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Published online: 19 Sep 2022.

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Learning analytics as modes of anticipation: enacting time in actor-networks

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ABSTRACT

Learning analytics platforms (LAPs) have become important modes of anticipatory governance in education. Educational futures are governed by utilizing various forms of learning analytics to track student data over time, suggesting that school leaders and teachers are expected to improve school quality by engaging with digital presentations of prediction, anticipation, and decision-making. This study investigates the LAPs Conexus Engage and Insight as they unfold in school leaders' practice by drawing from actor-network theory. School leaders' interaction with the tools are examined through audio and screen recorded interviews at three lower secondary schools in Norway. The findings show how anticipation emerged in actor-networks as both fluid and stable, encouraging the problematizations and priorities of school leaders. School leaders also adapted the LAPs to their own practice. The findings further suggested that time emerges on the premises of LAPs as entangled events rather than through chronological understandings of time.

Introduction

Learning analytics platforms (LAPs) have become important modes of anticipating education as they emphasize the prediction of educational futures by virtues of forethought and risk, impacting the course of action for the user interacting with the platform (Beer, 2018; Mackenzie, 2013; West et al., 2016). LAPs refer to forms of data mining that track students' development over time and can, in this sense, steer the present by referring to possible images of the future, while also drawing on lessons from the past (Gedrimiene et al., 2020; Thompson & Cook, 2017). Such emerging forms of data use enable schools to govern educational futures and have been described as forms of anticipation (Williamson, 2016). Anticipation is 'the palpable effect of the speculative future on the present' (Adams et al., 2009, p. 247). The strong connection to the future, in this understanding of anticipation, implies that time is an essential component; the way time emerges in educational life makes anticipation a speculative practice. Anticipation in education is thus about orienting learning in time, of creating connections with the past and the future, and of using prediction as a narrative mode to invoke actions in the present.

Anticipating the future in education has previously been studied by exploring how policy and curriculum construct images of the future on a national and international level (for instance Bansel, 2016; Voogt & Roblin, 2012). Some recent studies, however, show how education now produces new instruments of anticipation, such as LAPs. Connecting anticipation to digital technologies

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are in the early stages of development (Lingard, 2021), however, two main research strains can be presented: one that explicitly targets anticipation as embedded in LAPs (Webb et al., 2020; Williamson, 2016), and one that implicitly discusses anticipation in LAPs and similar digital technologies through conceptualizations of time (Decuypere & Simons, 2020; Hassan, 2017; Lingard & Thompson, 2017). These studies draw from different theoretical approaches, but what they have in common is that they critically address how anticipation and time gain new meanings in digital educational environments by interrogating issues of educational politics and practice. The majority of the studies thus far are theorizations, or studies of inherent properties of platforms, meaning few have investigated what happens in schools when the tools are employed (although see Alirezabeigi et al., 2022 for research on student level). Studies exploring how anticipation in LAPs encourage problematizations and decision-making in schools remain underdeveloped.

This article makes further contributions to this body of research by examining two LAPs in practice (Engage and Insight) as they unfold in school leaders' work-life. The platforms are developed by the company Conexus that work in cooperation with the Norwegian Directorate for Education and Training. They are designed to combine data from multiple sources, including the Directorate's yearly student survey ('elevundersøkelsen'), national tests, and mapping tests stemming from over 30 different learning modules (Conexus, 2021). Academic performance and well-being can be compared across the different data sources, and some utilize visualizations that resemble a traffic light system. The two LAPs are offered across the Scandinavian countries and are utilized by the majority of Norwegian municipalities (Conexus, 2021).

