

Beyond Nature & Culture

A Praxiography of the Digital Classroom

Abstract

Education systems around the world face great challenges as social distancing measures force physical classrooms to close down in order to mitigate the spread of sars-cov-2. Consequently, teachers and students have resorted to digital classrooms. This research investigates the resulting edtech market (re)formation, with a purpose to understand how edtech *might* be organized. Based on the integration of three literatures (pedagogy, human-computer interaction, and markets-as-practice) and with the vantage point in one Swedish edtech platform, practices are traced throughout the edtech market. The central site was identified as the newly formed digital classroom, in which a participant observation is conducted. Further, the concept of affordance is used to bridge the gap between organization studies and IT, allowing for an extensive praxiography of the platform itself. Together, these studies investigate the process of reterritorialization in search of emergent pedagogical practices and pedagogical value. The discussion highlights the importance of the agencements formed between teachers, students, and digital platforms — rather than any particular component part. Hence, the author emphasizes the importance of implementation (the ‘how’) in edtech innovation, rather than any particular tool (the ‘what’). Finally, such successful implementation is tied to learning, affirmation, and experimentation. Aiming to provide practical relevance, the thesis includes an in-depth, practice-based example of how one might successfully conduct discussion-based seminars, given the restrictions and opportunities of the digital classroom.

Keywords: Education technology, market practices, Gilles Deleuze, pedagogy, human-computer interaction

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Explanatory note: impact of sars-cov-2

Several measures were taken as a consequence of the sars-cov-2 pandemic.

When Digilär and I discussed access with schools, we made sure to involve not only teachers but also the school leadership. We decided to cancel the planned participant observation, even in comprehensive schools (Swedish. *grundskola*), in order to mitigate the risk of sars-cov-2 spread. This was a measure taken not only to reduce the spread of the virus, but also to ensure the children's and their parents' sense of safety. Given the international political debate regarding Sweden's low levels of restrictive measures, such as allowing comprehensive schools to remain open, this was an important measure to ensure the integrity and sense of trust within the community under study.

Although initially this considerably obstructed the aim of observing everyday practices, it opened up the opportunity to study a rapid digitalization effort under exceptional circumstances. What started off as future-directed and exploratory, quickly became current and socially relevant.

For this language use, I wish to express regret. As a result of this thesis' narrow focus on innovation and technology, I will occasionally refer to the current situation as an opportunity. However, in any wider perspective, it shall be no doubt that the events currently unfolding are great tragedies.

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Glossary

Difference Gives rise to and subsist through the identities in which it actualizes. Fundamentally relational, via shifting levels of intensities (Deleuze, 1968). Drives the continuous recursive process described by Kjellberg and Helgesson (2006, 2007).

Digilär Edtech firm now acquired by publisher Natur & Kultur. Both the name the *organization* and the *platform* (see *Platform*) they are developing and commercializing.

Digital “Involving or relating to the use of computer technology”. Created /made to exist /constituted by means of computing. Equivalent to *virtual* in computing, for instance: a *virtual* environment is equivalent to a *digital* environment.

Digital classroom Echoing the traditional physical classroom, “a room in which a class of pupils or students is taught”. The digital classroom, however, is enabled by computing (see *Digital*).

Digital class “An occasion when pupils meet with their teacher for instruction”. In this research classes are of three types, comprising *lectures* (instructional presentation), *seminars* (interactive discussions), and *labs* (laboratory-like experimentation). Classes can occur both physically and digitally (see *Digital classroom*).

Edtech Abbreviation of education technology. Refers to digital technology products and services aimed to facilitate learning. *Edtech firms* seek to develop and commercialize such education technology.

Pedagogical materials Learning materials /educations materials. In this study, centered on various forms of textual and visual content, such as informational texts and exercises. Constitutes the product portfolio of Digilär. Exist as both traditional *pedagogical materials* (textbooks) and *digital pedagogical materials* (see *Digital*).

Platform Refers to *digital platforms*, including Digilär’s platform (see *Digilär*). Enables the digital interaction between its users (see *Digital*).

Virtual Has two distinct significations, none of which will be used in this thesis, due to the risk of conceptual confusion:

- In *Deleuze*, the virtual is conceptually paired with the actual, as in ‘the actualization of the virtual field’ (see *Difference*)
- In *computing*, the virtual means “not physically existing as such but made by software to appear to do so”. Under a materialist paradigm, non-physical existence becomes problematic (see methodological discussion, 4.3.2.2 *The digital setting*). Instead, I will refer strictly to the *digital*.

Cited definitions in quotes are taken from the website Lexico.com (Oxford Dictionaries).

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“More has happened with the digitalization of Swedish schools
this past week than during the *last five years*”

— Peter Fredriksson

Director-General of the Swedish National Agency for Education

1 Introduction

1.1 Background

Four thousand years ago in Sumerian Babylonia, designated *houses* were established to facilitate learning. For the first time in history, learning was disconnected from the context in which it was to be applied, spurred by the increased importance of written language. The Greeks later gave these houses the name ‘schools’ (*skhole*), signifying the ‘leisure’ in ‘freedom from work’ that this early form of education entailed (Stensmo, 2007). Education was initially defined by the physical location in which it was conducted.

Thousands of years later, in the Prussian effort to solidify their state, compulsory state-sponsored schooling was formalized, although the original meaning ‘leisure’ was now perhaps the least appropriate term (cf. Meshchaninov, 2012). Although pedagogical thought has undergone several paradigmatic shifts since then (Stensmo, 2007), much of the organizational structure that was institutionalization have remained (Khan, 2012).

In the wake of the internet, digitalization has transformed established industries. In recent years, retail, media, and finance have all experienced systemic changes (Manyika et al., 2016), while education is still in an early phase (World Economic Forum, 2016). However, education technology (hereafter *edtech*) firms aim to change this. With USD \$8.2 bn in global education venture capital spend in 2018, compared to USD \$1.8 bn in 2014 (NIX, 2019), edtech is expected to become a disruptive force to traditional education systems.

As if this potentially radical change was not enough, education systems are now facing further disruptive challenges. In the beginning of 2020, the *sars-cov-2* pandemic forced nations across the world to impose social distancing measures, including the closing of schools. The number of learners affected is estimated to have reached 1.38 bn as of March 23rd (McCarthy, 2020). Schools, the *houses* from which education originally sprung, are now inaccessible to teachers and students.

1.2 Research gap

Likewise, academic interest in edtech is growing, with volumes of research rising significantly in recent years (Hsu et al., 2013). The knowledge base, however, is distributed among a wide range of disciplines. Even seemingly coherent fields, such as that of Instructional Design and Technology, are in themselves ‘meta-fields’ (Hill, 2004). Partially because of interdisciplinarity, the field is disparate and unconnected, comprising perhaps hundreds of journals (Bodily et al., 2019) and yet, this otherwise appropriate field bears little connection to other relevant fields such as those organizing, business, or management (cf. Bond et al., 2019).

The research gap, however, is primarily empirical. The underlying shift is perhaps best illustrated by the introductory quote by the Peter Fredriksson, Director-General of the Swedish National Agency for Education (Swedish. *Skolverket*), “More has happened with the digitalization of Swedish schools *this past week* than during the *last five years*” (Dagens Nyheter, 2020).

An issue with the edtech literature is the operationalization of simplified variables, in which generalizability is quickly outplayed by the changing empirical reality. Often, the optimal use of technology is assumed to be reached quickly, stripping away the complexity, and possibilities, of technology use (cf. Hsieh & Huang, 2019).

Indeed, there are no studies of edtech under which the ‘context’ is constituted by a global pandemic that forces national education systems to close physical classrooms. This is particularly true, given the underlying transformation caused by technology. By these two disruptions, technology adoption and sars-cov-2, empirical reality is fundamentally changing.

In such an uncertain situation, that has never been studied before, one must ignore neither the education nor the technology side of organizing. The importance of transdisciplinarity in organization studies has been highlighted (Czarniawska, 2017b). Further, the integration of IT into organization studies has long been futilely requested (Orlikowski & Iacono, 2001; Akhlaghpour et al., 2009; Akaka & Vargo, 2014; Nambisan et al., 2017). This research seeks to understand a novel development of the edtech market, and in this pursuit, I must take seriously all of its three constitutive parts: *education*, *technology*, and *markets* (see 2 Literature Review).

1.3 Purpose and research question

This research aims to contribute to the future of edtech organizing. The education system faces large changes, driven by technological development. Thus far, adoption of technology has been conservative. However, as the sars-cov-2 pandemic shut down physical classrooms, a reluctance towards technology-use has become impossible to uphold in practice.

The future of edtech will constitute a particular *problematic field*, with multiple potential *solutions* (Deleuze, 1968). The conservativeness in education hitherto implies that desirable solutions are not easily attained. Although the dazzling complexity of the social world is increasingly acknowledged, organization studies have somehow become more qualified in identifying how things have gone wrong¹, then in guiding organizing to manifest the new and potentially desirable.

In this research, I follow the tradition of Bruno Latour. I wish to bring back some aspects of his indebtedness to Gilles Deleuze, which have seemingly been lost in translation. This will manifest throughout the theoretical and methodological sections but begins here, in the formulation of the research question. By emphasizing how one *might* organize², I wish to contribute to amend this lack, by producing knowledge that might help shape solutions to future problematic fields.

Under the particular problematic field of digitalization and the sars-cov-2 pandemic, the purpose of this thesis is to investigate *how edtech might be organized*. From the theoretical review, empirical observations, and process of tracing of practices, the following research questions arose:

RQ How might edtech practices create value in the digital classroom?

This specific question relates to a conceptual frame in which the continuous emergence of agencements constitute certain pedagogical practices and pedagogical value (see 3 Theoretical foundation). With no pre-given solution, all potential solutions to this problematic field are experiments until they are actualized. This thesis gives an account of how one edtech firm, Digilär, is currently being actualized as a particular solution to a particular problematic field. The intention is to give an account of the practices that shape the edtech market, providing an affirmative

¹ Management research has become increasingly skilled at identifying ways in which organizing support the oppressive or destructive. This is mainly indebted to the work of scholars in labour process theory, radical humanism, ‘critical’ post modernism, under the umbrella of CMS (Alvesson & Willmott, 1992).

² In this sense, I follow the Deleuzian inquiry “how might one live?” (May, 2005), but in agreement with Czarniawska (2017a), the aim to study human nature is “too ambitious for organization scholars”.

instance of what might become, and hence providing a desirable alternative to practitioners creating the future³.

‘Traditional’ questions will inevitably be touched upon, such as market drivers, blockers of innovation adoption, and the market formation process. The primary aim, however, is to enable practitioners to compare their practices with those of others (Czarniawska, 2017a) and in doing so following the lead of Deleuze’s (1991) central concern — how to create new ideas, new ways of thinking, and new ways of understanding the world.

1.4 Delimitations

Because of the ontological and methodological approach described below, few hard limits were placed on the scope of the study. Its abductive nature enabled an openness to follow the most notable trails. However, some concrete delimitations were nonetheless set. The edtech practices under study had to aim at the established national education system. Because education systems are nation-centric, it was natural to focus on only one country (Sweden). Because the study focused on national education system, age became important. The study focused on upper secondary school (Swedish. *gymnasieskola*; K-12, years 10-12; students aged 16-19).

³ Here, *desirability*, is not intended as axiological in relation to the solution itself. If the solution is desirable from the point of view of the practitioner, if it seems ‘useful’ to them, they might be inspired to experiment with similar solutions, handing them greater options as they are participating in creating the future. The only such axiological assumption Deleuze makes is that of affirming creation itself.

2 Literature review

The underlying empirical change currently occurring demands a wide integration of theory. For this reason, I seek to understand all three aspects of the edtech market: the ed- (pedagogy), the -tech (human computer interaction) and the market (market reformation processes).

2.1 Market (re)formation processes

The market (re)formation process has been described by a variety of authors emphasizing different mechanisms for change and stabilization. Institutions' shape markets by rules (Roth, 2017) and power struggles (Fligstein, 1996), networks' shape markets by social relationships of trust and embedded relations (Granovetter, 1985), and socio-cognitive dynamics' shape the conceptual systems of producers and consumers (Rosa and Porac, 1999). Further perspectives emphasize the entrepreneurial firm as central in shaping markets (Sarasvathy, 2005; Holloway & Sebastiao, 2010; Zott & Hui, 2007), in which the liability of newness (Stinchcombe, 1965; Aldrich & Fiol, 1994) can be overcome by acts of legitimation (Suchman, 1995).

In this research, I adopt a conceptualization of markets as constituted by practice (Kjellberg & Helgesson, 2007). Under uncertainty, it is important to view the market as an outcome of an ongoing process, but also to account for historical and systemic influences (Kjellberg & Olson, 2017; Baker et al., 2018). More importantly, indebted to *Science and Technology Studies* (STS), the attention to materiality is imperative in explaining the 'diffusion' of technologies. It is important to consider the entire system involved, going beyond 'nature' and 'culture' (Latour, 1993), and be open for its non-linear and non-determined process (Akrich, 2002).

2.2 Pedagogy

2.2.1 Pedagogy-in-practice

It is important to consider the particular context in which this research is conducted. Particularly, accounting for not only market transactions but also the public service (cf. Mattsson & Andersson, 2019; *public service provision model* as opposed to *business model*) that is delivered by the education system. Because the language and practice of education differs significantly between countries, it has been important to base this theoretical review in the Swedish context. The key distinction lies in the word *pedagogy*, which is not particularly engaged with in the English-speaking tradition. To bring the concept of pedagogy into this study, three works have been of central importance: *Introduction to pedagogy* (Svensson, 2014), *Philosophy of pedagogy* (Stensmo, 2007), and *The cultural heritage of pedagogy* (Hartman, 2005).

In the language of this literature, there is a clear difference between pedagogy and education. On the one hand, *education* is an organized operation. *Pedagogy*, on the other hand, is defined by specific properties, though these can be manifested in such organized operations. Pedagogy is "*support for learning*" —the helping of another to increase their knowing, knowledge, ability, responsibility and more. Consequently, although pedagogy is a necessary condition for education, it also occurs in most forms of social relations and contexts. Svensson's (2014) illustrative example is about the young child who teaches its parents about new technology – a pedagogical effort. It is a form of leadership that support learning. Pedagogy thus comprises both *practice* and a *field of knowledge*. When this field of knowledge is manifested in practice, Svensson calls it *pedagogy-in-practice*⁴. This concept will be returned to and further elaborated upon (see 3.2.3 *Pedagogical practices*).

⁴ Swedish: "Pedagogik i praktiken".

2.2.2 Pedagogy in education

Pedagogy-in-practice manifests in the activities and operations performed by the education system. In addition to pedagogy, both Svensson (2015) and Stensmo (2007) forwards three interrelated concepts related to education: *uppföstran* (Swedish), *teaching* (Swedish. *undervisning*), and *education* (Swedish. *utbildning*), which must not be confounded.

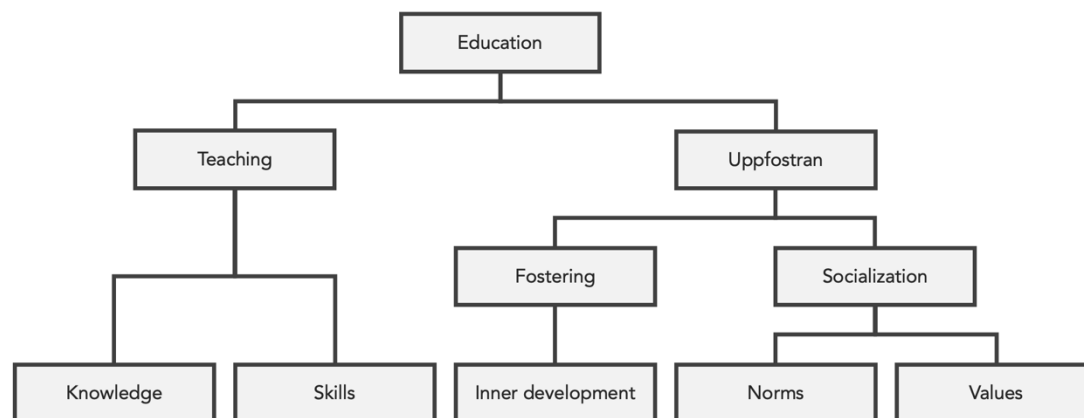


Figure 1: The role of teaching and uppföstran in education.

Uppfostran relates to norms, values, and inner development. It has no corresponding term in English, why it has been kept in its original form⁵. The term signifies a form of upbringing, a combination of *fostering* (nurturing an inner natural development towards individual freedom) and *socialization* (the individual conforming to society as a whole). *Uppfostran* signifies both the practice of uppföstran as well as uppföstran as an outcome of that process. *Uppfostran* has been one of the two main components, together with teaching, of the education system. As modern thought progressed to praise the individual, the general eschew towards traditional *authoritarian uppföstran* has shifted the original emphasis of schools on socialization towards fostering and teaching. Consequently, socialization is now mainly considered under the overarching aim to develop democratic citizens (Hartman, 2005; Svensson, 2014).

Teaching relates to knowledge and skills. It relates to presenting some form of content that relates to how things are, or how they should be. Historically, the role of uppföstran in schools was a key part of teaching (the teaching of Christian values, order, and discipline). The contemporary emphasis on disciplines (subject knowledge) has placed the development of skills and knowledge at the center of teaching. As a consequence, research has focused on *teaching methods* aimed at understanding the process, situation, and technique of lecturing (Svensson, 2014).

Education is the systematic way in which both uppföstran and teaching is organized (Figure 1). It has not only grown in terms of its social importance (since the introduction of the public education system), but also within companies and organizations as a “knowledge-intensive economy” has placed higher demands on workers (Stensmo, 2007; Svensson, 2014)

While the education system necessarily comprises both uppföstran and teaching, those activities are also performed throughout society (e.g. parents engaging in *uppföstran* of their children; IT-consultants *teaching* clients how to implement a computer system). Hence, studying ‘education’ directly as a phenomenon distinct from its practice would be as implausible as studying a ‘market’ in the same way (cf. Kjellberg & Helgesson, 2007).

⁵ *Fostering* would confuse the reader by only relating to one aspect of the twofold concept, while *Upbringing* has a misleading connotation to the parent-child relationship.

2.3 Human-computer interaction

The foundation for edtech in general and Digilär in particular is that digital technology enables software to support learning, that is, pedagogy. In an education environment where social interaction is increasingly digital, facilitated by re-presentations rendered by software, the interaction between humans and computer systems must not be neglected.

