressed. At the start of this paper, a research horizon was outlined with two sub-research streams. On the one hand, a body of research was found dedicated to LMS research (e.g., Araka, et al., 2020; Turnbull, et al., 2020), while, on the other hand, there was emerging educational research literature on sociomateriality (e.g., Bhatt and de Roock, 2013; Fenwick, 2014; Han and Ellis, 2019; Hannon, 2013; Lundtofte, et al., 2019; Smythe, 2018; Wilson, et al., 2017; Zukas and Malcolm, 2017). This study suggests added new knowledge to both research streams. Empirically, few studies have investigated the implementation of an LMS at a Nordic university, although the research literature on LMS is extensive. Theoretically, very few studies in educational research have applied a sociomaterial research lens to understand the implementation of an LMS.

As with all research, this study has limitations. Firstly, as a qualitative study, it was inherently limited to its particular empirical and cultural contexts. Exploring different cultural contexts might lead to different
results, conclusions, and analyses. Similarly, if alternative theoretical perspectives such as cognitivist, sociocultural, or any others had been applied, different insights and nuances could have been generated. However, this study focused on one specific research perspective and did not attempt to apply multiple theories. Additionally, like many qualitative studies, this study cannot claim statistical generalizability due to the limited size of the data sample. Finally, a potential limitation is the risk of bias as the researcher’s interpretation and personal experience may influence the results. This risk applies to any study that aims to display itself as objectively true, but acknowledging and minimizing bias is essential to ensure research quality.

Part V: Conclusion

To create an effective digital technology for educators, the use of LMS should incorporate a digital pedagogy that blends material and immaterial elements. Unfortunately, this approach is frequently not the case, as digital technologies and pedagogy are often treated as distinct entities. To effectively merge these two fields, investing in professional development to help educators grasp how digital technologies can shape pedagogy is critical.

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