In Norway, the trend of anticipating education can be attributed to various governing initiatives over the last decade. Efforts include the introduction of the National Quality Assessment System (NQAS), where national tests were introduced, in addition to self-evaluations, student surveys, and publicly available statistics (Bergesen, 2006). These efforts are characterized by predictive forms of testing, usually in reference to national standards and benchmarks. In the aftermath of these new quality measures, several national webpages and platforms have been developed to provide schools with various datasets in one place, including Engage and Insight (Caspersen et al., 2017). Today, anticipating education is digitalized in the form of policy texts and curricula (imagining 'the future school'), the introduction of the value-added indicator (schools' contribution to student achievement), and an increased interest in learning analytics and adaptive tests through various digitalization strategies in basic education and training[1] (Directorate for Education and Training, 2020; Ministry of Education and Research, 2017). Within Norwegian schools, educational futures are governed through an increased concern with how new learning technology will develop educational practices considering unpredictable futures and societal risks (Hansen et al., 2021). School leaders are responsible for facilitating these processes and ensuring that their students have the necessary skills to learn and adapt to future uncertainties (Lunde & Gunnulfsen, 2021).

The main aim of this article is to unfold anticipation in Norwegian school leaders' interactions with two LAPs. I further aim to problematize the traditional understanding of time in educational research as chronological by drawing from actor-network theory (ANT) to conduct analyses on the interactions that produce and connect anticipation in practice. I analyzed data from three lower secondary schools in Norway, including interviews with screen recordings from the LAPs. I asked two main questions: (i) How do LAPs, in practice, enact[2] anticipation?, and (ii) How do school leaders act on these modes of anticipation?

The article proceeds in five sections. First, I begin by discussing how anticipation is intrinsic to LAPs. Secondly, I introduce how to think about time and anticipation through ANT. Third, I present the data, methods, and analytical steps of the study. Fourth, I unfold the LAPs by structuring the findings in three modes of anticipation. Finally, I discuss the multiple modes of anticipation that emerged in the examples drawn from school leaders' practice and what these may imply for the

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[1]Here, basic education and training refers to primary and lower secondary levels.
[2]I use 'enactment' as a word, and not a concept in this article.

understanding of time in education. In the conclusion, I discuss this article's contributions and suggest further routes of inquiry.

Anticipation in learning analytics platforms

Learning analytics platforms act as anticipatory devices that are embedded within the pedagogic routines of the classroom, and are based on technical developments in 'machine learning'. The importance of machine learning algorithms is that they exhibit some tendencies of emergence, adaptivity, anticipation, and prediction (Williamson, 2016, p. 136).

In the quotation above, Williamson (2016) describes the production of big data through learning analytics as a new form of anticipation that monitor, track, and audit students' development, optimizing teaching and learning over time. Typically, LAPs connect the past to the present and future by drawing upon data, things, people, subjectivities, and values to predict the future (Williamson, 2016). Consequently, to understand how LAPs enact particular modes of anticipation, it is important to understand the arrangements of time that may emerge in practice. Linear time was created in modern times as a way of structuring and administrating life as an "arrow of time" (Latour, 2005), a timeline oriented towards the future. This has been the dominant form of managing time in education and can also be found in LAPs as a broad form of 'computational policy' (Gulson & Webb, 2017). Other practices of chronological time in education include timetabling, performance goals, and end-of-year examinations. Although the present is the object of intervention, the past and the future become manageable and governable through interventions in the present.

After being prompted by *risk subjects* (e.g., a score below the national average), school leaders may engage in processes that consider *how* they can move forward (Adams et al., 2009), including accepting that both the past and future can be presented and acted upon in the present. Thus, the future and the past may encourage school leaders' habits, tasks, and concerns (Luckin et al., 2016). The focus on action as a way for anticipation to emerge conforms to science and technology studies (STS) and ANT literature, where scholars argue that "platforms are what platforms do" (Bratton, 2015, p. 41). Platforms prepare for action by modeling past, present, and future outcomes as numerical and visual data, textual recommendations, and support material (Kaliisa et al., 2021; Van Dijck, 2013). By organizing its internal elements, such as data and text, platforms represent an external environment in which the action takes place. School leaders, as the heads of schools and prime authorities to secure in-house quality, are one external reality that can be prompted by the plan of action inscribed to the platform (Bratton, 2015). In this sense, a LAP is a framing machine that has the ability to draw time together through interactions in practice. Thus, platforms should be analyzed by the performance they enable in practice, as they favor and blur some actions over others. In the next section, the analytical framework used in this study is presented to explore how LAPs may emerge as a form of anticipation in practice, as effects of time produced by actor-networks.