For this reason, this research is influenced by human-computer interaction (HCI), a multidisciplinary field with roots in computer science, engineering, psychology, and cognitive science. To achieve an understanding of this field, I have studied the online video lectures and content of the course *Human Computer Interaction* (2012) taught at Stanford University taught by Scott Klemmer, now Professor of Cognitive Science and Computer Science & Engineering at UC San Diego. The purpose has been twofold. First, to train myself in evaluating and understanding the interactive design of computer systems, by various methods and heuristics. Second, to bring theoretical perspectives to complement the gap between organization studies and IT outlined previously.

HCI aims at optimizing the collective action of humans and computer systems, partially by means of *distributed cognition* (Hutchins, 1995) in which the unit of analysis is not the individual, but the distributed cognitive system. These systems are integrated by affordances, defined as “the allowable actions specified by the environment coupled with the properties of the organism” (Gibson, 1979; Zhang & Patel, 2006; Faraj & Azad, 2012).

To enable distributed cognition, affordances created by users of a system must reflect the functionality the system actually affords. The person is seen as interacting with technical systems based on *mental models* (‘how you believe the system will work based your learning and experience’), comprised of *systems models* (‘how the system works’) and *interaction models* (‘how the system is used’). If the interactive model aligns with your expectations, you will understand how to use it. (Klemmer, 2012). A functional mental model reduces recognition-based memory (Wright et al., 2000), which enables the user to spend their cognitive efforts more productively.

To this aim, practitioners develop software under the guidance of what has been termed the *naturalness principle* (Klemmer, 2012). Actions that appear *natural* (as opposed to *unexpected*), makes the system (or technology) “disappear” to you. For instance, while driving “the car becomes an unproblematic means to an end”, what Heidegger calls *transparent* or ‘*ready-to-hand*’ (Knorr Cetina, 2001; cf. what Vervaeke (2019) calls *opacity-to-transparency shift*). These insights of human-computer interaction will be important in understanding and interacting with the digital setting of this study.

3 Theoretical foundation

This research aims at understanding a potentially radical change in the way the education system is organized. To this end, I first outline a Deleuzian process ontology and social theory. Second, I present a frame for market (re)formation based on the concept of agencement and Kjellberg's markets-as-practice as a heuristic.

3.1 Ontology and social theory

3.1.1 Requirements

Organization studies tend to start with ontological assumptions, in general debating *objectivism* (essentialism) versus *interpretivism* (social constructionism) (Burrell & Morgan, 1979; Clever & Rudberg, 2014). In this research, the following reasons make both those sets of assumptions inappropriate. First, the high uncertainty of the situation. The future edtech market is unknown⁶ and there is an uncertainty in even distinguishing the new market and it is unclear which actants⁷ are relevant (cf. 'hot' situation in Callon, 1998), perhaps best illustrated by the sudden importance of videoconferencing providers. This research needs to account for a market 'in-the-making'. Second, the wide range of market participants necessitates a perspective beyond micro-macro distinctions. It would be severely limiting to study edtech without understanding, for instance, both individual students and public institutions. Third, the rise of edtech is driven by significant technological change and, thus, technical devices are highly relevant. This research needs to account for the impact of materiality.

3.1.2 Process

This research is founded on an ontology of process, which has its roots⁸ in the thoughts of G. W. F. Hegel and was further developed by A. N. Whitehead. *Process* questions the Cartesian view of independent material objects with a transcendent reality. Instead, the world is appreciated as immanent and fundamentally mobilistic, that is, *in movement*. That fundamental aspect of reality is *becoming*, rather than *being*. In *Difference and Repetition* (1968), Deleuze moves beyond Hegel's emphasis on negation, and instead, considers the recurrence of the creative force of *difference* as primary. This implies not taking scientific abstractions (concepts like "edtech" or "market") to be ultimate reality. It is not that static propositions of such abstractions would not be true (A still equals A), but rather that they are merely true in that exact moment. Particularly in a changing market environment 'in-the-making', such research would instantly become obsolete and trivial. Instead, the attempt will be to explain how reality is being realized through processes of change.

3.1.3 Social theory

To further answer to the requirements above, inspiration is taken from Deleuze and Guattari (1972; 1980). Specifically, four ideas are employed: *machines*, *flow*, *territorialization*, and *agencement*.

Machines are defined in that they *seek connection with other machines to bring about a specific actuality*. Thus, this definition includes individual persons, subpersonalities within a person, and cultural movements. While machines are not defined as actual technical machines, such technical machines are certainly part of the notion. This idea underlies understanding non-humans, software,

⁶ Also, *theoretically unknowable*. Although a discussion on chaos and emergence does not fit the space limits of this thesis, the emergence of sars-cov-2 in Wuhan that now has the entire global economy (including education) on its knees is an apt example of a how the butterfly effect makes the future unknowable.

⁷ In *On recalling ANT*, Latour (1999) admits that his theory would perhaps more appropriately been named *actant-rhizome ontology*, implicitly illustrating his indebtedness to Deleuze.

⁸ Although ancient thinkers like Heraclitus, Lao Zi, and many others had similar ideas, they do not necessarily provide the underlying thought structure that is required in a contemporary discussion of ontology.

interfaces, and algorithms built on machine intelligence, as having the ability to perform practices, as long as they can be understood as machines in the Deleuzian sense.

To Deleuze and Guattari (1972), economic activity is centered around *flow*. Rather than observing an assumed static market, there is a need to understand its movement. In line with the ontology above, the market must be seen as emergent, plastic, and rhizomatic (cf. Kjellberg & Helgesson, 2007; Latour, 1998). I will rather ask: *Why is the flow in a certain direction? What is responsible for the movement? Why between these particular sites (poles)?* This notion underlies the tracing of practices outlined in 4 *Methodology*.

DeLanda (2006) develops *assemblage theory*,⁹ based on Deleuze and Guattari's (1972) concept of *agencement*, in order to study social complexity. In an *agencement*, emergent properties arise from the constant interaction between its parts. Further, an *agencement* is *irreducible* to its parts, meaning that the emergent properties are immanent to the constant interaction of the parts. Further, *agencements* are *decomposable*, meaning that the component parts retain their 'identity', enabling their reformation into other future *agencements* (DeLanda, 2011).

Once again inspired by Deleuze, DeLanda (2006, emphasis in original) adds that "processes of *territorialization* work to stabilise the assemblage's identity, while processes of *detrterritorialization* transform the assemblage in the expression of new functions, capacities, forms, and/or boundaries". DeLanda's theory is a form of *new materialism* (DeLanda, 2011) related to STS and ANT, which seeks to transcend the fault lines between 'nature' and 'culture' (Price-Robertson & Duff, 2015). This positions the theory well in relation to the following theoretical model. The following section expands the notion of *agencements* to account for the social complexity in market and education (re)formation.

3.2 Integrated theoretical model

3.2.1 Agencement and transformation

This section outlines how I have come to view market, and classroom¹⁰, (re)formation throughout this research (*Figure 2*). It describes how *agencements* are transformed through constant movement. There are necessary limits to this illustration, such that a figure is still while reality is in process. The generative processes are portrayed as an arrow from one *agencement* to another, while it should rather be understood as one *agencement* changing from within.

Instead of further disclaiming limitations, I choose to highlight what I intend to convey. The model describes the continuous process of territorialization, an *agencement* as an actualized solution to a particular problematic field. The particular solution is an *agencement* with particular emergent properties (social complexity). In the context of edtech, it enables certain pedagogical practices with certain pedagogical value (see 3.2.4 *Creation of pedagogical value*).

Over time, a new problematic field arises. In a process of detrterritorialization, some emergent properties are dissolved as the previous *agencement* is partially reduced. In this particular research, the intrusion of both technology and sars-cov-2 has appeared as forces of detrterritorialization. Hence, some of the pedagogical practices cannot be maintained (e.g. physical classes) and pedagogical value is 'destroyed' (or more accurately, no longer being created).

⁹ The term *assemblage* is not used in this text, because of its connotations to a stable, reducible 'collection of things'.

¹⁰ Similar to Deleuze's machines, there is no predetermined 'level' of analysis, there are *agencements* all the way down to sub-personal level.

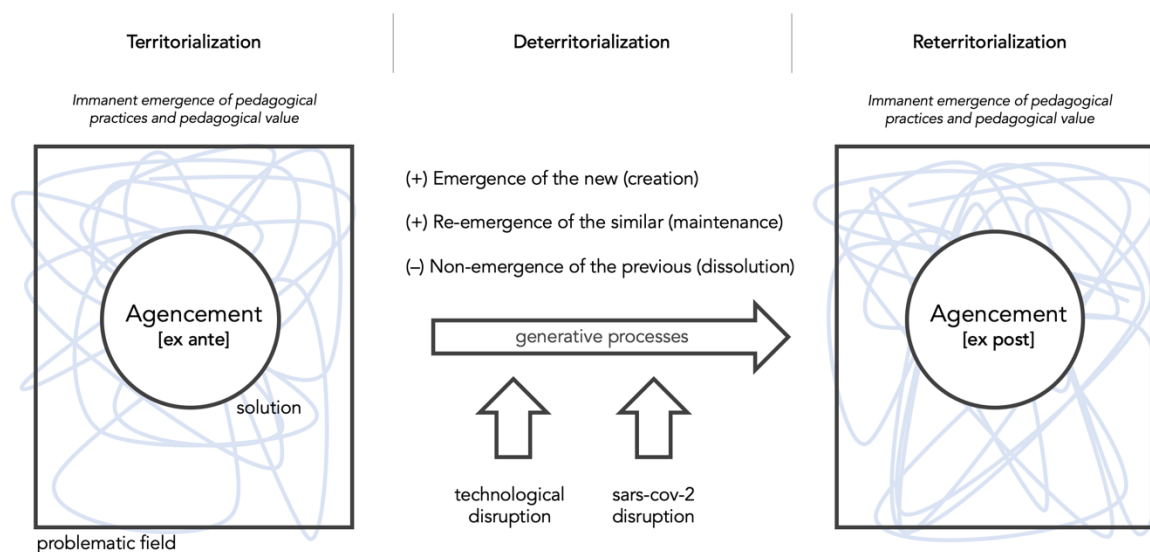


Figure 2: The process of agencement (re)formation by territorialization, de-territorialization, and re-territorialization.

In response to this new problematic field, a solution arises. In the process of reterritorialization, the creation of a new agencement, new emergent properties arise. Hence, the agencement has gone through de- and re-territorialization to produce something that did not exist before. All transformation in the market and in the digital classroom can be explained by processes of emergence — by the emergence of the new (creation), the re-emergence of the similar (maintenance), and the non-emergence of the previous (dissolution). Driven by this eternally recurring shift (cf. *difference*; Deleuze, 1968) in the problematic field, new pedagogical practices and new pedagogical value arise.

3.2.2 Heuristic model

Although the previous framework explains emergent social complexity and the process of transformation, the methodological challenges of such complexity remains. Hence, I will adopt a sharp focus on the practices such transformation actualizes. In doing this, I adopt Kjellberg & Helgesson's (2006, 2007) "conceptualization of markets as constituted by market practices" (henceforth *markets-as-practice*). Markets-as-practice integrates practice theory and the concept of translation, both inspired by the development in STS. The heuristic is considered particularly useful as it facilitates a crystallization of the complexity of the current edtech market.

In stark contrast to other notions of practice theory which has focused on "routinized behavior" and "bodily activities" (Reckwitz, 2002), Kjellberg & Helgesson (2007, italics in original) define market practice "*as all activities that contribute to constitute markets*". To account for the shaping of markets, the authors propose a threefold conceptualization. *Normalizing practices* establish guidelines for how a market should work. *Representational practices* generate depictions of the market and how it works. Finally, *exchange practices* are the "concrete activities related to the consummation of individual economic exchanges" (Kjellberg & Helgesson, 2007).

For three reasons, I have chosen to adopt Wieland et al.'s (2016, emphasis added) adaption of this model¹¹, where, instead of exchange practices, *integrative practices* are practices that "enable actors to create value for themselves and for others and are not restricted to exchanges involving money or other types of economic compensation." Firstly, although Wieland et al. are largely fighting a strawman when interpreting Kjellberg & Helgesson (2006, 2007) as taking a "neoclassical

¹¹ I do not adopt their integration of institutional theory into the framework.

economic view of markets”, their notion of integrative practices is useful, particularly in a public market such as that of edtech. Second, Wieland et al. (2016) introduce the notion of *value creation*¹² to reduce the emphasis on economic exchanges. Third, Wieland et al.’s adaption opens up the model for not only viewing markets but entire *service ecosystems*. This is particularly important as much of the current education system is organized in a bureaucracy (cf. Ouchi, 1980) and it is uncertain what types of organizing will prevail in the future. These three aspects are elaborated upon further in 3.2.4 *Creation of pedagogical value*.

Akin to Deleuze’s emphasis on *flows*, however, a satisfying model explains not only mere bundles of practices, but also account for their interlinking. To this aim, Kjellberg and Helgesson (2006, 2007) advance the concept of *translation*, borrowed from their three great influences Callon, Latour, and Law, in the authors three respective chapters of Law’s (1986) *Power, Action and Belief*, wherein translation is defined as “the social process in which something spreads through time and space”. *Chains of translations* interlink practices, such that those translations fundamentally realize the market through a continuous recursive process. In these chains of translations, the outcome of one practice influences another through intermediaries. For instance, the outcome of a normalizing practice is translated into a representational practice through *measures and methods of measurement* (Kjellberg and Helgesson, 2007).

3.2.3 Pedagogical practices

Svensson (2014) views pedagogy as a field of knowledge that is manifested in practice, what he calls *pedagogy-in-practice*. In this thesis, this concept will illustrate the performativity of pedagogical thought, for instance via teacher education. Based in an ontology of immanence, however, I reject Svensson’s allusion to an ideal pedagogy that transcends its practices. Still, the author’s focus on practices makes the view well-aligned to the following study, given adjustments to its ontological foundation. To this end, I have chosen to contrast Svensson’s *pedagogy-in-practice* (the performativity of a research body, *normalizing practice*), by introducing the concept of *pedagogical practices* (support for learning, *integrative practice*). In doing so, I conceptually and ontologically align the concept with the adjusted markets-as-practice framework (Wieland, 2016; Kjellberg, 2007).

Pedagogical practice is derived from the pedagogical literature, in which pedagogy is defined as *support for learning*. In practice terms, I define *pedagogical practice* as *all activities that contribute to learning*. Thus, in applying the adjusted markets-as-practice model to education, *integrative practices* must be inclusive of *pedagogical practices*. In the context of education, such pedagogical practices take the form of teaching and *uppfostran* (see 2.2.2 *Pedagogy in education*), that is, practices that result in students learning skills, knowledge, norms¹³, values, as well as inner development (see *Figure 1*).

3.2.4 Creation of pedagogical value

In considering what might be created, or more specifically *how edtech might be organized*, it is important to consider the impact of these processes. From a traditional economic point of view the ‘value’ of market activities is taken as the sum of economic transactions. However, public services, such as education, has wider aims (see 2.2.1 *Pedagogy-in-practice*). To account for this, I have adopted the concepts of *value creation* and *service ecosystem* to the markets-as-practice model (see 3.2.2 *Heuristic model*).

¹² In the authors’ language, *value cocreation*. However, ‘collaboration’ is already implied in the notion of agencements.

¹³ Notice the difference between *norms* in terms of *uppfostran as a pedagogical practice* (supporting students’ inner development and learning of *norms* and values) and the *normalizing practice* of *pedagogy-in-practice* (establishing *norms* for teaching, *uppfostran*, education, and the edtech market).

Value is created as a result of the practices constituting the service ecosystem, but it is not yet obvious what this value implies. Vargo et al (2008) postulate: “Value is always phenomenologically determined by a service beneficiary”. This shows a similarity with the aim of STS to stay true to the view of the actants (Callon, 1986). Further, Vargo et al. (2008) further postulate that value is measured by “the adaptability and survivability of the beneficiary system”. The beneficiary system of edtech is the education (service eco-)system. The beneficiaries are, at least supposedly, the students. Based on Vargo et al.’s (2008) view on value determination and measurement, I reengage the pedagogical literature to create a proxy for value creation.

It has been shown that education is the systematic way in which both uppfostran and teaching is organized (see 2.2.2 *Pedagogy in education*). Further, uppfostran and teaching in the education system is constituted by pedagogical practices (see 3.2.3 *Pedagogical practices*). Hence, *value creation* in education is to facilitate or perform pedagogical practices. This form of value I call *pedagogical value*. Pedagogical value, then, is the outcome of uppfostran and teaching, which consists of skills, knowledge, norms, values, and inner development. In short, *learning*.

By observing their constitutive practices, I will study the agencements of the edtech service ecosystem in general and the digital classroom in particular. By doing this, I hope to understand how Digilär contributes to emergent pedagogical value. Consequently, I aim to provide an understanding of what practices might constitute an agencement from which pedagogical value arise.

4 Methodology

With symmetrical ethnology as a vantage point, I describe a praxiography consisting of participant observation, (expert) interviews, and a self-reflexive (auto)praxiography. This section outlines the methodological approach in general and the specific techniques in particular.

4.1 Methodological fit

In order to achieve a fit between the empirical reality and the ontological approach, I build on 2 *Literature review* and 3 *Theoretical foundation* to outline three methodological imperatives:

- *Literature review*: The edtech market is constituted by a complex dynamic influenced by market practices, pedagogy, and human-computer interaction:
 - I. Neither *ed-*, nor *-tech*, nor *market* must be neglected.
- *Theoretical foundation*: Reality is chaotic, emergent and plastic – which manifest particularly in the current edtech market, as a result of technological disruption and global pandemic:
 - II. A fully preconceived theoretical model must not guide the empirical observation.
 - III. ‘Education’, ‘organizations’ and ‘markets’ must be understood through their constitutive practices.

These imperatives and their underlying logic permeate the following section on methodology, in which the specificities of the study are outlined.

4.2. Research design

4.2.1 Research strategy

In this exploratory research, it has been important to be boundaryless and holistic in considering the wide range of practices that might affect the edtech market. In this flexible approach to a vast and complex empirical world, it has been important to stay highly focused. This has been executed through the tracing of practices (see 4.2.3.2 *Praxiography*) throughout the edtech market, but initially also in finding an appropriate starting point — what *flow* serves as an appropriate vantage point?

This ideal vantage point was determined (see 1.4 *Delimitations*) to be an edtech firm — partly because of the challenge of access. Because of the relatively fewer available edtech firms than schools, getting access to the former before the latter would minimize the risk of finding myself halted in the following of practices. Further, the underlying rationale of working with the edtech firm *Digilär*, in particular, was twofold.