Actor-Network Theory (ANT) and time

ANT is an approach that has widely been used in the STS literature but also in fields such as anthropology, sociology, philosophy of social science, and education. In general, ANT seeks to treat human and non-human actors symmetrically (Law, 2004), which in this study implies that LAPs can become performative and obtain agential characteristics. In addition to directing attention to the anti-anthropocentric notion of agency, ANT is a relational approach concerned with how actors coalesce in networks of social practice (Latour, 2005; Law, 2004). This means that school leaders as individuals cannot be confined to their own intentions, perceptions, or actions in practice; they are shaped by whatever or whomever they interact with. ANT concepts are used as 'sensitivities', meaning, they are used as an analytical lenses to draw nearer to a phenomenon. Early ANT studies are characterized by the works of scholars like Bruno Latour and Michel Callon, and include

discussions of how actors come to be actors (both human and non-human) and how these are enrolled in networks. 'After-ANT' studies proliferated towards the end of the 1990s, aiming to further broaden the conceptual scope of ANT by exploring links within networks and showing multiple modes of reality (see for instance Law, 2004). I draw inspiration from the 'after-ANT' turn to construct the analytical lens in this study.

The previous section explaining anticipation suggested that to understand anticipation in education, there is also a need to understand time. Traditionally, ANT literature rarely discusses time. An exception is Latour's (1988) comment on time in modernity, where he urges scholars to focus on "the construction of time itself on the basis of the agents' own translations" (p. 51), suggesting that time is folded by relations. Despite ANT's limited attention devoted to time (explicitly), time is implicitly described as a possible effect of actor-networks (Fenwick & Edwards, 2012; Thompson & Cook, 2015). Actor-networks are fluid, meaning they exist in particular places of space and time (Decuypere, 2019). As actors form different or extending relations in practice, so does the network, indicating that actors may enact time through any connections with actors in the past, present, or future. In this sense, there are two concomitant points I use to consider time through ANT: (a) examining the fluidity of actor-networks, and (b) considering how time emerges in multiple ways through the fluid actor-networks. I draw from two ANT sensitivities to address these two points: fluidity and multiplicity.

A network in its accomplished state is a frozen mirror of an activity or practice. Simultaneously, networks are 'black-boxed' in that they conceal all the negotiations that have brought the network to life, making the network a fluid presentation of the social world (Latour, 1987). Connections between actors are negotiated by forces of persuasion, governance, resistance, and opposition (Fenwick & Edwards, 2012). The emphasis is less on the structure but rather on how actors move and change across time and space. This can be illustrated by an example from schools. A school improvement project on numeracy brings together school leaders, texts, guidelines, numbers, and schemes during the course of an introductory leadership meeting. This network can be stable by stretching during the course of the project and into the future, for instance, as the leadership team makes changes to the next semester's timetable to fit with new priorities. In this case, the network has extended in time. However, during a second meeting, there are contesting thoughts on the necessity of introducing a new school improvement project, as national test results from the year before show that there is no immediate risk concerning students' numeracy skills; this contention makes the network appear less static. The network established in the first leadership meeting is broken by a set of new relations (and a new actor), dating back to a year-old test. It may be that the new actor, last years' national test results, circulates towards future leadership meetings 'gathering allies, shaping thoughts and action and thus creating new networks' (Fenwick & Edwards, 2012, p. 14), as it shows that literacy as opposed to numeracy seems to be the *risk subject* at the school (Adams et al., 2009). In this sense, networks are fluid, as actors retain their agency and integrity by virtue of the relations that are formed (Law, 1999). 'Fluidity' therefore moves the analytical attention towards movement in relations and interactions (Fenwick & Edwards, 2012), and I have used this sensitivity to draw nearer to interactions between school leaders, the LAPs, and other actors that emerged in their direct sphere. LAPs' ability to anticipate, and possibly steer action, can in this sense be said to not center around a number of allies, but rather on keeping those interactions stable over time (Law, 1999).

As a network effect, time can be conceived as mechanics that emerge out of particular network compositions (Decuypere, 2019). The example above indicates that whenever actors connect with other actors at different points in time, they simultaneously perform time. The actors' ability to partake in multiple networks simultaneously and/or across time is therefore essential (Deleuze, 1988). From the specific example above, the national test results can connect and emerge with other networks at any given point in time or space. National test results may emerge as an actor in multiple schools, district offices, departments, and directorates and can come to present different things in different practices because the way the relations unfold is different (Law & Singleton, 2014). Mol (2002) utilized the ANT sensitivity of 'multiplicity' to describe how practices are enacted differently.

That study explored different enactments of atherosclerosis based on clinicians', pathologists', and radiographers' practice, among others. These enactments were emphasized because they illustrate multiple realities. Multiplicity suggests that when the world is made of relational compositions that can attach, detach, and re-attach (as was discussed above), many realities will exist over time and alongside each other (Law & Singleton, 2014; Mol, 2002). In this sense, time also becomes networked.

Networked time is different from that of linear clock time. Likewise, if the network represents a digital platform in practice, the network follows the logic of the digital as a "febrile and discontinuous" process (Hassan, 2017, p. 76). Therefore, time may emerge as limitless or bounded; it can span backwards for years or only reach the next few minutes—there are multiple ways for them to unfold. Moreover, just as an actor does not exist in isolation, time can also be thought of as interconnected (Sheail, 2017). This suggests that there is a relationship *between* times that connect with each other.

In this article, the fluidity and multiplicity of time coalesce to illustrate multiple webs of relations that enact anticipation and encourages school leaders to act accordingly. I chose to use these two sensitivities as the analytical lens in my analysis because they resonate strongly with the performative effects of LAPs. LAPs, being digital devices that can adapt to and adapt practice, are devices whose inherent characteristics can change and mean different things according to how their activities unfold in practice (Ruppert et al., 2013). This attunes to an understanding of practice as fluid, and as multiple, because the different relational compositions move and are enacted continuously through digital flows. In addition, the two sensitivities provide a novel understanding of time in digital education practices, which explores more closely how different times exist conjointly. While LAPs can be thought of as an activity and a place in which school leadership practice emerges, where space and time are closely linked (Decuypere & Simons, 2020; Lingard & Thompson, 2017), this article focuses on an area that has been somewhat neglected in educational research (Lingard, 2021); micro examples of how LAPs produce modes of anticipation in schools. In other words, anticipation is presented implicitly in the performance of time within the actor-networks of the LAPs. In the forthcoming section, the methodological steps taken to place the analysis at the level of enactment (rather than perception) are presented to explain how the data collection and analysis were designed to account for school leaders' interactions with the LAPs.

Data and methods

Research setting and design

Insight and Engage were both chosen as examples of LAPs in Norwegian school leaders' practice because the school leaders frequently interacted with data from both platforms when analyzing school results. This study aimed to 'follow' the actors through rich descriptions provided by school leaders at three lower secondary schools. Semi-structured interviews were conducted during the fall and winter of 2019/2020. Conexus platforms are utilized primarily in primary and lower secondary schools in Norway. Informants were interviewed in lower secondary schools for two reasons: assessment through numerical grading is introduced to Norwegian students as they enter lower secondary school; and a larger databank is available from lower secondary schools as it includes data registered throughout primary school, in addition to the data collected from 8th to 10th grade. These considerations suggest that data flow in the Conexus platforms is rich in the lower secondary schools and would provide further examples from practice. Thus, participating schools were selected based on grade level (lower secondary), that their municipality had purchased and mandated the use of Conexus platforms, and that the leadership teams used Insight and Engage as part of their leadership roles within the schools.