First, the edtech market is still in its cradle and many firms are still struggling to monetize their products. One necessary condition for a *market* (as opposed to service ecosystem) to become is individual economic exchanges (cf. *exchange practices*; Kjellberg, 2007). Similarly, “value-in-exchange remains an essential component in the co-creation of value, as it provides a way of estimating future value-in-use among actors and their contexts” (Wieland et al., 2016). With over 100,000 users of its digital pedagogical materials (Swedish. *läromedel*), *Digilär* is actively engaging in economic transactions with the public education system, which was taken as an initial proxy for its contribution to the service ecosystem. Hence, the firm has a foothold in the current ongoing market realization — as opposed to the persuasive but vague visions so commonly forwarded by startups.

Second, *Digilär* is operating from an interconnected position. In 2017, the firm was acquired by the publisher Natur & Kultur and was from this point forward integrated with the market for traditional textbooks. This would open up additional potential pathways for tracing practices.

4.2.2 Research approach

This approach of exploratory tracing of practices requires empirical data before existing theory (Imperative II). However, the study must not neglect certain theoretical perspectives (Imperative I). To balance these demands, I am taking an abductive approach (Dubois & Gadde, 2002). The advantage I am seeking is perhaps best explained by the authors themselves: “[an] abductive approach is fruitful if the researcher’s objective is to discover new things”, followed by “our main concern is related to the generation of new concepts and development of theoretical models”.

The practical advantage of an abductive logic is the application of *systematic combining*. First, it was important to *match* the continuously unfolding empirical observation with the three fields of literature. Second, the possibility of *redirecting* the case was central in the tracing of practices — enabling decision-making en route. Additionally, a very similar situation emerged during my study as did in Dubois & Gadde’s (2002) main example of the truck company. Just before engaging in participant observation, public education shut down all physical teaching — making that particular study impossible. *Redirection* enabled this misfortune to be seized as an opportunity.

4.2.3 Research choice

4.2.3.1 Symmetrical ethnology

In response to the third (III) imperative, I follow Latour’s (1993) *symmetrical anthropology* in its adoption by Czarniawska (2017a, 2017b), as *symmetrical ethnology*, to organizational research. This means studying organizations under a *performative* definition, implying that (Latour, 1986) “organizations are constructed by acting and interpreting” (cf. Kjellberg & Helgesson, 2006) and that “the purpose of the researcher is to explore the practice of organizing”. This definition reconnects the methodology to the theoretical heritage of STS, practice theory, and the heuristic model.

The problem, and irony, with this practice ‘turn’ is its strong focus on theoretical development, with few scholars focus on the practical side of conducting practice research (Bueger, 2014). This implies a risk that theories become disconnected from what they are theories *of* (Latour, 1987). Consequently, Czarniawska concludes her article (2017a) on symmetrical ethnology by welcoming Bueger’s (2014) adaption of Mol’s (2002) concept of praxiography.

4.2.3.2 Praxiography

Praxiography is the “practice of doing *practice theory*-driven research” (Mol, 2002; emphasis added), which seeks to transform practice theory into a methodology. While, theoretically, a field of study is constituted by its practices, a methodological challenge is that many practices resist observation. In response, Bueger (2014) outlines three non-exclusionary strategies for praxiography. My emphasis is on the emergent character of practice, rather than the repetitive, which will become clear in my application of these strategies.

Firstly, the strategy to “study crisis and controversy” is an inherent, overarching theme in this study — a result of the sars-cov-2 pandemic. Under changing circumstances, implicit knowledge often surfaces because explicit justifications are necessary when determining if adjustment is necessary (Bueger, 2014). This was highly useful in interviews with teachers and students as they were engaging in practices for the first time.

Secondly, the “strategy of following” guided the study. Bueger (2014) explains:

“The research process can hence be initiated by a detailed study of an artefact followed by the observation of how it is used and an interpretation of which practices are inscribed in it. Such an

approach to the complexity and multisitedness of practice [...] reconstruct the activities that were required to bring it about by following the object backwards in time, visiting the sites of its manufacture and speaking to the actors whose relations were required. But it also means following the object forwards in time and tracing how it is used in various contexts and how its quality as a carrier of practice is maintained.” (Bueger, 2014)

This process maps very closely to what I ended up having done, although in a slightly different order and for slightly different purposes, described in the coming section. The reason I adopted this strategy of following, aside from coping with non-observable practices, is how it relates to Latour’s concept of translation: “Rather than depicting causalities, these translations generate traceable associations between practices” (Kjellberg and Helgesson, 2007; referring to Latour, 2005). This strategy of *following* (or in this case, *tracing*) was central to the empirical observations, as it enabled explication of translation processes. Most importantly, it guided the research through more peripheral flows in the search for the most relevant agencements.

4.3 Research process

4.3.1 The unfolding of the research

By first describing how the praxiography unfolded, I wish to emphasize the primacy of the process of tracing (research process) before any particular site or organization (research setting). In the tracing, I outline my decisions regarding direction and redirection, which was guided by the research question’s connection to pedagogical practices and the creation of pedagogical value.

As previously described, the vantage point of the study was [2] Digilär (see *Figure 3*) as an [1] appropriate edtech firm. In the first two conversations, two main directions were identified: what I labeled the supply-side (content creation and platform building) and demand-side (sales and teacher support) of the platform.

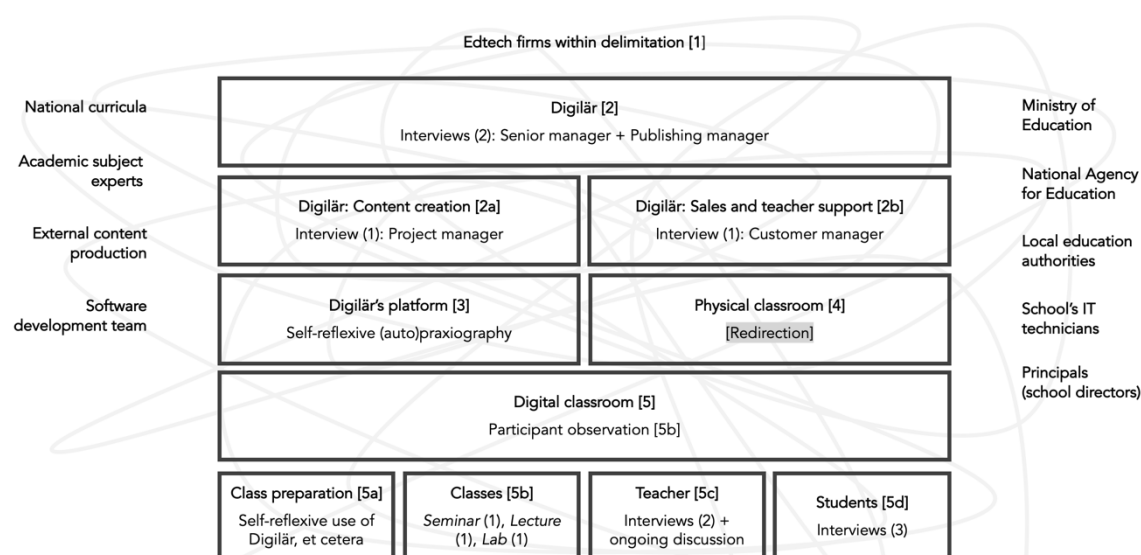


Figure 3: The unfolding of the research process, throughout the edtech market, including de-prioritized flows.

From the [2a] supply side, I learned about the practices constituting the process of creating pedagogical materials. Most content creation was done rather independently from students and teachers, relying instead on the expertise of software developers, subject experts, former teachers. A high importance was placed on quality assurance and alignment to the national curricula. With the platform portrayed as a standalone product, I figured this trace would explain much of its

pedagogical value. Hence, other flows were deprioritized in the tracing, in favor of a direct investigation of [3] the Digilär platform.

From the [2b] demand-side, I learned about the practices constituting the sales and implementation of Digilär's platform. The sales team were quite concerned with the implications of municipalities (for overview of Sweden's education system, see *Appendix 1*) making large purchases of Digilär licenses – often the adoption by teachers was low. The most successful cases were described as those in which the teacher made the decision. This is more common in upper secondary schools, where teachers were described as having more influence. I decided to follow this path and enter [4] the classroom.

Consequently, I decided for a praxiographic participant observation in an upper secondary school that had already implemented Digilär. However, a week before my study was to commence, the plan was interrupted. The abrupt closing of all upper secondary schools in Sweden was a social distancing measure from the government to hinder the spread of sars-cov-2. To overcome this challenge, I decided a redirection was necessary (cf. Dubois & Gadde, 2002). To avoid the physical classroom, I took the opportunity to study the practices shaping what was to become the [5] digital classroom. This enabled me to study novel practices as they were unfolding for the first time.

In order to trace particular flows from the [5b] digital classes, I followed up with interviews with [5d] students and [5c] the teacher. Before class participation, I [5a] self-reflexively studied the preparatory material, partly facilitated by the Digilär platform.

Throughout the tracing, it was never clear where the field would take me. The path was open, although never serendipitous, as it was closely guided by the continuously developing research question. The share number of possible flows to trace could have resulted an even longer process of following and, hence, the data collection came to an end as a result of time constraints. The major redirection, due to schools closing, had already pushed the data collection into later stages of the process than ideal. A brief overview of the data collected is presented in *Appendix 2*.

4.3.2 Research setting

4.3.2.1 Digilär and the edtech market

As a result of this research process, I have come in contact with two broad stabilizations that could be described as research settings: Digilär and the upper secondary school.

Digilär was launched in 2011 by history teacher Stellan Wigh, as Sweden's first completely digital pedagogical material. In 2017, it was acquired by Swedish publisher Natur & Kultur, which existing offerings included traditional pedagogical materials. Textbooks are sold through regular purchase, while access to the platform is licensed. I contacted Digilär via email, after which the leadership team agreed to our collaboration for this thesis. The suitability of Digilär has been outlined in *4.2.1 Research Strategy* and the structure of its operations will be further elaborated upon in *5 Empirical observation*.

After deciding to redirect the study, Digilär referred me to one of their users, a teacher at an upper secondary school in Stockholm, Sweden. I partook in classes in Biology 1 and Biology 2, courses in the core curriculum of the upper secondary education's natural science (approx. STEM) program. The participants were first- and second-year students. While each course runs from August to June, I joined the course in March. It should be noted that the students taking these

courses are highly ambitious, the particular school being one of the most competitive upper secondary schools in Stockholm.

4.3.2.2 The digital setting

I participated in these classes in the same way students did, that is, via various computer systems. This type of research setting is underdeveloped in organizational studies (see 1.2 *Research gap*). Czarniawska's (2017a) comment on Strannegård and Friberg's (2001) ethnography is particularly illuminating:

“Consequently, another problem with transferring the traditional techniques [of anthropology and ethnography] to contemporary organizations is the spatial mobility typical of such organizations. Lars Strannegård aimed to produce a proper ethnography of a young IT company, and he placed himself in an appropriate spot, in order to observe the crucial developments. What he could mostly see were the people coming to book their new flight tickets or report on their previous travels. Eventually, he titled his report ‘Already elsewhere’. Even worse, much of contemporary organizing occurs on the web.” (Czarniawska, 2017a)

From a broad perspective, Czarniawska raises the issue I want to address, the shallow understanding rendered by studying organizing in an ‘IT-company’ without studying the technology itself. The specific issue I am addressing, however, is the limited understanding of digital environments in organization studies.

Quite ironically, the two ‘turns’ that lay the foundation for this thesis each contribute to the issue. The practice turn has extended the focus on “bodily activities” (Reckwitz, 2002). The material turn has focused on physical “artefacts” (Latour, 1993). The two turns have thus neglected the mediating role of, and the interaction between, consciousness and software, respectively.

The problem is easy to comprehend. In an agencement between users and software (e.g. two students in a video call watching and discussing an instructional clip about photosynthesis), little is to be understood from the mere bodily movements interacting with hardware (e.g. pixels shifting, eyeballs moving, touchpads swiped). Yet, there are clear emergent properties to this agencement (e.g. an increased understanding of the conversion process between energy forms) which are epistemologically incomprehensible with regards to the bodily movements and physical artefacts involved.

The field of HCI is well positioned to solve the problem. The missing piece: among the interconnected Deleuzian machines constituting the agencement is human consciousness¹⁴, continuously generating affordances. It is one of many practices that make the features rendered by software intelligible. Hence, it has nothing to do with the ontological status of software itself¹⁵, although such arguments have been forwarded convincingly (cf. Brey, 2005; Reichert & Richterich, 2015).

Hence, I will move past understanding the digital as ‘merely virtual’ (less than real), because practices in the digital environment shape edtech and, hence, constitute it. Following this reasoning, I will study the practices that are performed in, and by, the digital environment with as much diligence as any other practice that constitute edtech — opening up what has been referred to as the ‘black box’ of the ‘IT artefact’ (Strand, 2010; Orlikowski & Iacono, 2001).

¹⁴ Perhaps neglected in fear of coming across as *idealist* (or *culturalist*). However, observing the functionality of the brain does not imply the ontological primacy of thought itself. In fact, affordances are rooted in a relational ontology similar to that forwarded in this thesis (cf. Faraj & Azad, 2012).

¹⁵ In a similar manner, Kjellberg and Helgesson (2007) cleverly bypass assumptions about ontological properties by defining market practice as “all activities that contribute to constitute markets”.

4.4 Techniques and procedures

4.4.1 Data collection

Symmetrical ethnology and praxiography advocates several methods of data collection (Bueger, 2014; Czarniawska, 2017a) out of which participant observation, (expert) interviews, and document analysis was engaged in. In an attempt to nuance the understanding of Digilär's platform, I conducted a self-reflexive praxiographic study of the software, which include elements of the first and the third of these methods.

I wish to reiterate my overarching approach. The following is neither a collection of observations and interviews with a 'sample' of similar actants, rather, they are a carefully selected, representing different steps in the continuous tracing of practices. In this way, the tracing process itself (4.4.1 *The unfolding of the research*) is a result of the empirical observations. Hence, there could have been no way of intelligently 'selecting' these actants ex ante. Furthermore, access to each person was granted only because of a good relationship with the previous, for example, when the teacher reached out to me before experimenting with new types of classes.

4.4.1.1 Participant observation

Methodological recommendations for both pedagogy (Kullberg, 2014) and HCI (Klemmer, 2012) research broadly agree on the usefulness of participant observation. Further, the technique has previously been employed together with the markets-as-practice heuristic (Kjellberg & Olson, 2017). This agreement between the three literatures has been accommodated and expanded upon. Participant observation is particularly important in praxiography as it is dependent on the direct observation of practices in their actual setting (Bueger, 2014).

I participated in three types of classes, ranging from 1 hour and 15 minutes to 1 hour and 35 minutes. After a discussion with the teacher about which class to participate in, I participated in one class of each type – *lecture*, *seminar*, and *lab* – as they constituted the most common types of classes. The other participating students were asked one day in advance if they would accept that I participate. This was important for integrity reasons because, even though I had my web camera switched on during the classes, my presence would not be as obvious as in a physical setting.

I participated by means of my own computer in the same way that the other students did. I had received the same preparation material and I participated in the same exercises during the classes. Bearing in mind the integrity of the students, I did not record the video of the classes in order to avoid faces of students appearing in the collected material. Instead, extensive note taking on what I had observed followed each class.

At some points when students were doing group projects in separate environments, I got opportunity to access the point of view of the teacher in real time. The teacher told "now the students are submitting their answers to the exercises" or "it seems like they are having some issues with the video, let me just fix that", and further narrating the events. This was empirical material that could have never been understood otherwise. Further, the fact that the teacher and students were doing many of the practices for the first time gave me great access to their explicit explanations of what they were trying to achieve or what was not working for them.

4.4.1.2 (Expert) interviews

To complement the observed practices, expert interviews were conducted. Within the realm of praxiography, the notion of *expert* does not necessarily signify an authority on a given subject, but

rather than “the interviewee is an *expert* in the practice” (Bueger, 2014). My interviewees were always practitioners in their respective field and the questions I asked related to their everyday activities.

To minimize the risk of ex-post rationalization even further, interviews were always treated in connection to some observed practice. During digital classroom fieldwork, interviews were conducted during or after the participant observation. Hence, I had always participated myself in precisely those practices that interviewees described. In the interviews with Digilär employees, I connected my questions to my prior research about the practices of Digilär as a firm as well as to the features I had observed when using Digilär’s platform myself. Due to the pandemic, all interviews were conducted by video call, however, only audio was recorded.

In the four interviews with Digilär, I had prepared questions on a few themes that related to the interviewee’s specific activities in their particular role. The main technique used was open-ended questions followed by extensive prompting, and hence, I was flexible in changing the order of themes and questions. Being new to the company, it was easy to be humble towards the experience of the interviewees. The interviews ranged from 50 minutes to 1 hour and 20 minutes, excluding the initial small talk and spiel.

In the three interviews with students, as well as in the continuous dialogue and interviews with the teacher, I moved to even less pre-conceived questions. Instead, because I had observed very specific practices in the digital classroom, I used these as vantage point for discussion. After the classes, I presented the students with an opportunity to part-take in interviews. No compensation was given. I asked some initial questions about the use of Digilär before and after the closing of physical classrooms, but the main part of the interview entailed the students telling me about the class that we both had just participated in, but from their perspective.

4.4.1.3 Self-reflexive (auto)praxiography

From my interviews with Digilär employees, I interpreted the two broad ways of using Digilär platform, either ‘*in-class*’ or ‘*as-homework*’. Before observing the platform as used in-class (participant observation), I conducted a study of the platform itself. In order to take seriously the practices performed in, and by, software (4.3.2.2 *The digital setting*), I conducted an in-depth study of Digilär’s platform. I engaged with the platform as it is sometimes used in practice, taking the role of a student. I choose subjects I had not studied before (to engage in learning proper) and worked my way through the platform (reading texts, watching clips, answering questions, following external links, et cetera) constituting approximately 20 hours of active engagement with the platform (i.e. time spent actually using the system, excluding moments of reflexivity and writing down insights for my study).

Contrary to standard forms of self-evaluating software qualitatively in the HCI literature (e.g. *heuristic evaluation*; Nielsen 1990), the purpose was not ‘need-finding’ or identifying ‘pain points’ in order to improve the design. It was rather to put myself in the position of a student, and in a self-reflexive manner get an initial understanding of a students experience as they engage with the platform. However, in parallel, I did engage the HCI literature by mapping functionalities and exploring what affordances was being formed between me and the platform. Studying the platform both *as-homework* (self-reflexive study) and *in-class* (participant observation) enabled me to experience the Digilär platform as used in two completely different ways.

4.4.2 Data analysis

As already initiated in the previous section, it has been important to ensure the differential treatment of the various types of data. Data from the participant observation is considered primary because of its immediacy to observed practices.