All three schools reside in Eastern Norway, but in three different municipalities. School A is a medium-large lower secondary school in a suburban area, whereas School B is a medium-sized lower secondary school in an urban area, and School C is a small lower secondary school in a rural area (Table 1). Please note that all names are pseudonyms that do not reflect the informants'

Table 1. Overview of participating schools and informants with pseudonyms.

School	Informants (pseudonyms)	Size and grade levels
School A (Sa)	Markus (principal) Petter (year head) Karina (year head) Lotte (year head)	450–500 students 8th–10th grade
School B (Sb)	Therese (principal) Marthe (year head) Randi (year head)	300–350 students 8th–10th grade
School C (Sc)	Anne (principal) Lars (deputy principal) Thomas (year head) Ingeborg (year head) Hedvig (year head)	200–250 students 8th–10th grade

gender. Three individual interviews with school principals and three group interviews with middle management (deputy principals and year heads/ department heads; Table 1) were conducted. The number of informants from the three schools varied according to the size of the leadership team, which is based on the number of enrolled students in some municipalities. Informants that formed middle management usually covered several roles outside of their leadership duties, such as teaching and special needs education responsibilities. However, during the interviews, they answered and participated based on their leadership positions.

Because some aspects of the Conexus platforms relate to steering mechanisms, practices in which principals usually have a different role as opposed to middle management, each principal was interviewed individually to prevent them from silencing the other participants (Smithson, 2000). The principals were asked to describe their personal use of the LAPs, and audio of all interviews was recorded. As a way of being sensible to ANT's agential side, where LAPs are thought of as what they *do* (Bratton, 2015), the LAPs were utilized during the group interviews. A demo-user based on a fictional school with fictional data was used for both Insight and Engage. The informants interacted with the software throughout the interviews. Rather than 'staging' the group interviews by giving the informants specific tasks on the platforms, open-ended questions were asked. Examples of when the informants used the software, in what situations, how, and with whom, were explored. The informants themselves chose how and when to interact with the LAPs during the interviews; thus, anticipation in familiar events and activities of the informants was examined. The intention was to use LAPs in the individual interviews as well; however, it became evident that the principals did not voluntarily engage with the platforms during the interviews.

The group interviews were recorded through the Captura software, which simultaneously recorded on-screen activity and audio. A backup recording was made that only recorded audio. The main aim of the interview design was two-fold: (i) LAPs were used to invoke familiar situations to help the participants elaborate on examples from practice (Greenbaum, 2000); and (ii) having LAPs 'present' during the interviews helped me follow both actors: the school leaders and the platforms. This captured a more symmetrical approach to following actors, as they were analyzed simultaneously based on what they performed in practice (Latour, 2005). The interviews were transcribed in two columns: one with text and one with screen prints of the platform features that were interacted with during the interviews. Based on these transcriptions, 16 screen prints were added to the analysis, including the front pages of Engage and Insight, results from national tests and the student survey, as well as individual student reports.

Data analyses

The interviews were analyzed in three steps. First, the interviews were analyzed to outline large trends in the data (Hsieh & Shannon, 2005) and to show the various actor-networks of LAP enactments in school leaders' practice. From this analysis, three main points were stressed:

1) There were several references to actors that belonged to past and future practices
2) The platforms emerged as relatively closed, in which the school leaders had little or no chance to make changes to it digitally

Table 2. Excerpts from the coding scheme.