The interviews have been treated as secondary, as they are one step removed from practice. In line with Deleuze and Guattari's (1980) call, to ask what something does rather than what it means, as well as STS' call to stay true to actants view (Callon, 1986), I have aimed to refrain from extensive interpretation. Instead I have analyzed the interviews in relation to the question of what something does. This is why it was important to anchor the interview questions to specific practices (see 4.4.1.2 *Expert interviews*).

Finally, the self-reflexive study is treated as the most peripheral of data types. However, it has been a crucial part of this study (4.3.2.2 *The digital setting*). The praxiographic literature (and indeed, the ethnographic literature in general) has focused on textual and visual documents (Bueger, 2014), rather than interactive software. Two main efforts were undertaken to mitigate these difficulties. First, I continuously practiced reflexivity, not only in observing my own actions, but in reflecting on how I impacted the quality of the data produced. Second, I contrasted the self-reflexive study with (1) the observation of how Digilär's platform was used in an actual setting, and (2) the questions to students about their current and previous use of Digilär as-homework.

Further, all interview quotes, textual, and visual material re-presented in this thesis has been translated into English. Because education (both literature and practice) is nationally centered, I have added parenthesized organization names and concepts in Swedish when necessary.

4.5 Quality of study

The closing of physical schools had a severe impact on the research process. As a result of the redirection, the timeline for data collection was significantly shortened. I had to renegotiate access with few options and was grateful for the opportunity to regain it so quickly, given the restricted timeline. Still, a potential weakness is the relatively brief engagement with each site throughout the tracing.

In light of a process ontology, however, I do not aim at absolute generalizations (3.1.2 Process). Instead, I aim to produce knowledge of how one might organize (see 1.3 *Purpose and research question*). Hence, the relevant criteria to assess this research should rather be its *importance*, *usefulness*, and *societal relevance*. In this sense, the redirection (Dubois & Gadde, 2002) actually increased the quality of the study, as I could experience, first-hand, the unfolding of events that had never occurred before.

With regards to my novel approach to studying software, I wish to make two remarks. Akemu & Abdelnour (2020) address the issue of *authenticity* in studying digital settings. I have followed the authors advice by following the participants' interactions across multiple sites. Further, to mitigate the issue that "digital artefacts are perpetually in the making" (Akemu & Abdelnour, 2020), I emphasize the practices performed rather than platform itself. Second, in re-presenting these interactions, I have prioritized protecting the integrity of students (not recording video from the classes) and Digilär (not displaying the platform's content at any length), which might have negatively impacted the *credibility* of the research.

5 Empirical observation

In response to the multitude of data types collected, I have split this section into three parts. First, I give a brief analysis of the education system and edtech market to show how practices are translated into the digital classroom. This explains my emphasis on the teacher-student interaction in understanding value creation. Second, I outline the 'as-homework' use-case of the Digilär platform. I have chosen to illustrate these practices through a narrative, built from the experiences of students and my own self-reflexive auto-praxiography. The presented data should be seen in this light. Although an unconventional approach, I believe this best conveys thickness to the reader about the experience of using the platform. Third, the practices of the digital classroom are described in depth.

5.1 Tracing practices to the classroom

5.1.1 The education system as constituted by practice

5.1.1.1 Integrative practices

In creating Digilär's platform content, a project leader is responsible for sourcing appropriate authors and setting the timeline. The content is quality assured, proofread, and published. After publication, feedback is mostly attained by teachers reaching out with corrections. This quite linear process has historical and systemic similarities with the traditional publishing industry.

The platform is sold through licenses that stretches over 12 months. They can include one subject or all subjects on the platform. For digital pedagogical material, the sales process is long. This appears in stark contrast to the purchases of textbooks, where teachers are described as experienced buyers quickly browsing through the books looking for specific pedagogical qualities. The customer manager says:

"It is a long process before they arrive at a place where they purchase digital. The teacher needs to go, try it themselves, and finally also try it with their students. The teachers who are testing the platform now with their students, this spring, they will not purchase until August [...] It is a long sales process that is preceded by much testing."

This requires much supporting work from Digilär. The process usually includes visits to schools, a form of open house where teachers can view the materials, which later leads to a demo for a specific group of teachers. The second step of the process is getting teachers started to test the platform.

The purchasing process is complex. In general, municipalities hold the principal responsibility for education (Swedish. *skolhuvudman*) through a designated administration, a Local Education Authority (Swedish. *Barn- och utbildningsförvaltningen*), in which there is usually a person or unit responsible for IT or ICT. These administrations are liable to the Swedish School Inspectorate (Swedish. *Skolinspektionen*). To achieve their goals, the Local Education Authority is responsible for allocating budget to the schools or they can choose to make central purchases.

These purchases, by schools or municipalities, are then executed via an intermediary, *Läromedia* or *GR Utbildning*, which have a standing public procurement contract with the collection of municipalities, The Swedish Association of Local Authorities and Regions (Swedish. *Sveriges Kommuner och Regioner*). Hence, if a teacher wants to make a purchase, they first need to pass by the school director.

5.1.1.2 Representational practices

The existing market for digital pedagogical material is largely sprung out of the market for traditional pedagogical materials, with Natur & Kultur, Gleerups, and NE being some of the

leading competitors from which the re-presentations in the new market shows systemic influences. The Digilär platform is cross sold together with Natur & Kultur's traditional textbooks. Both are referred to as a pedagogical material and continually compared. The term *blended learning*, using both traditional and digital, integrates these markets even more.

In the sales process, Digilär's regionally based customer managers spend much time auditing the needs of the municipality, asking for numbers relating to the opening of new schools, whether the yearly 'batch' of students is increasing or decreasing in numbers, and other specific requirements like various strategies and aims (re-presentations resulting from normalizing practices).

The performance of schools is described in research reports, in which various specific re-presentations appear, such as 'classroom time spent on problem-solving'. Further, specifically in terms of digitalization, governmental institutions consider various measures such as fractions, '1:1' or '1:2', to represent how many students there are per computer and consider 'Mbit/s' to represent IT infrastructure.

Further, resulting from student-platform interaction, Digilär's platform produce re-presentations of student performance in the form of data accessible to teachers. This data is shown on both an individual level and as statistic, such as the percentage of students who failed a particular exercise.

5.1.1.3 Normalizing practices

The education system is heavily influenced by normalizing practices, particularly those of public policy and research. The Swedish government administers education through the Ministry of Education (policymaking) and the National Agency for Education (see *Appendix 1*), which creates strategies and curricula for the municipalities to implement. These normalizing practices are complemented by the work of agencies such as the previously mentioned School Inspectorate and the National Agency for Special Needs Education and Schools (Swedish. *Specialpedagogiska skolmyndigheten*). These normalizing practices are translated to the municipalities. Further, they directly affect the development process of Digilär's platform.

Two of the most important guiding norms in the education system are, firstly, the principle of equivalency (Swedish. *likvärdighet*) and, secondly, the combination of human rights and democratic values. These values are translated throughout the ecosystem, as demonstrated by Digilär customer manager's comment on licenses that were purchased but not activated:

"I think this is wrong. What happens to equivalency at this school? What happens to equivalency and [the principle of] democracy? You create such bad conditions for both students and teachers. With our public resources, even. Such a waste."

The impact of those normalizing practices is far-reaching, even into a sales organization in a highly competitive market.

Another important source of normalizing practices is academic research. To the government agencies, this research comes from a variety of sources such as academic journals, whitepapers by private companies (for instance, by *CISCO*, in the case of Mbit/s above), and other countries' government agencies. This is equally important for content producers such as Digilär. In creating pedagogical material, it is very important that it is science-based, quality assured, and in accordance with national curricula.

Finally, the academic fields of pedagogy, including didactic methods, are important sources of normalizing practices. These fields of knowledge are translated into the classroom by the

normalizing practices of teacher education. It also shows up inside Digilär's development of the platform, highlighted by the project leader:

"All children in Sweden must be given the conditions to be able to achieve the goals of Swedish education. And this means that based on the students' needs and conditions, the children should receive support based on what they need, and so on. It is the Local Education Authority's responsibility."

Once again the importance of *equivalency* is emphasized. Further, the quote illustrates well the move that has occurred from an *essentialist* to a more *progressive* pedagogical thought based on students' needs (Stensmo, 2007).

5.1.2 Chains of translations

In this section I wish to stress the importance of the teacher in trying to grasp value creation in the edtech market. I will exemplify with two chains of translations, experienced by Digilär's employees. The first highlights the detrimental aspect of not involving teachers, while the second highlights the potential upside of teacher involvement. Finally, I turn to explain the importance of teachers in adopting digital pedagogical material.

5.1.2.1 A national IT strategy

The first example is about the national effort to increase the prevalence of computers throughout education system:

"If you go back to 5 years ago, the government [Ministry for Education] asked the National Agency for Education to develop a new IT strategy. So, then the National Agency for Education creates this proposal. The proposal was approved. [It stated] that every student should have a computer, at least one unit [computer or tablet], and that this should be the case before 2022."

Before the story starts, computers have already been widely adopted in schools (*integrative practices*). The effects were depicted in international research (*representational practices*) which was picked up in various reports (further *re-presentation*) by, for instance, the Agency for School Development (Swedish. *Myndigheten för skolutveckling*). The combination of the interests of schools and the Ministry for Education taking part of these descriptive reports were translated into a formal request (*normalizing practice*) by the government. The strategy was translated into a specific measure, the 1:1 ratio of computers to students (*representational practice*).

"And what happened? Well, then the municipalities started to purchase computers, smartboards, and so on."

Once implemented, the resulting guidelines of the IT strategy (*normalizing practice*) was a translated into the implementation by municipalities as they purchased equipment (*integrative practice*).

And then you [*herself*; implied] come out to the schools to make school visits. It turns out that the smartboard is in a cleaning closet. They don't know how to use it. They don't know what content to fill it with. There you have begun at the wrong end, instead of [conducting] a needs audit of what the digital tools are supposed to do for us, and begin at that end"

The chain of translation shows the failure to realize the original intention. In these recurring representations, the most important aspect of what was intended to be normalizing vanished. The technology was not picked up by the teachers, and hence, its transportation stopped before any pedagogical value was realized. The customer manager claims that this pattern repeats over and over again, for reasons that are turned to at the end of this section.

5.1.2.2 The flipped classroom

This second example is about a teacher who became famous for introducing his style of learning and applying it to meet a demand for more problem-solving in mathematics:

“The School Inspectorate had decided that there is far too much individual counting exercises with the textbook and too little problem solving. And this you can see in our future jobs. The jobs available are [requiring] high education, [are] very technical, and [based on] problem-solving.

The School Inspectorate stepped in and mandated (*normalizing practice*) that measures be taken to adopt more applied problem-solving in mathematics education. This was a result from a shift in work practices (*integrative practices* of the referential Swedish labour market).

“Five years ago, when I was out at [visiting] the upper secondary schools, and I was with Daniel a few times when we met math teachers and Daniel were to go through NOK Flex with them. When we arrived at the schoolyard, students came up to Daniel Barker and shouted ‘Oh it’s Daniel, it’s Daniel! We want an autograph! Can we get an autograph?’. He was *well-known* [emphasis] by the students.”

The upper secondary school mathematics and physics teacher Daniel Barker had started putting his lectures online (*integrative practices*). He applied the concept of *flipped classroom* (*representational practice*) inspired by King’s (1993) pedagogical methods in the book *From Sage on the Stage to Guide on the Side* (*normalizing practice*) and perhaps most widely applied by Khan Academy (*integrative practice*). The lectures Barker had posted online had been picked up by various students (*integrative practice*) in Sweden. Barker (2013) proceeded to write a book, *Input Flipped Classroom* (2013), in which he described his way of working (*representational* and *normalizing practice*). Together with Natur & Kultur, Barker started developing his own digital pedagogical material, NOK Flex (*integrative practice*), which is now integrated into Digilär.

“Then he quit [as a teacher] and started working full-time at Natur & Kultur to develop NOK Flex. And, among other things, he developed classes, that is, complete class activities that the teacher can use. [...] It was a problem-solving activity. Then Daniel created, as a model, a trail for you [teachers] to follow. He built these class activities and I believe they really show digitalization at its best.”

Working at Digilär, Barker developed pedagogical materials, applying his teaching style (*integrative practice*). In NOK Flex (now in Digilär), Barker outlined mathematics classes, presented through step-by-step trail (*representational practice*).

“It is about using the students as resources for each other. These are fantastic maths discussions [arising in the classes], instead of having students sit and hide behind a book. This is when digital pedagogical materials are at their very best.”

The trails would give a detailed account of students watching a short video clip with a problem, try to solve it, then discuss their answers in groups, and finally present it to the class. These trails (*representational practices*) directly responded to the School Inspectorates demands (*normalizing practice*), by guiding teachers (*normalizing practices*) to engage in more problem-based classes (*integrative practices*).

5.1.2.3 The importance of involving teachers

However, the theme of non-adoption by teachers, repeats itself, which, the customer managers says, is a problem for Digilär:

“The Local Education Authority sometimes make decisions above the teachers’ heads. All of a sudden [they say], ‘Now all upper secondary students should have Digilär. Here you go. You’re welcome.’ So then they purchase licenses for all the students, say 500 licenses. Then, unfortunately [...] if you don’t have the teachers onboard, by having them participate as a reference group, having them test, evaluate. You have all of this preliminary work with the teachers and you can also audit the teachers’ previous knowledge, what kind of support, what kind of training do the teachers need?

If you do not do this, then it will be an instant failure. Then only perhaps 10-15% of the teachers will activate their licenses.”

This provides yet another example of failed adoption of new pedagogical technology. It is a similar chain of translation as previously outlined (5.1.2.1 *A national IT strategy*). It shows an effort from the municipality to implement digitalization initiatives, but without advising teachers regarding the purchase and subsequently not supporting the teachers in the implementation, the adoption falls short.

“Some [teachers] get a lot of support. Some get nothing at all. A prerequisite for the success of digitalization is that the teachers receive support and furthered education [Swedish. *fortbildning*]. There are so vast possibilities with digitalization, and you can interact in a completely different way. [...] but it requires a lot from the teacher. But if you get the right support, it also becomes a personal development for the teacher. Many teachers testify to this, when they receive support and furthered education [*fortbildning*], they feel that they themselves are taking a step forward in their development. It is a bit win-win but it has to be done properly.”

The quote summarizes the recurring theme of the importance of teachers in facilitating the adoption of edtech, in procurement and implementation, the second of which led me to follow Digilär's platform into the digital classroom. This illustrates the rationale behind my tracing, particularly in the most decisive step from *Sales and implementation* [2b] and *Digilär as a platform* [3] to the *Physical classroom* [4], which was eventually redirected into the *Digital classroom* [5].

5.2 Digilär as standalone platform

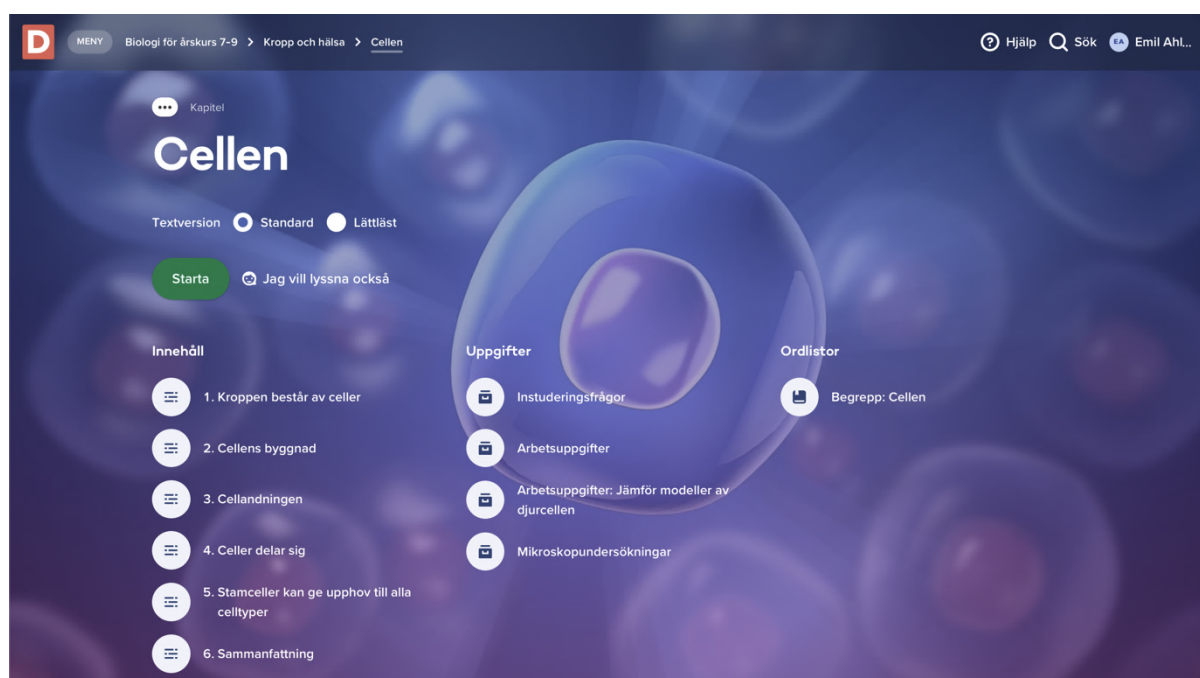
The following narrative is based on the self-reflexive (auto)praxiography along with and the interviews with students and Digilär employees. It has been constructed to illustrate: (1) the functionality, navigation, and graphical user interface of the platform and (2) the use-case of Digilär as a standalone platform when used *as-homework*.



I

Open laptop. Enter password. Click browser. You have done this before, barely noticing as you steer the cursor across the screen. Your direction, however, is new. The page currently loading is supposed to reveal a new textbook. Your teacher told you to explore the new material — learn how to use it and answer the questions. Well, you know how to navigate books and use websites, it should be no problem really. “Homework as homework”, you think as you scramble for the login details. “Just hand in the assignment, then off to football practice. Simple as that”.