Segments from transcriptions Contextual information	Activity	Relations/interactions	Time Past/present/future
"We use it to map new 8th graders who come to us. And in a way, that's work that has been done in primary, right" "And then, we look at what has happened between 8th and 9th grade (…) sometimes it has not gone too well, and that's not good for anyone, right. So first, as a leadership team, we sit and look at that [results from national tests on Conexus]. We try to analyze by looking backwards, and I would say we do that with all these datasets, we look backwards to see whether there is a consistent trend."	Analyzing trends of upcoming/future students Analyzing trends of present students	Principal – results from primary on Conexus Engage (past results) Leadership team – national test results on Conexus Insight (present results)	Results from the past (primary) are presented to map future students Past (results) and present (results) Chronological

3) The school leaders were prompted to design a set of future actions. In this sense, the school leaders acted upon the modes of anticipation to optimize the present and the future, and some autonomy emerged in practice

In the second step, the interviews were coded relationally. Four columns were added, one for contextual information that included quotes from the interviews, one that included a short description of the activity, one for interactions and relations (including the period for these interactions where deemed necessary), and one that commented on the types of time that grew out of the actions (see Table 2). This part of the analysis disclosed the various networks that emerged in the informants' interactions with the LAPs, while simultaneously placing the networks in multiple enactments of time.

The three schools proved to have similar enactments; thus, the coding scheme (interviews from each school were coded individually) was further developed. Rather than framing the analysis as three different enactments at three different schools, the first coding scheme was categorized into three main modes of anticipation in Nvivo. These present an overarching categorization of interactions between school leaders and the LAPs that produced time and anticipation. The screen prints, subtracted from the screen recordings, were included and analyzed at the level of action. The analysis displayed which elements from the LAPs that the school leaders connected with, and these were compared to the transcription data to illustrate how digital elements and school leaders emerged collectively in practice. Moreover, the design and analysis of the interviews (audio and screen recordings) focused on actual interactions between the LAPs and school leaders, rather than through the informants' perceptions of interactions.

The main limitation of this study concerns the sample size. This study presents data from three schools in one country (although, in three different municipalities), and its findings should therefore not be treated as generalizable, but as suggestive (Maxwell, 2012). Digital platforms, and their practices, are characterized by their particularities. This means that generalizations extending to other LAPs should also be treated as suggestive. However, the consistency in examples from practice across the three schools may strengthen the validity of the findings by implying analytical generalizations in that the findings can be used to invoke questions of what might unfold in other schools (Kvale & Brinkmann, 2009). In light of the analytical framework used in this study, I have therefore not attempted to quantify connections/interactions or generalize across contexts. Rather, I zoom in on a small number of practices.

Unfolding modes of anticipation

Three modes of anticipation emerged from the analysis: (a) analyzing trends, (b) calculating risk subjects, and (c) possibilities for action. These present several disparate but connected enactments

of time as an implicit presentation of anticipation. This section shows how actor-networks move in time as anticipation emerges with different characteristics in the various enactments. Quotations from the interviews and screen prints are presented in the analysis to provide the readers with contextual information.

Analyzing trends: from near past to present future

From the interviews, a dominant example from practice that emerged was the school leaders' frequent use of data to analyze trends within student groups. The level of data analysis at this stage focused on a group level, referring either to classes or to whole-grade groups. Inherent to these enactments were historical data and the stretches of time in which student data was gathered and made available to the school leaders. To engage with the data, school leaders interacted with data from Insight belonging to graduated, current, and incoming students. In the following quotes, the leadership team and the results from student surveys, exams, and end-of-year grades from various points in time materialize as actors by contributing to the action of analyzing school trends:

> We just got in the results from the student survey in 10th grade. Before the leadership meeting, I looked into the numbers on Insight. I made a PDF file where I see 10th grade this year, and I see 9th grade last year, meaning the same group of students (…). That's when we can identify what stands out; suddenly there is someone who is flaming red, while others are green. (Petter, School A)

> The surveys on Insight are used on a processual basis, in addition to exam results and end-of-year-results. It's to monitor and follow the students' development over time (…). We carry out the student survey on all three grades [8th–10th grade], so we have the opportunity to follow the students through the three years. (…) We also have access to completion rates from upper secondary. So we go in and measure them [the students] three and five years after graduation. (…) And they have a portfolio from primary with different test results. The students we get in 8th grade, they have a lot of data on there [Insight and Engage] already, it usually starts with mandatory mapping tests in first, second, and third grade, and national tests in fifth grade (…) So after a while, Conexus gains a pretty big base of results that stays in the system. (Anne, School C)