II



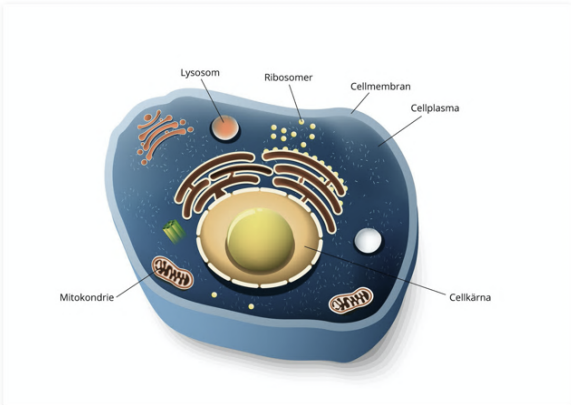
From the main menu you see an overview of all courses assigned to you. You are looking for a chapter about the cell. Biology — click. Body and health — click. The cell — click. You are at the main page. It doesn't look like a regular textbook chapter. Three sections become salient to you: Content, Exercises, and Glossary. A big green button wants to be pushed, 'Start'. "I can probably finish this quickly", you think as you click 'Assignments' instead. "After all, biology is my favorite subject".

III

Biologi för årskurs 7-9 > Kropp och hälsa > Cellen

Lyssna Anpassa Uppgifter Ordlistor Anteckningar

2 Cellens byggnad



I cellen finns det organeller. Varje organell har en speciell uppgift i cellen.

Gemensamt för alla celler är att de har organeller. Organell betyder 'litet organ' och det är cellens olika delar som kallas så. Exempel på

Uppgifter

Arbetsuppgifter Uppgift 1 av 4

Övning Kommentarer (0)

1. Organell och funktion

Här ska du para ihop funktion och organell. Dra organellen till rätt plats.

mitokondrier lysosomer
cellplasma cellmembran
cellkärna ribosomer

Innehåller cellens arvsmassa.

PÅBÖRJAD Svara

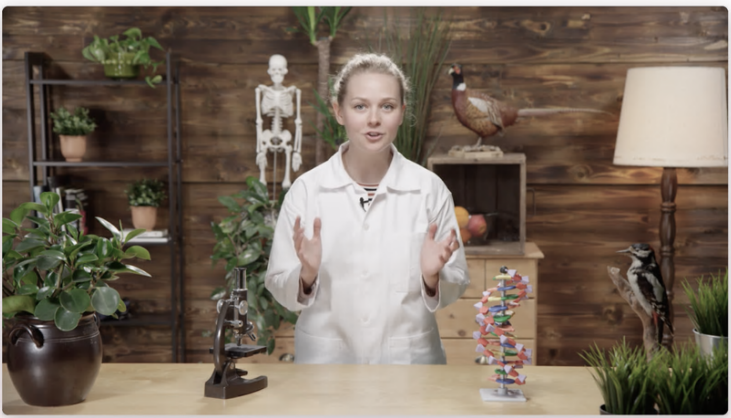
Your eyes are immediately drawn to the right-hand side. Under the 'Exercises' heading, you find the four questions that need to be answered and handed in today. You have to pair each organelle name with a description of its function. "This would be simple", you think, "had I only known what an organelle was" and start scrolling down the page. You realize that you are already in the chapter. There are texts, figures, and descriptions. You search and find information about organelles. You drag and drop the organelle names into their respective boxes and click 'Answer'. Two boxes go red – you have conflated ribosomes with lysosomes. You correct your mistake and move on.

IV

Biologi för årskurs 7-9 > Kropp och hälsa > Cellen

Lyssna Anpassa Uppgifter Ordlistor Anteckningar

Cellen



Uppgifter

Arbetsuppgifter Uppgift 2 av 4

Arbetsuppgift Kommentarer (0)

2. Kroppen behöver energi

Om vi håller andan frigörs mindre energi i cellerna. Förklara hur det hänger ihop. Motivera!

Paragraf B I S U x₂ x²

Bifoga

Lämna in

The next question, related to breathing, asks you for a written answer. You remember noticing a video clip on the top of the page, 'I should probably watch it before answering', you figure. The video shows a teacher giving a 2-minute introduction, she gives an overview of the cell, giving examples and illustrating with images. 'Perhaps not answering the specific question, but at least now I know what it is that I am reading about', you think as you continue looking for the answer.

V

The question is not as easy as the previous, but you find a section related to oxygen and, you suppose, therefore breathing. Some of the words stand out as underlined – when you click, screens pop open with explanations of the word or concept, and sometimes, even a figure or a video clip. You find some of the concepts useful, so you click 'Save'. When you click on 'Glossary', you find the word. Back to the text. You make some inferences from the text and write an answer to the exercise question. Your answer is submitted to your teacher — you are hopeful that you are correct.

VI

The next question reads: 'A human body consists of billions of cells. We can for example ride a bike, sing, eat, think, see, and hear. But we are only made up of cells! How is this possible?' The question also includes an external link to a Swedish e-health webpage (1177.se). There, you find information about stem cells, cell division, and various types of tissue, along with images of bodies with organs. "This answers the question!", you think as you type your answer and move on to the final exercise question.

VII

The screenshot shows a digital learning environment. At the top, there's a navigation bar with a 'D' logo, a 'MENY' button, and a breadcrumb trail: 'Biologi för årskurs 7-9 > Kropp och hälsa > Cellen'. On the right, there are links for 'Hjälp', 'Sök', and a user profile 'Emil Ahl...'. Below the navigation bar, there are icons for 'Lyssna' and 'Anpassa'. The main content area features a video player titled '4 Celler delar sig' with a subtitle 'Film: Celldelning'. The video shows two cells in the process of dividing. Below the video, there's a caption: 'Celler förökar sig genom att dela sig.' and a paragraph of text: 'Av en cell kan det bli många celler och det beror på att de har celldelning. Det innebär att de delar sig. Om vi har en enda cell från början kan den dela sig och ge upphov till två identiska celler. De'. To the right of the video player, there's a task panel titled 'Uppgifter' with a sub-header 'Arbetsuppgifter' and 'Uppgift 4 av 4'. It shows a task '4. Vad händer på bilden?' with an image of cells. Below the image, there's a prompt: 'Försök förklara vad du ser på bilden. Vad är det som händer? Motivera!'. At the bottom of the task panel, there's a text input area with a 'Lämna in' button.

As you are looking for the answer to the fourth and last exercise question, you stumble over the 'Settings' and 'Listening' buttons. It is surprisingly amusing to customize your page. You change the background color, font type, and font size until you get bored. All considered, the text should be what is most important. But then you remember one of your friends, who usually has trouble reading, s/he could probably make use of the built-in reading ruler.

VIII

You realize that the 'Listening' button enables you to have all the text read out loud to you. As you play around with the various local dialects provided by the reading functionality, suddenly, you hear a sound that does not come from the computer. You have lost track of time. Your inward giggle turns into outward attention. Your older sibling opens the door fiercely, "We're late for practice – come on, let's go". You submit the last question and head for the door.



This story intends to describe Digilär's platform in its particular application to a homework situation (further images are provided in *Appendix 3* and *Appendix 4*). While the story aims to outline the core functionality, it should be known that no course on the platform is exactly equivalently in its type of content. In general, social science subjects have a heavier focus placed on discussion questions and critical thinking. In language courses, on the other hand, the exercises are more sophisticated in terms of audio (input/output) content.

Digilär is cross sold together with Natur & Kultur's traditional textbooks. With this presumed similarity as a starting point, I want to outline some key differences. While the content on the platform does follow the core structure of a textbook including chapters, sections, and body text explaining key concepts ending with a summary followed by exercises, Digilär also includes short clips and teacher instructions. More importantly, the difference is even clearer when considering interactivity. There is a layering of content 'below the surface' (one click away), which keeps the 'reader' in constant 'movement'. Examples include links to external sources, the interactive glossary, and assignments with direct feedback.

Being a mere reader of the text (as if it were a textbook) is possible, but there is constantly a large amount of additional opportunities for movement. In my experience with using the platform, this shift from passivity to 'activity' was the greatest difference between Digilär and a traditional textbook. However, this can also cause problems, described by one of the students:

"Sometimes it feels like, it can be a bit of a pain. You are so used to a book you know. This [using Digilär] becomes like another thing. Then again, it is also probably just out of habit. By now, we have worked with it [Digilär] quite a lot, so now you have become more – it feels better. But especially in the beginning it was like a transition, that you do not really... [tries to find words] It was new somehow. That was a pretty big deal, I would say."

Using the platform is not the same as reading a textbook. This was further described by the project leader when asked about how teaching is impacted by digital pedagogical materials:

You read a little bit differently. Digitally, they search more in the text. If you have a question then you look for it. In the printed textbook, you read a little bit more from 'top to bottom'. Then again, we do not know how you learn best, there is not very much research. It is up to the teacher how they use the pedagogical material in the classroom."

Once again, the importance of the teacher and the specific implementation is emphasized. It is this in-class usage to which I turn to next.

5.3 The digital classroom

In this section, I have chosen to emphasize the *seminar* to illustrate the classroom interaction. However, first, I describe the foundation of the digital classroom.

5.3.1 The constitution of the classroom

The foundation for the classroom is facilitated by videoconferencing (hereafter “video call”) applications *Zoom* and *Microsoft Teams* (hereafter “Teams”). Teams also facilitates information-sharing between students and teacher outside the classroom. For instance, the question if I could participate in the classes was posted to the students via Teams.

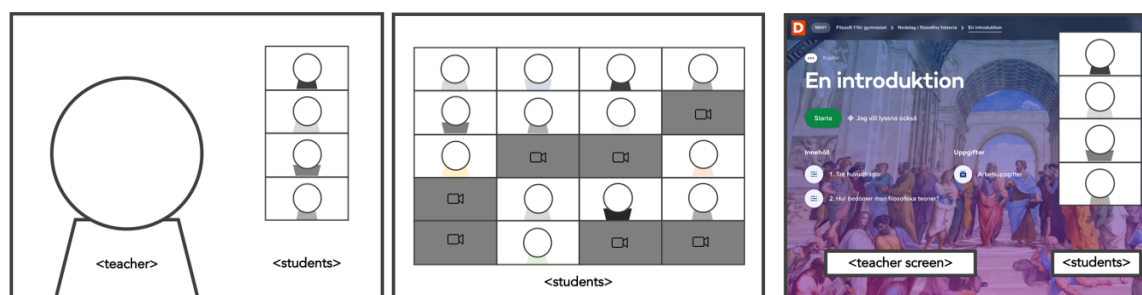


Figure 4: The digital classroom interface, in three variations (left: focus on the teacher, middle: focus on all participants, right: focus on teacher's screen sharing)

The teacher invites the students through a calendar event or a URL-link. Web cameras are requested, but not mandated, to be switched on and microphones are manually switched off by each student while not speaking to reduce unnecessary noise. Participants can choose what to display: the particular participant speaking, only one participant (primarily the teacher) or all participants. The latter option is used by the teacher to get an overview of all students. Another very important functionality is screen sharing. It is utilized mainly by the teacher, who will share various content with the students (PowerPoint-slides, Digilär exercises, Google-searches, et cetera). Figure 4 outlines the three most common views, which, seemingly, serves similar roles as the three key basic components of a physical classroom: a teacher on stage (teacher-focus), a student audience (all participant-focus), and a supporting whiteboard and/or projector (screen-sharing).

5.3.2 The unfolding of a class

Before the seminar, preparatory information is distributed to the students through the Teams platform (see Appendix 5). The information included (1) a scheduled agenda for the class, (2) a grouping of all students into pairs, and (3) instructions for ‘checking in’. This specific seminar focused on *energy flows in ecosystems*, within the theme of ecology. Students are instructed to ‘check-in’ using the Digilär platform, by answering the first two attendance questions¹⁶ (cf. 5.2 *Digilär as standalone platform, part III*). Hence, no roll call is necessary.

Before the class commences, the teacher awaits most students to login to Zoom, while engaging in small talk with the students. During the introduction that follows, the teacher switches back and forth from screen sharing (for instance, showing the agenda via the Teams platform). The class is then split into pairs. Students leave the Zoom video call and pairwise move into separate video calls via Teams. The teacher stays in the original Zoom video call, where students can revert back

¹⁶ To avoid confusion, questions are separated into *attendance questions* (Digilär), *exercise questions* (Digilär), *questions* (to the teacher), and *quiz questions* (Kahoot!).

if they have questions or technical issues. Further, students also enter Digilär to access the exercise questions they are to discuss. The exercises in Digilär are displayed in connection with the content (cf. 5.2 *Digilär as standalone platform, part III*). Students are familiar with the topic as they have read this content previous to the class.

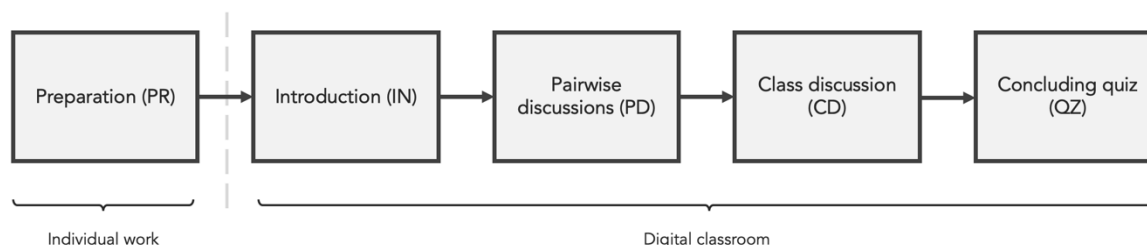


Figure 5: Chronological overview of the five stages of the seminar class.

Their work in the pairwise discussions are recorded in two ways. Firstly, answers are collected in Digilär and accessible to the teacher in real time. Secondly, the video call between students are recorded and viewable to the teacher after the class. The teacher uses this output in two ways. After the class s/he views the recordings of the students:

“The hardest thing with teaching on a distance is getting a basis for assessment. It’s hard to sit with everyone in a class of 32. It is easier if you record, you can just participate and peek in.”

In real time, s/he can follow the development of the students work, receiving notifications on students answers from a teacher-side of Digilär’s platform. This enables the teacher to follow the progress of students, tracking developments relating to exercise questions such as: *How many exercise questions have they managed to answer? How well are they understanding the topic? Where are they most commonly in error?* This guides the teacher in the next step of the class.

Students then rewind to the original Zoom video call where the teacher is waiting. The pairs have proceeded at different pace and some are further ahead than others. Now, all of the exercise questions are discussed together in full class. The teacher uses the screen-sharing function to enter into the student side of Digilär. This enables the simultaneous display of both the exercise question and the Digilär chapter content. The discussion varies depending on the specific exercise. At times, the teacher asks the class to answer the exercises question, whereby s/he will add supplementing information. Continuously, s/he asks students about concepts they did not understand or have questions about. Consequently, students engage in the discussion both by providing their answer to the exercise questions and by asking further clarifying questions to the teacher. In this way, discussions arise continuously. The process ends with the teacher filling in or writing a correct answer and subsequently proceeding with the next exercise.

The class ends with a quiz. The quiz questions are prepared by the teacher before the lecture and relate to previous course material. It is created in the game-based learning platform *Kahoot!*. Students enter a new digital environment through their respective devices. After the quiz is finalized, the lecture ends. The teacher follows up by reviewing the pairwise discussion. The complete process is outlined in Figure 5.

5.3.3 Forms of teaching

Three ‘types of classes’ were identified during the research. In addition to the class described above, what I have categorized as a *seminar*, the two other types of classes are *lecture* and *lab*. While the seminar is more of an interactive discussion between teacher and students (as well as students and students), the lecture is more like a traditional instructional presentation led by the teacher,

while the lab is an attempt to simulate the experimentation that is usually conducted in a physical laboratory classroom.

Although these ideal ‘types of classes’ are termed like traditional types of classes, from a practice perspective the borders blur. At a closer look, they are not individual events so much as they are *forms of teaching*. Consequently, all three types of classes included a combination of at least two of these forms of teaching. Thus, the types of classes are only defined by the main teaching form practiced.

The *lecture* mimics the traditional learning situation in which a teacher stands in-front of blackboard¹⁷, ready to ‘deliver’ their knowledge to the students. However, it is important to understand this as a form of teaching, a practice, rather than entire type of class. The lecture that I participated in involved much student engagement, at many times tending more towards the seminar teaching form. The lecture was centered around a PowerPoint-presentation, screen shared by the teacher to the other students via Zoom.

To engage students in the discussion, the teacher assigned two designated students to ask questions during the class. These students were particularly encouraged to ask questions that other students might find useful. Moreover, through a text chat between the students, other students could ask questions via these two designated students. This seemed to work quite well, as the class quickly ‘opened up’ with question after question being posed to the teacher. Throughout the lecture, there was a constant movement back and forth between the seminar and lecture form of teaching.

The *lab* form of teaching mimics conventional laboratory-like experimentation. The class I participated in was the first of this kind, that is, an experiment in itself. The aim of the teacher was to test whether lab classes could be performed via video call. The lab was focused on *sexually transmitted diseases*, within the theme of *love and reproduction*. Because the experiment illustrated the spread of infectious disease, the opportunity was also taken to talk about it in terms of the current spread of sars-cov-2. Students had been instructed to find or purchase a few grocery items, with the key ingredient being either red cabbage or blueberries. The teacher then instructed the students through the computer’s camera and microphone, facilitated by Zoom. Students followed the teachers lead, but in their own kitchens at home. Experiments were in most cases successful (see image in *Appendix 6*).

Experiments were also conducted outside the lab class. As part of an ongoing project, with students using their own bodies (physical strength and voice exercises) to collect data. The data was discussed during the lecture class (analysis of p-values, et cetera) through screen sharing and shared access to a Microsoft Excel spreadsheet at the end of the lecture.

5.3.4 The digital classroom as constituted by practice

5.3.4.1 Practices

The various practices performed during the seminar class is summarized in *Figure 6* below. The figure presents a collection of those practices that was identified during the class. These are all practices that in themselves are contingent on a multitude of other practices. For instance, the ability of Zoom to facilitate a video call of 34 participants is conditional on the internet service

¹⁷ Swedish. *Katederundervisning*

provider in each one of the homes of students and teacher. As a result of my focus on pedagogical practices, this flow, along with many others, was necessarily deprioritized¹⁸.

Teacher		Students		Stage
Prepare class	(PR)	Check-in (attendance)	(IN)	Preparation (PR)
Post preparatory information	(PR)	Participate in pairwise discussion	(PD)	Introduction (IN)
[Chatting before lectures starts]	(IN)	Search for information on topic	(PD)	Pairwise discussions (PD)
Move class forward	(TA)	Submit answer to exercise questions	(PD)	Class discussion (CD)
Solve technology issues	(TA)	Answer exercise questions in class discussion	(CD)	Concluding quiz (QZ)
Follow progress of student's pairwise discussions	(PD)	Ask teacher clarifying questions	(CD)	Throughout or after class (TA)
Tailor class discussion to level of students answers	(PD)	Listen to teacher explanations	(CD)	
Explain topic	(CD)	Answer quiz questions	(QZ)	
Reframe students' explanations	(CD)			
Elaborate on Digilär content	(CD)			
Answer questions from students	(CD)			
Initiate quiz	(QZ)			
Assign homework	(TA)			
Watch recordings of pairwise discussions after class	(PD)			
Zoom		Digilär		
Facilitate video call (34 participants)	(TA)	Provide background reading	(PR)	
Enable teacher screen share	(TA)	Record attendance	(IN)	
Enables recording of video call	(TA)	Display content to students	(PD)	
		Provide exercise questions	(PD)	
		Record answers to exercise questions	(PD)	
		Display exercise question to teacher	(PD)	
		Display content through screen share	(CD)	
		Provide homework content and exercises	(TA)	
Teams		Kahoot!		
Distribute preparatory information to students	(PR)	Enable creation of quiz	(PR)	
Enable 16 pairwise discussions	(PD)	Pose quiz questions	(QZ)	
Record pairwise discussion	(PD)	Enable student answers	(QZ)	
Avail pairwise discussion recordings to teacher	(PD)	Display answers to quiz questions	(QZ)	
		Display leaderboard	(QZ)	
		Assign winner	(QZ)	

Figure 6: Practices constituting a digital class, split by actant (box) and stage of the class (notation).

Some initial insights can be drawn from this simple outline of performed practices. First, the highest variety of identified practices that constitute the classroom are performed by the teacher. Second, many of the key practices performed in the classroom are attributed to non-human actants. Third, the practices of each actant is intensely interrelated (except for perhaps Kahoot!, which was used as a relatively standalone service), shown by the variety of stages of the class that each actant is involved in. This shows how each practice builds on the facilitation or input information of other practices. This underlying process of the interaction will now be turned to.

5.3.4.2 Layers of platforms

This section serves to explicate the complexity of computing systems interacting with each other. To understand how a digital classroom is organized, it is important to understand the processes beneath it, that is, how practices are interrelated. Although many different platforms (Kahoot!, as well as *Microsoft Excel* and *Microsoft PowerPoint* in later classes) have been observed, the general understanding is similar. For this reason, I will prioritize the deeper understanding of one situation, the seminar. This section outlines the platforms supporting the process described as the third and fourth part of the seminar, the *pairwise discussions* and the *class discussion*. The aim of the two figures below is to provide sketches of the flow of information and practices throughout the platforms, as students engage in these parts of the seminar. These various flows illustrated in the figures constitute the class sometimes consecutively, and sometimes simultaneously, but are broken up into two figures for increased clarity.

¹⁸ Nevertheless, these flows are perhaps relevant to other questions. This example should constitute a highly relevant discussion between, let us suppose, the Swedish Civil Contingencies Agency (*Myndigheten för samhällsskydd och beredskap*, MSB) and the Swedish National Agency for Education as education becomes increasingly reliant on internet access.

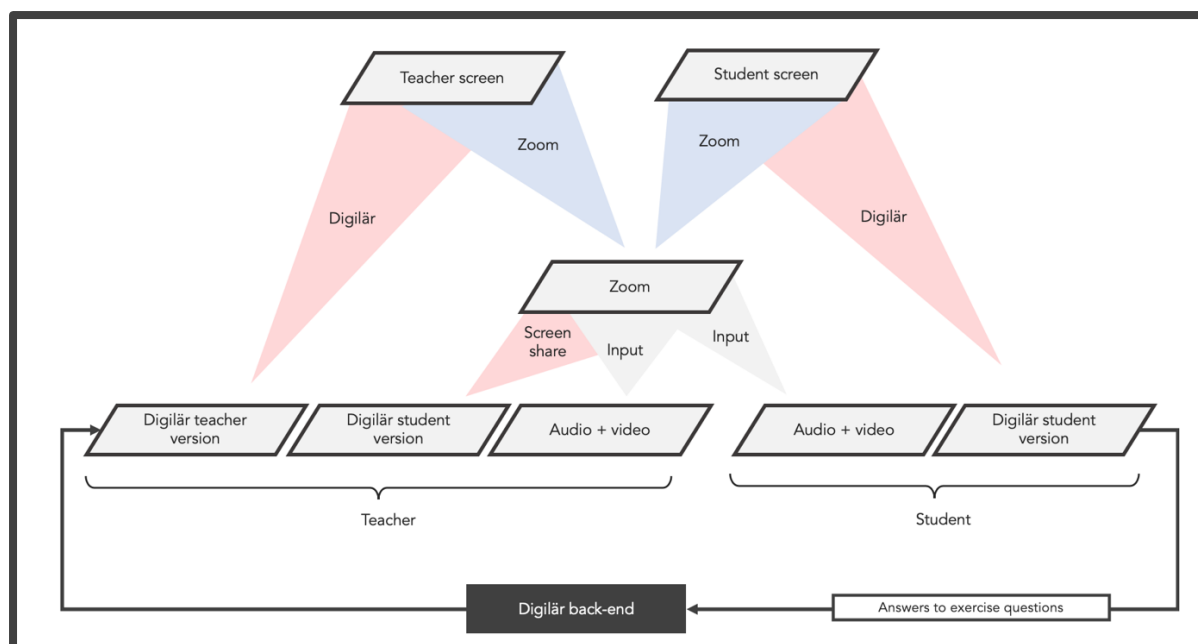


Figure 7a: Digital class constituted by Digilär and Zoom. The figure outlines the flows of information from each platform to the next. Representations are displayed upward. Permanently stored data is displayed as a thick line.

Figure 7a illustrates how classroom interaction is shaped by various enablers. The computer operating systems facilitate the collection of audio and video to represent its own user, which is displayed through Zoom to both student and teacher. The student version of Digilär (cf. 5.2 *Digilär as standalone platform*) will be displayed on the student's screen through a web browser, whereby the student's answers are collected and sent to the teacher's version of Digilär, where s/he can review the answers in real time.

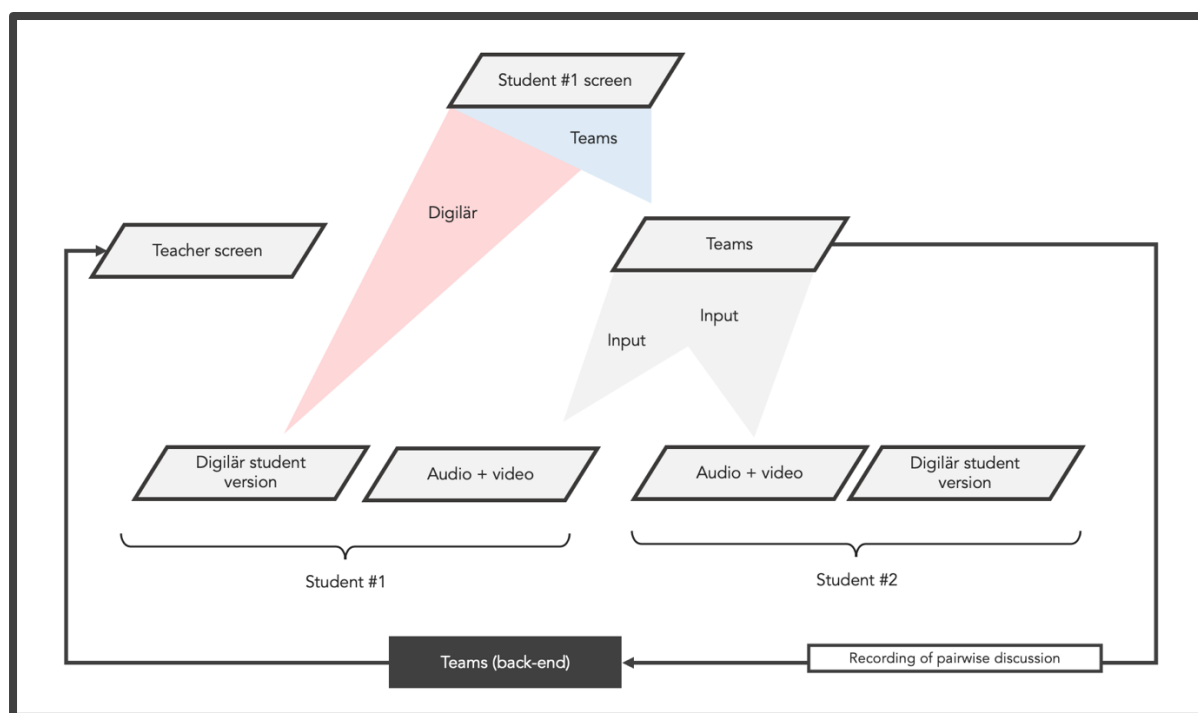


Figure 7b: Digital class constituted by Digilär and Teams.

The collection and re-presentations of answers by Digilär occur at the same time as students are conducting their pairwise discussions. This is facilitated by Teams (see Figure 7b), which re-presents

the collected audio and video input from both students. Both students are able to view this Teams meeting on their own screen, along with their personal Digilär version of the exercise questions through their own web browser. The meeting in Zoom is collected and sent to the teacher, so that s/he can review it after the class.

So far, the teacher has been observing the interactions indirectly through the access of students' answers. In the final step, facilitated by Zoom (see Figure 7a), the teacher uses the student version of Digilär to answer the questions as if s/he was a student. This is screen shared with the rest of the classroom participants through the screen sharing functionality of Zoom. Students can now compare their own answers in Digilär with the teacher's answers. At this stage, as outlined previously, students are participating in the interaction by providing their own explanations and asking questions.

6 Discussion

In this section, I apply the integrated theoretical model to analyze the empirical observations in order to synthesize insights that answer the research question. First, I outline a new frame for understanding edtech organizing. Second, using this frame, I show how edtech might facilitate pedagogical value creation.

6.1 A frame for understanding edtech organizing

6.1.1 The disconnect between intent and use

In separate ways, this research has shown that education technology does not behave ‘as intended’. The question often asked (see 1.2 *Research gap*) is whether edtech is beneficial, for instance by measuring how well students’ generally learn depending on whether they use traditional or digital means. In light of this study, however, the interesting and important answers come from asking *how* to implement edtech in order to increase pedagogical value.

This question is by no means obvious. From the tracing of practices, the chains of translations illustrated the detrimental aspects of assuming that there is a pre-existing relationship between technology and learning outcomes. The purchase of technology does not guarantee usage, and usage does not guarantee successful usage. Particularly in the two examples with mass-purchase by the local education authorities, first of hardware units and later edtech licenses, illustrates the problem. Technology needs to be picked up, transported. If it is not, it will not facilitate any value, such as those unutilized Digilär licenses or the smartboards lying in a cleaning closet.

This was further illustrated in the two parallel studies of Digilär as a platform and Digilär in the digital classroom. When using Digilär as-homework, I followed the inscriptions (Bueger, 2014; cf. *inscription*, Akrich, 1992) outlined by the platform. In addition, I worked hard to experiment with it, as to align my interactive model with the platform’s system model. An agencement was created between me and the platform that enabled the creation of pedagogical value in several ways. Particularly the flexibility and ‘movement’ provided by the interactive layers of links. Nonetheless, I could never predict what agencement this same platform would contribute to create in the context of a digital classroom. The complex intermingling between humans and computer systems outlined in 5.3.4.2 *Layers of platforms* were not identifiable ex ante, much less the pedagogical practices and pedagogical value that arose from that agencement (Figure 6).

To use education technology or not, that is *not* the question. Edtech must not be seen merely as an artefact to implemented or not. Evidently, there are clear differences in what a computer system is intended to do and what it can afford once the user is well organized. This holds for both success and failure. It is the complexity of this organizing that I turn to next.

6.1.2 Learning to navigate education technology

Throughout the study, an important insight recurred in relation to the implementation of edtech — that one must learn in two steps. In order to facilitate the intended pedagogical value (*learning*), participants must first *learn* to use the technology. A functioning implementation of technology is dependent on the creation of an agencement between users and computer systems.

Through the auto-praxiography, it was noted how much more movement was enabled by the interactive nature of the platform — layers of affordances were continuously created. This was further described in the interviews with Digilär, which had created a ‘focus mode’ that strips away everything except text and images from the screen. This was a consequence of some students’

difficulty to focus, relative to reading a traditional textbook. Herein lies both the dangers and opportunities of affordances, attention, and working memory.

The difference from a regular textbook can be explained through the concept of *psychotechnology* (Vervaeke, 2019). In the philosopher and cognitive scientist John Vervaeke's (2019) language, the act of reading text on a paper is a 'technology' we integrate as a cognitive ability. This ability is something we spend much effort acquiring, one of early-stage education's primary functions. Just as we need to learn to read books in order to acquire further knowledge, we must learn to navigate computer systems in order to realize the potential of edtech. This becomes challenging, the psychotechnology of reading is not only taken-for-granted, it is also much more rigid – stable over time and not differing so much between contexts. The skill of navigating computer systems cannot be described as a coherent psychotechnology in the same way as literacy, it requires more flexibility. The interactive nature of navigating a computer system is not only a new skill to pick up, is also a skill with less generalizability in its execution than learning to read a book. Hence, this learning is required for each new system.

To engage in this learning, edtech firms, students, and teachers must become proficient in organizing systems of distributed cognition. It is first when we outsource our working memory to the computer that we have created an agencement with emergent pedagogical value. These systems are what enables the students to effectively utilize the additional functionality on the platform without getting overwhelmed.

This requires learning to create useful affordances in order to establish an appropriate interaction model. The result of this learning is that the system 'disappears', the platform itself becomes *transparent* and, instead, what becomes *opaque* is the significance of the content, that which create pedagogical value. Hence, learning requires learning.

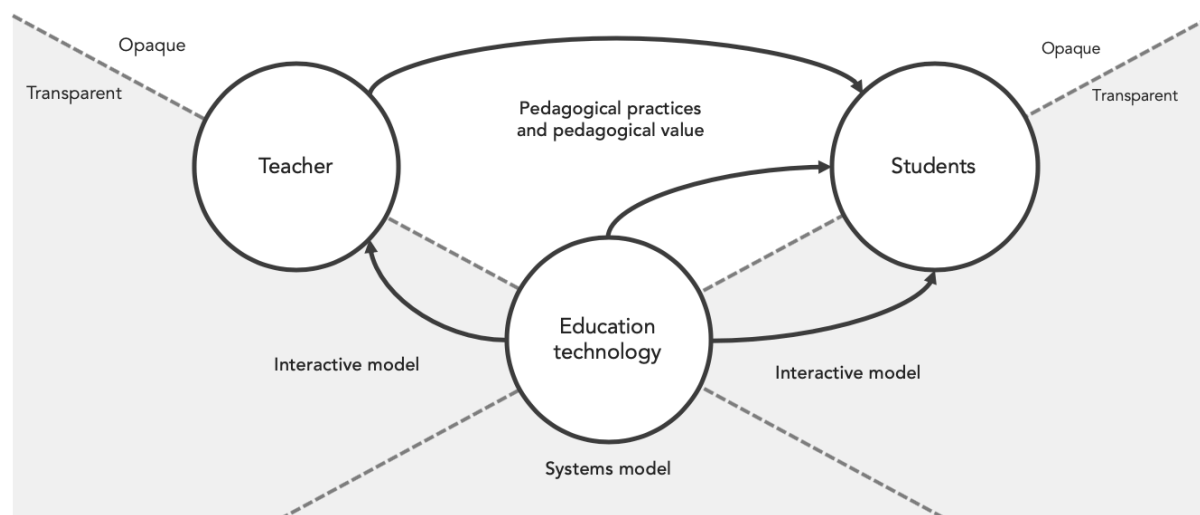


Figure 8: Conceptual model of distributed cognition between teacher and student. Students' and teacher's interactive models align with the platform's systems model, rendering it transparent. Consequently, the platform affords opacity to the student to engage with the pedagogical practices of teacher and platform.

In this context, Figure 8 explains the necessary conditions of a functioning learning situation enabled by education technology. It shows the importance of mutual learning and teaching. Both the students and teacher has learned how to interact with the system, so that those practices that are facilitate pedagogical value is opaque, while the underlying functioning of the system has become transparent.

This was also demonstrated, illustrated by the quote from the student in 5.2 *Digilär as a standalone platform*. It was harder in the beginning, but it became easier — the platform is not merely a book. This was, with no surprise, already noted during the auto-praxiography. The first hours were significantly slower, and attention was constantly drawn to the functionality of the platform rather than the actual content. The same learning process was also apparent in the digital classes, particularly in the lab. In the beginning, students were scrambling around in their kitchens, focusing on where to put the computer rather than on the experiment itself. This was the first time this type of lecture was performed, and in the end of the lecture the uncertainty had to a large extent settled.

This further explains the extensive purchasing processes described by Digilär. During the ‘open house’ demonstrations by Digilär at schools, teachers would briefly open the textbook merely to confirm some of the pedagogical qualities. However, when purchasing digital pedagogical materials, they typically need to spend half a year testing the product. Further, a strategy that was not pursued by Digilär, but by their competitors, was to try to ‘lock in’ schools and teachers by giving large discounts, sometimes almost for free, in the beginning in order to get contracts running for several years, after which they would increase prices. This further demonstrates the lock-in effects explained by the model. Once implemented, the switching costs of learning how to interact with a completely new system are high.

This too is explained by *Figure 8* — the value of edtech is not immediate, it requires learning. It shows the importance of *learning* for students and teachers, and of *teaching* for edtech firms. This model shows that, in this process of adopting technology, practitioners must all become students and teachers, regardless of their formal identity. Only when affordances are clear and well-adjusted, and the agencement built on distributed cognition is functioning, learning can be focused on pedagogical value.

6.2 What might be created

Thus far, the discussion has focused on the challenges that needs to be overcome in order to adopt edtech successfully. In this section, I wish to emphasize the emergent pedagogical value that was observed during the study and what practices might constitute its re-emergence.

6.2.1 Reterritorialization

As a result of the closing of physical schools, the component parts of the Swedish upper secondary schools were all completely deterritorialized from their usual physical immediacy. Given nothing else, in a world of process, such a complete deterritorialization would halt all generative processes of that particular agencement. No pedagogical value would be created. What has unfolded since, however, is a continuous process of reterritorialization. The outcome of the practices involved in this process was the digital class and the digital classroom.

The most basic step in this process was to enable communication between students and teacher without physical immediacy. This was facilitated by video calls that enabled the creation of digital environments. This reterritorialized students and teacher into a new agencement, out of which re-emerged the most basic pedagogical practices of presenting information, explaining concepts, asking questions, and providing explanations. The fundament of the digital classroom was established in a process seemingly shaped by historical influences, illustrated by the similarity of the digital and physical classroom elements (see *Figure 4*).

Further, the types of classes and forms of teaching re-emerged as reterritorializations of previous agencements as lectures and seminars were recreated in the digital environment. Even labs were conducted in a similar manner as in physical classrooms, although with minimal resources.

As the integrative practices of education was stripped of out of their physical sites, it became apparent how much of the education system was already digitally enabled. Much of the administrative tasks were already handled through technology platforms such as Teams. Likewise, homework and pedagogical materials (such as Digilär) was already being used before the closing of schools. Such practices created stability in the otherwise uncertain situation, as those practices had already been organized in a way that was compatible with the changing situation.

6.2.2 New value-creating practices

The previous section outlined the reterritorialization of practices into a new digital environment. Although many of the practices of physical classrooms re-emerged in a similar form when their component actants were reterritorialized to form the digital classroom, it was not without transformation. This study has shown examples of the creative implementation of edtech in such a way that the inscriptions of technology are pushed beyond their intentions. This has facilitated novel pedagogical practices and novel pedagogical value:

(1) *Observe student interaction* — The seminar form of teaching was the one constituting the most complex agencement. Several layers of platforms enabled the collection of data that enabled novel pedagogical practices. Influenced by traditional. The problems with traditional pairwise discussions in physical classrooms is that the teacher will have no insight into what is discussed and that it typically requires a discussion with the whole class summarize key takeaways. Breaking students into separate video calls enabled them to automatically record their discussion. The pedagogical value arises through a more focused discussion by the student's pairs, less time spent reiterating the same discussion to the whole class, and, most importantly, the teacher gets an improved understanding of both student performance and individual needs.

(2) *Tailor discussion to student need* — Once again, the seminar class enabled layers of platforms to facilitate an entirely new dynamic. While students answered the exercise questions during their pairwise discussion, the teacher receives statistics on the performance of students along with their specific answers. It enables an entirely new pedagogical practice of analyzing student performance in real time. The teacher will know how many of the exercises the students have managed to work their way through, what specific questions are considered tougher, as well as qualitatively reading the answers of students. Based on these insights, the teacher may subsequently tailor the remainder of the group discussion to these identified areas that needs support.

(3) *Teach by showing* — The screen-sharing functionality has been important throughout the empirical observations. It is the most common functionality to manually integrate digital platforms into each other. This was used for presenting slideshows during lectures, illustrating the typing of input into spreadsheet formulas, facilitating quizzes, and demonstrating how to search information on specific websites. This pedagogical practice creates to two types of learning. It not only facilitates pedagogical value by teaching, but also demonstrates the usage of other computer systems, facilitating learning so as to improve the distributed cognition of the classroom itself.

(4) *Active participation* — The assignment of designated students to ask questions during lectures can facilitate increased interaction in any classroom. The novel aspect was the separate (textual) chatgroup in which students could ask questions to each other, to the teacher, and to the designated students. Further, although I had no oversight of this during the participant observation, students could potentially even ask questions directly to the teacher. This created

pedagogical value in the form of increased interaction between student and teacher as well as students to students.

(5) *Automated roll call* — Once again, the functionality in Digilär was used in a novel way. Some of the exercise questions were used as an initial attendance check. This created added value in terms of time saved and the integration of a pedagogical activity in the otherwise mundane task of calling out student names.

(6) *Gamification* — The application of quizzes was already a tradition in the class I participated in. However, already in the physical classroom, the interactions were facilitated through an edtech platform via students' own devices. The element of competition, but without formal examination, was described by the students as the main reason for the increased excitement.

(8) *Qualitative examination* — One of the most challenging aspects of the digital environment is the examinations. Some edtech firms have developed software with the capacity for locking computers from all other functionality aside from the exam platform itself. However, the students worried, the risk of some students cheating is still high if no one is watching. The solution applied in this case was a reframing. Instead of insisting on traditional modes of examination, the teacher changed the form of teaching and redirected it to more seminar and less lectures. This enabled more discussions and, hence, more teacher-student interaction in which the teacher could grasp students' abilities in a different way. This was partly facilitated by list items (1) and (2) above.

These practices, along with the more detailed accounts outlined in *5 Empirical observations*, are solutions to a particular problematic field. However, as no problematic field ever recurs in the same exact form, the implementation of these solutions, as with any solution, involves uncertainty. This is particularly true in the context of edtech, which is undergoing much change. It is this experimentation that I know finally turn to.

6.2.3 Affirmation and experimentation

I have shown that the implementation of edtech is neither straightforward nor easy. It requires a certain effort from the participants, both students, teachers, edtech firms, as well as the wider ecosystem. I have also shown that by focusing on learning, these challenges can be overcome. However, perhaps the most interesting and remarkable aspects of the digital classroom has been realized by the creative actions of the participants (*6.2.2 New value creating practices*). The most interesting aspects are not inscribed directly in the technology itself but is constituted by novel emergent properties.

In this section I wish to highlight the importance of experimentation and affirmation in edtech adoption. One clear example of this is the creation of the lab class. The teacher and students pushed the limits of the intended use of what became component parts. They pulled together kitchens, webcams, a video conferencing platform, foods such as red cabbage, and various household utilities. None of these component parts were used in a way that their producer could have foreseen and in this newly forged agencement emergent pedagogical practices arose. These practices enabled certain pedagogical value: understanding the spread of infectious disease (knowledge) and acting out the basic notion of the scientific method (skills). This enabled pedagogical practices inspired by progressive pedagogical thought (performative *pedagogy-in-practice*), that is, *learning-by-doing*.

Without the affirmation and experimentation of the teacher and students, this organizing would never have been engaged in. A teacher might just as well have reasoned that without the access to a proper lab classroom, labs are impossible. In fact, this was heard in the interviews with students

talking about other classes with other teachers, in which teachers had essentially given up on teaching completely.

The same is true for the example with Daniel Barker, who created his own video lectures. He used equipment from the lab classroom to mount his mobile phone in an angle that enabled him to record himself writing on a paper while narrating the class. This pedagogical practice created so much pedagogical value that students across the country would recognize him. It is this experimentation and affirmation of new technology that I wish to emphasize as the key to success in innovation. The most interesting aspects are not inscribed but enabled through experimentation with combining component parts into novel agencements.

In order to explain this, I tie together the pedagogical literature, HCI, and organization studies, by a common denominator found in Deleuze. From an HCI perspective, the unexpected arises when our interaction model does not align with the system model. John Dewey, perhaps the most influential pedagogical thinker to the Swedish education system, forwards a model of *reflective thinking* that starts with this same unexpected event, a *problem-situation* (Stensmo, 2007; referring to Dewey, 1933). What follows is an experimental logic that drives the production of knowledge (cf. *learning-by-doing*). For organization researchers not familiar with any of these previous fields, a similar notion can be found in leveraging uncertainty by means of *effectuation* (Sarasvathy, 2005). Deleuze forwards a similar view, his transcendental empiricism starts from precisely this fundamental encounter with the unexpected – the birthplace of creative action.

Thus, it is in affirming the unexpected that both learning (6.1.2 *Learning to navigate education technology*) and novel creative solutions (6.2.2 *New value-creating practices*) emerge. It is by facing those challenges that we become *worthy of the event*. In this study, this is perhaps best illustrated by a brief outtake from the teacher interview: “things are still changing, and we are still learning”.

7 Conclusion

The pedagogical practices of physical classroom teaching have been continuously organized into direct person-to-person agencements for four thousand years since the emergence of written language. However, as a consequence of sars-cov-2, pedagogical practices have now been deterritorialized from its physical sites. Only half a century ago, such a deterritorialization would have rendered the education system unable to perform most pedagogical practices.

Equipped with education technology, we are now able to create digital environments to organize pedagogical practices. However, the process of reterritorializing is hardly frictionless. I have therefore asked *how might edtech practices create value in the digital classroom?*

By tracing practices through the education system and the edtech market, I have observed several challenges in implementing education technology. First, the uneasy relation between intent and use. Second, the high effort required to learn how to navigate such systems. However, the praxiography of the digital classroom provides an example of an implementation that not only recreates the physical classroom in a digital form but also creates novel pedagogical value in its own right. This highlights the importance of the agencements between teacher, students, and digital platforms — rather than any particular component part.

Finally, in order to create circumstances for pedagogical value in the digital classroom, successful implementation is tied to learning, affirmation, and experimentation. The most important insight is that none of these practices create such pedagogical value in isolation. Rather, it is the combination, the agencement, that generates emergent pedagogical value in the digital classroom. This is how edtech practices can create value in the digital classroom.

8 Contribution and future research

Managerial implications have been of great focus in the previous section. In this following section I focus on theoretical contributions, limitations, and future research.

8.1 Theoretical contributions

The theoretical contribution of this thesis is fourfold. First, I connect the concepts of agencement and territorialization to the market (re)formation literature, in particular with regards to the internet. Traditionally, the internet has been seen as an exclusively deterritorializing force. However, in showing that even greater complexity can emerge from an agencement that has been deterritorialized of its physical site, internet is shown to have the capacity to reterritorialize.

Second, to be able to see the internet as this potential force of reterritorializing, the digital environment must be taken seriously. Although the re-inclusion of materiality into social theory¹⁹ is foundational to this study, it is that very word which implicitly excludes the digital (the *virtual* defined as ‘not physically existing’). By integrating the concepts of affordance and distributed cognition into practice theory, collective action is tied to the digital environment. This study demonstrates the importance of the ‘IT artefact’ finally dissolving.

Thirdly, three literatures related to the edtech market are tied together by their common denominator in Deleuze’s transcendental empiricism, thereby connecting learning-by-doing from pedagogy, mental models from HCI, and effectuation from organizational research.

Finally, I emphasize the importance of an affirmative stance to the complexity of reality, which in management and organization research has too often deteriorated into either reductionism or deconstructionism. Instead, I ask the question “how might we organize?” in the hope that it can transcend the discord between relevance and legitimacy²⁰.

8.2 Limitations

The purpose of this research was to create solutions that might be used in practice. Limitations to the research should be seen in this light. My way of disseminating these insights is through Digilär, the firm that I have been working with. However, much of the insights require experimentation, in particular by teachers, students, and edtech firms. Hence, a central limitation is my limited reach and access to practitioners.

A further limitation in applying the insight of this research is that I investigated a very high performing school. Hence, some of mechanisms outlined here might be less applicable to other schools.

Further, I was only able to observe an early formation of market, which starts at the level of the digital classroom. The future is still uncertain with regards to reopening schools. So far, there is nothing close to a stabilized market. The study has not been longitudinal enough to describe how this transformation in the classroom will translate across the edtech market.

¹⁹ Under various labels: *new materialism* (DeLanda, 2011), *material turn* (Clever & Rudberg, 2014) *neo-materialism* (Talaga, 2018) *relational materialism* (Bruni, 2005).

²⁰ The similar discord between pragmatism and purism in CMS (Fournier & Grey, 2000) has recently been met by a similar call for an affirmative stance by Spicer, Alvesson & Kärreman (2009, 2016).

8.3 Future research

One opportunity for future research relates to the public procurement processes in the digital transformation processes of public education. Specifically, the training and further education of teachers was identified as one area with potential for improved adoption of edtech. This would require an in-depth understanding of the interaction between municipalities, local education authorities, and teachers.

Already in 2014, Svensson argued, that in the refusal to take a stand on what moral development is desirable, the education system is negating the socialization aspect of *uppfostran*. In light of this empirical study, the role of *uppfostran* in education risks decaying in a system built without physical person-to-person interaction. In this study, the commercial edtech market did not seem to have the issue of *uppfostran* at its core, nor were these forms of pedagogical value addressed.

First, *democracy* and *equivalency* in education seem to be severely limited by the highly differing ability to implement education technology, that largely depends on the teacher. Second, during the sars-cov-2 pandemic, the interviewed students described a restricted social life after physical schools closed. As Sweden has imposed lower levels of social distancing measures, this might have contributed to a lower prevalence of this during the study. However, students did report having less energy to do homework after classes ended, because of a lacking change in environment. In an international study by *Save the Children* (2020), 27 % of children living under both social distancing and closed school reported being anxious. These effects must be further investigated before a balanced stance can be taken with regards to digital classrooms.

9 References

Printed

- Akaka, M. A. and Vargo, S. L. (2014) *Technology as an operant resource in service (eco)systems*. Information Systems and e-Business Management.
- Akemu, O. and Abdelnour, S. (2020) *Confronting the Digital: Doing Ethnography in Modern Organizational Settings*. Organizational Research Methods.
- Akhlaghpour, S., Wu J. and Lapointe, L. (2013) *The ongoing quest for the IT artifact: Looking back, moving forward*. Journal of Information Technology.
- Akrich, M., Callon, M. and Latour, B. (2002) *The Key to Success in Innovation* Part I: The Art of Interestement*. International Journal of Innovation Management.
- Akrich, M. (1992). *The De-Description of Technical Objects*. In: Bijker, W. E. & Law, J. *Shaping technology/ building society: studies in sociotechnical change*. MIT Press.
- Aldrich, H. E. and Fiol, C. M. (1994) *Fools rush in? The institutional context of industry creation*. Academy of Management Review.
- Alvesson, M. and Willmott, H. (1992) *On the Idea of Emancipation in Management and Organization Studies*. Academy of Management Review.
- Atkinson, P. (2006) *Rescuing autoethnography*. Journal of Contemporary Ethnography.
- Badhani, S. and Mut, J. (2017) *Business Model Innovation in Edtech: an exploratory study of business model innovation in a complex market environment*. MSc thesis, Stockholm School of Economics.
- Baker, J. J., Storbacka, K. and Brodie, R. J. (2018) *Markets changing, changing markets: Institutional work as market shaping*. Marketing Theory.
- Barker, D. (2013) *Input Flipped Classroom*. Natur Kultur Läromedel.
- Bodily, R., Leary, H. and West, R. E. (2019) *Research trends in instructional design and technology journals*. British Journal of Educational Technology.
- Bond, M., Zawacki-Richter, O. and Nichols, M. (2019) *Revisiting five decades of educational technology research: A content and authorship analysis of the British Journal of Educational Technology*. British Journal of Educational Technology.
- Brey, P. (2005) *The Epistemology and Ontology of Human-Computer Interaction*. Minds and Machines.
- Bruni, A. (2005) *Shadowing Software and Clinical Records: On the Ethnography of Non-Humans and Heterogeneous Contexts*. Organization.
- Bueger, C. (2014) *Pathways to practice: praxiography and international politics*. European Political Science Review.
- Burrell, G. and Morgan, G. (1979) *Sociological paradigms and organisational analysis: Elements of the sociology of corporate life*. Ashgate Publishing.
- Callon, M. (1986) *Some elements of a sociology of translation: domestication of the scallops and the fishermen of St Brieuc Bay*. In: Law, J. *Power, Action, and Belief*. London Routledge.
- Callon, M. (1998) *An essay on framing and overflowing: economic externalities revisited by sociology*. The Sociological Review.

- Clever, I. and Rudberg, W. (2014) *Beyond Cultural History? The Material Turn, Praxiography, and Body History*. Humanities.
- Czarniawska, B. (2017a). *Organization studies as symmetrical ethnology*. Journal of Organizational Ethnography.
- Czarniawska, B. (2017b). *Bruno Latour and Niklas Luhmann as organizational theorists*. European Management Journal.
- DeLanda, M. (2006) *A New Philosophy of Society: Assemblage Theory and Social Complexity*. Continuum International Publishing Group.
- Deleuze, G. (1968) *Difference and Repetition*. [1994 edition] Columbia University Press.
- Deleuze, G. and Guattari, F. (1972) *Anti-Oedipus: Capitalism and Schizophrenia*. [1983 edition] University of Minnesota Press.
- Deleuze, G. and Guattari, F. (1980) *A Thousand Plateaus: Capitalism and Schizophrenia*. [1987 edition] University of Minnesota Press.
- Deleuze, G. and Guattari, F. (1991) *What is Philosophy?* [1994 edition] Columbia University Press.
- Dewey, J. (1933) *How we think*. In: Boydston, J. A. (1986) *The later works volume 8*. Carbondale and Edwardsville: Southern Illinois University Press.
- Dubois, A. and Gadde, L. E. (2002) *Systematic combining: an abductive approach to case research*. Journal of Business Research.
- Ekbja, H. R. (2009) *Digital Artifacts as Quasi-Objects: Qualification, Mediation, and Materiality*. Journal of the American Society for Information Science and Technology.
- Faraj, S. and Azad, B. (2012) *The Materiality of Technology: An Affordance Perspective*. In: *Materiality and Organizing: Social Interaction in a Technological World*. Oxford University Press.
- Fligstein, N. (1996) *Markets as Politics: A Political-Cultural Approach to Market Institutions*. American Sociological Review.
- Fournier, V. and Grey, C. (2000) *At the critical moment: Conditions and prospects for critical management studies*. Human Relations.
- Gibson, J. J. (1979) *The Ecological Approach to Visual Perception*. [2015 edition] Psychology Press Ltd.
- Granovetter, M. (1985) *Economic Action and Social Structure: The Problem of Embeddedness*. American Journal of Sociology.
- Hartman, S. (2005) *Det pedagogiska kulturarvet [The cultural heritage of pedagogy]*. Natur & Kultur.
- Helgesson, C.-F., Kjellberg, H. and Liljenberg, A. (2004) *Den där marknaden: om utbyten, normer, och bilder [That market: on exchanges, norms and re-presentations]*. Studentlitteratur.
- Hill, J. R., Bichelmeyer, B. A., Boling, E., Gibbons, A. S., Grabowski, B. L., Osguthorpe, R. T., & Wager, W. (2004). *Perspectives on significant issues facing instructional design and technology*. In M. Orey, M. A. Fitzgerald & R. M. Branch. *Educational media and technology yearbook*. Libraries Unlimited.
- Holloway, S. S. and Sebastiao, H. J. (2010) *The Role of Business Model Innovation in the Emergence of Markets: A Missing Dimension of Entrepreneurial Strategy?* Journal of Strategic Innovation and Sustainability.
- Hsieh, Y. and Huang, S. (2019) *Using an E-book in the secondary English classroom: Effects on EFL reading and listening*. Education and Information Technologies.

- Hsu, Y. C., Hung, J. L. and Ching, Y. H. (2013) *Trends of educational technology research: more than a decade of international research in six SSCI-indexed refereed journals*. Educational Technology Research and Development.
- Hutchins, E. (1995) *Cognition in the wild*. MIT Press.
- Khan, S. (2012) *The One World Schoolhouse: Education Reimagined*. Hodder Stoughton.
- King, A. (1993) *From Sage on the Stage to Guide on the Side*. College teaching.
- Kjellberg, H. and Helgesson, C.-F. (2006) *Multiple Versions of Markets: Multiplicity and Performativity in Market Practice*. Industrial Marketing Management.
- Kjellberg, H. and Helgesson, C.-F. (2007) *On the Nature of Markets and Their Practices*. Marketing Theory.
- Kjellberg, H. and Olson, D. (2017) *Joint markets: How adjacent markets influence the formation of regulated markets*. Marketing Theory.
- Kullberg, B. (2014) *Ethnography in the classroom [Etnografi i klassrummet]*. Studentlitteratur.
- Knorr Cetina, K. (2001) *Objectual knowledge*. In: *The Practice Turn in Contemporary Theory*. Routledge.
- Law, J. (1986) *Power, Action, and Belief: A New Sociology of Knowledge?* Routledge & Kegan Paul.
- Latour, B. (1986) *The Pasteurization of France*. Harvard University Press.
- Latour, B. (1993) *We Have Never Been Modern*. Harvard University Press.
- Latour, B. (1996) *Review: Cognition in the wild. Mind, Culture, and Activity*.
- Latour, B. (1999) *On Recalling ANT*. The Sociological Review.
- Latour, B. (2005) *Reassembling the Social: An Introduction to Actor-Network-Theory*. Oxford University Press.
- Mattsson, L. G. and Andersson, P. (2019) *Private-public interaction in public service innovation processes – business model challenges for a start-up EdTech firm*. Journal of Business & Industrial Marketing.
- May, T. (2005) *Gilles Deleuze: An Introduction*. Cambridge University Press.
- Meshchaninov, J. (2012) *The Prussian-Industrial History of Public Schooling*. The New American Academy.
- Mol, A. (2002) *The body multiple: Ontology in medical practice*. Duke University Press.
- Nambisan, S., Lyytinen, K., Majchrzak, A. and Song, M. (2017) *Digital innovation management: reinventing innovation management research in a digital world*. MIS Quarterly.
- Nielsen, J. (1990) *Heuristic Evaluation of Interfaces*. CHI '90: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems.
- Orlikowski, W. J. and Iacono, C. S. (2001) *Desperately seeking the "IT" in IT research—a call to theorizing the IT artifact*. Information Systems Research.
- Orlikowski, W. J. and Scott, S. V. (2008) *Sociomateriality: Challenging the Separation of Technology, Work and Organization*. The Academy of Management Annals.
- Price-Robertson, R. and Duff, C. (2015) *Realism, materialism, and the assemblage: Thinking psychologically with Manuel DeLanda*. Theory & Psychology.

- Rosa, J. A. and Porac, J. F. (1999) *Sociocognitive Dynamics in a Product Market*. Journal of Marketing.
- Roth, A. E. (2017) *The Art of Designing Markets*. Harvard Business Review.
- Reckwitz, A. (2002) *The Status of the "Material" in Theories of Culture: From "Social Structure" to "Artefacts"*. Journal for the Theory of Social Behaviour.
- Sarasvathy, S. (2005) *New market creation through transformation*. Journal of Evolutionary Economics.
- Spicer, A., Alvesson M., and Kärreman, D. (2009) *Critical Performativity: The unfinished business of critical management studies*. Human Relations.
- Spicer, A., Alvesson M., and Kärreman, D. (2016) *Extending critical performativity*. Human Relations.
- Stensmo, C. (2007) *Pedagogisk filosofi [Philosophy of pedagogy]*. Studentlitteratur.
- Stinchcombe, A. L. (1965) *Social structure and organizations*. Handbook of organizations.
- Strand, D. L. (2010) *Principles for IT Praxiography*. Paper presented at The 6th International Conference on Social and Organizational Informatics and Cybernetics.
- Strannegård, L. and Friberg, M. (2001) *Already elsewhere: Play, identity and speed in the business world*. Raster.
- Suchman, M. C. (1995) *Managing Legitimacy: Strategic and Institutional Approaches*. Academy of Management Review.
- Svensson, L. (2014) *Introduktion till pedagogik [Introduction to pedagogy]*. Studentlitteratur.
- Talaga, M. (2018) *Affordances theory as an operational framework for interpretation of past material culture and practices*. Praxiography of things, bodies, and motions. Avant.
- Vargo, S. L., Maglio, P. P. and Akaka, M. A. (2008) *On value and value co-creation: A service systems and service logic perspective*. European Management Journal.
- Wieland, H., Koskela-Huotari, K. and Vargo, S. L. (2016) *Extending actor participation in value creation: an institutional view*. Journal of Strategic Marketing.
- Wright, P. C., Fields, R. E. and Harrison, M. D. (2000) *Analysing Human-Computer Interaction as Distributed Cognition: The Resources Model*. Human-Computer Interaction.
- Zhang, J. and Patel, V. L. (2006) *Distributed cognition, representation, and affordance*. Pragmatics & Cognition.
- Zott, C. and Hui, Q. N. (2007) *How Entrepreneurs Use Symbolic Management to Acquire Resources*. Administrative Science Quarterly.

Digital

Dagens Nyheter (2020)

Skolverket vill ha nya regler för gymnasieexamen
<https://www.dn.se/nyheter/sverige/skolverket-vill-ha-nya-regler-for-gymnasieexamen/>

McKinsey Global Institute (2016) by James Manyika, Susan Lund, Jacques Bughin, Jonathan Woetzel, Kalin Stamenov, and Dhruv Dhingra.

Digital globalization: The new era of global flows
<https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/digital-globalization-the-new-era-of-global-flows>

NIX (2019)

2019 EdTech Funding Breakthrough – Great Investment or Not?
<https://nix-united.com/blog/2019-edtech-funding-breakthrough-great-investment-or-not/>

Save the Children (2020)

Children at Risk of Lasting Psychological Distress from Coronavirus Lockdown
<https://www.savethechildren.org/us/about-us/media-and-news/2020-press-releases/children-at-risk-of-psychological-distress-from-coronavirus-lockdown>

Statista (2020) by Niall McCarthy

COVID-19's Staggering Impact On Global Education
<https://www.statista.com/chart/21224/learners-impacted-by-national-school-closures/>

World Economic Forum (2016)

New Vision For Education: Fostering Social and Emotional Learning Through Technology
http://www3.weforum.org/docs/WEF_New_Vision_for_Education.pdf

Video lectures

DeLanda, M. (2011) *Assemblage Theory, Society, and Deleuze*. European Graduate School Video Lectures. [Accessed via Youtube].
<https://www.youtube.com/watch?v=J-I5e7ixw78&t=4535s>

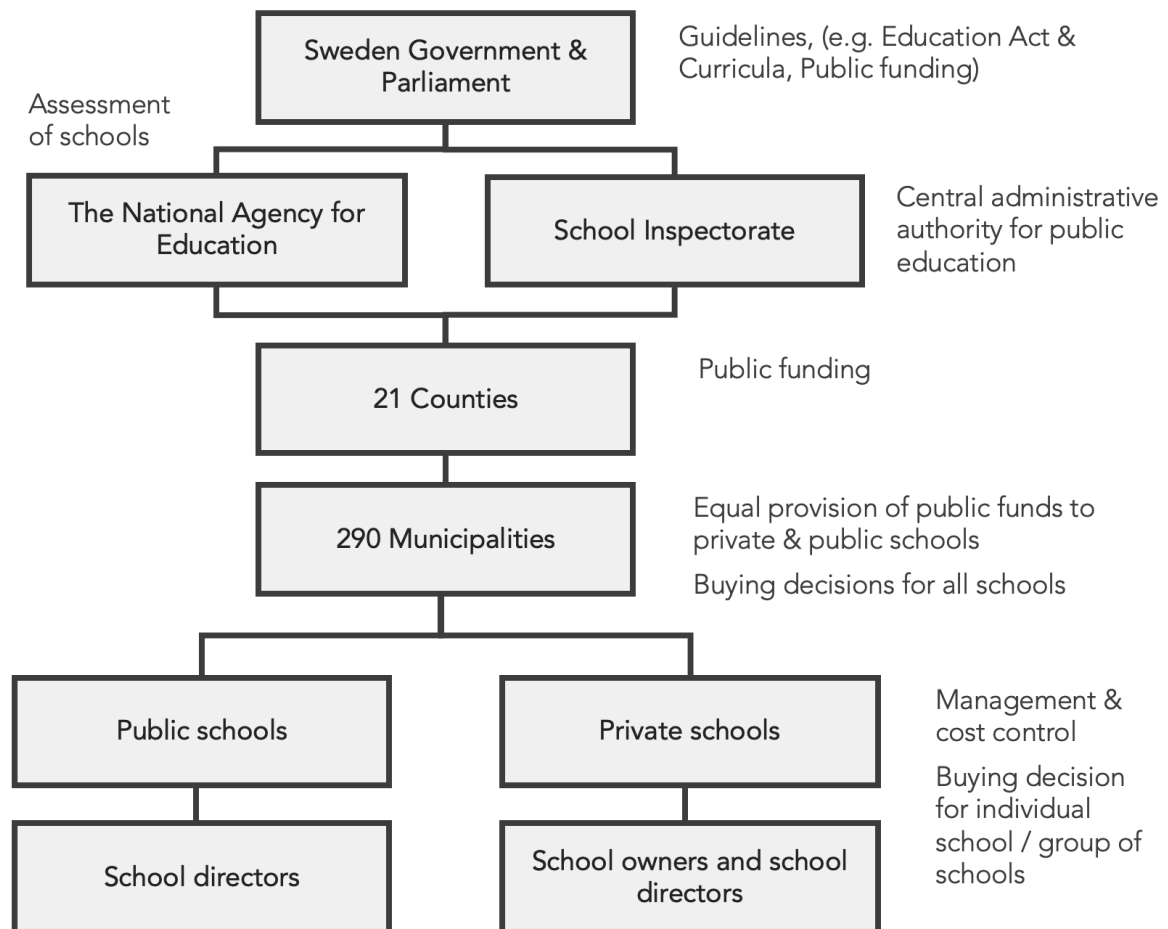
Klemmer, S. (2012) *Human Computer Interaction*. Stanford University. [32 Lectures posted on Youtube].
https://www.youtube.com/playlist?list=PL_LssT5z_DsK_nusHL_Mjt87THSTlgrsyJ

May, T. (2017) *About Deleuze*. 2017. DISPUK Uddannelsescenter. [7 lectures posted on Youtube]
<https://www.youtube.com/playlist?list=PLh3zlKNSZLuHx39s-pfuAQ7ZId-aLk-fd>

Vervaeke, J. (2019) *Awakening from the Meaning Crisis*. [Lecture 9, *Insight*; Lecture 10, *Consciousness*]
<https://www.youtube.com/playlist?list=PLND1JCRq8Vuh3f0P5qjrSdb5eC1ZfZwWJ>

Appendix 1: The Swedish Education System

Formal overview of the Swedish Education System. Adapted from Badhani & Mut (2017).



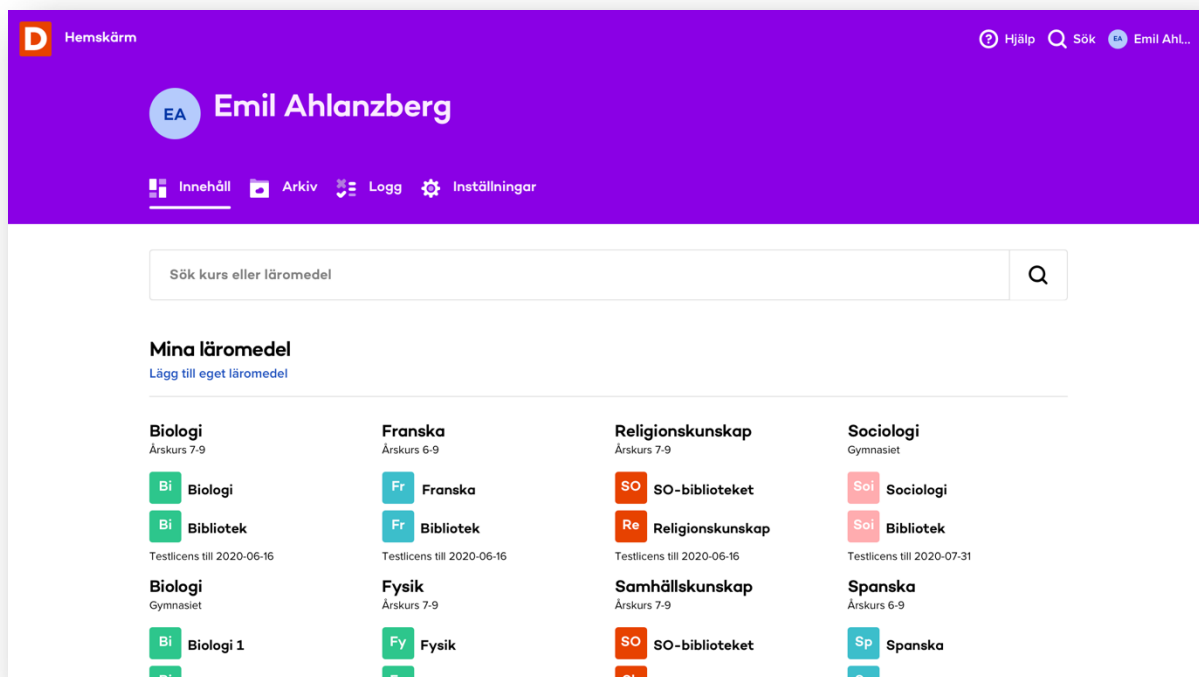
Appendix 2: Data collection

The following table outlines the type of data collected and the extent to which it was collected (*n* = number of, for instance, interviews; and time spent).

Type	(n)		Duration
Digilär interviews	4	à	40-80 min
Senior manager			
Publishing manager			
Project leader (platform content)			
Customer manager			
Autopraxiography study	1	à	20 hours*
Participant observation	3	à	75-95 min
Lecture			
Seminar			
Lab			
Lecture preparation ('homework')	3	à	60 min
Teacher interviews**	2	à	30 min
Post-class student interviews	3	à	30-35 min
*actively engaged in learning			
**excluding continuous discussion before, during, and after lectures			

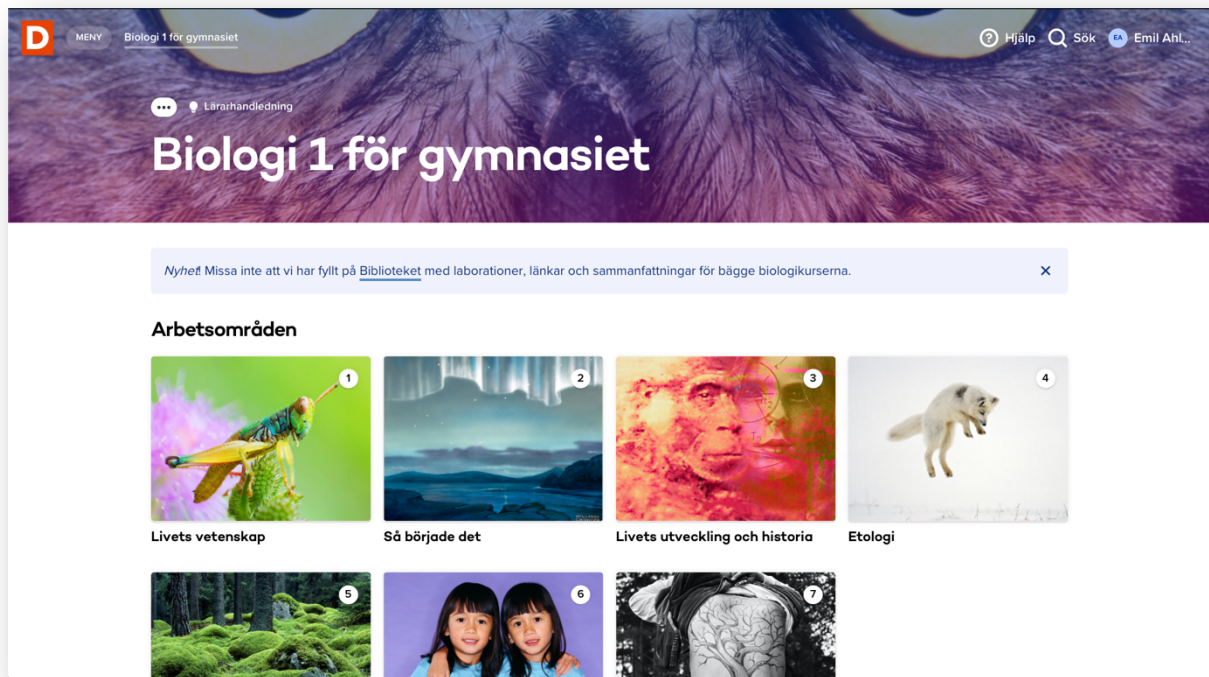
Appendix 3: Digilär home screen

Screen view related to 5.2 Digilär as standalone platform – II.



Appendix 4: Digilär course overview

Screen view to 5.2 Digilär as standalone platform – II.



Appendix 5: Sample of preparatory information (seminar)

Sample of lecture preparatory information posted on the Microsoft Teams internal student platform, forward via email. Names and links are removed. Kept in original language for nuance.

Hej,

Så här ser lektionsplaneringen ut för idag. Det är första gången jag testat zoom med klassen, så jag ber en bön till teknik-guden att det ska fungera. Annars blir det som det blir. Välkommen att delta i vår lite annorlunda vardag 😊

//

Lektionsplanering 1 april

11:15 Gemensam samling i Zoom. Klistra in följande [redacted] i en webbläsare eller klicka på länken nedan.

Som incheckning (för närvaro) gör ni frågor i Digilär: Ekologi > Grundförutsättningar för liv > Uppgifter > Arbeta på egen hand > Fråga 1 + 2.

När ni är klara med de två uppgifterna ska ni i par arbeta med en fördjupningsfråga i samma kapitel. Digilär: Ekologi > Grundförutsättningar för liv > Uppgifter > Fördjupning: Energiflöden i ett ekosystem.

Paren hör till samma Grupp här i Teams. Det gör att ni lätt kan starta ett möte i er grupp. Den som står först startar ett möte och bjuder in den andra i paret.

Ni lämnar in svaren i Digilär + spelar in ert möte.

Grupp 1	Grupp 2	Grupp 3	Grupp 4	Grupp 5	Grupp 6	Grupp 7	Grupp 8
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Jag finns tillgänglig i Zoom eller chatten i Teams.

12:00 Återsamling i Zoom (eventuellt en ny inbjudan) Diskussion kring energiflöden.

12:20 Onsdagstävling!!! En Kahoot förstås - koden kommer senare 😊

Appendix 6: Results from lab class

The results of the lab-like class performed via Zoom, teaching knowledge relating to the spread of infectious disease and introducing skills relating to the scientific method.