In these examples, the network has stretched backwards in time by connecting to actors from the past. This includes historical data from students' past achievements at the primary level and within their time spent at lower secondary school (see Figure 1). Data is gathered and analyzed on a processual basis, i.e., last year's 9th graders who are now in the 10th grade. On the one hand, trends in student performance portray a linear enactment of time, as the school leaders follow the students chronologically from year to year. As LAPs, the platforms can organize chronological anticipations in the past, present, and future with a certain continuity (Webb et al., 2020). On the other hand, by connecting to pieces of historical data, multiple realities are enacted simultaneously (Law &
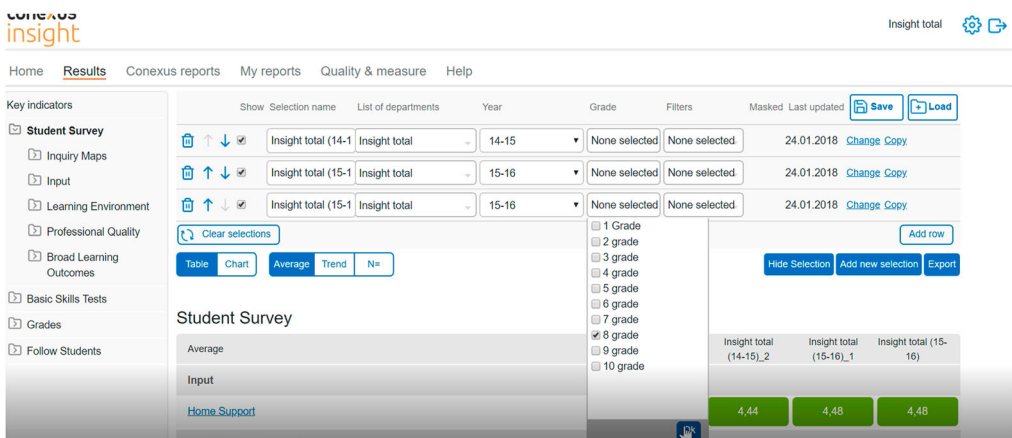

Figure 1. Historical data on insight.

Singleton, 2014; Mol, 2002), e.g., past and present performance. By interacting with data that represents a past reality (albeit for the same students), the past and present are juxtaposed and display two realities that connect through Insight and Engage.

The network also expands in time as informants follow the completion rates of graduated students. Their group of students may promptly graduate upper secondary school (within three years), or they may graduate within five, six, or eight years. In either case, following the students across their school life is extended and strengthened by attaching to the data referring to graduated students. Thus, anticipation is reinforced by gaining new allies (Law, 1999), which in this case, is presented by completion rates. As a form of time, completion rates can be thought of as 'present futures,' an enactment of the future that is fabricated and inhabited in the present. The network time, as explained by Hassan (2017), is here enacted by various timelines that are 'stacked' alongside each other (Bratton, 2015); the past, present, and future, but which emerge conjointly in 'real-time' (Luckin et al., 2016; Williamson, 2016). This reflects a form of anticipation that provides surveillance on student performance at every level, even beyond the boundaries of a particular school, grade, or class (Luckin et al., 2016).

Calculating risk subjects: betting on the future

When large datasets are analyzed and school leaders look for trends indicating positive or negative curves, the data are rarely based on an individual. Once a deviation is detected, however, the school leaders move to look for answers in individual students, which can be seen in this example from Hedvig in School C:

The student survey in our grade showed that some girls felt violated two to three times a month. It was dark red. So, we went on a mission to find out who these girls were.

By interrogating exactly to whom the data belonged to, a set of new relations unfold as school leaders enroll new actors to take part in practice. In this particular case, the informants connected to several students, teachers, and other staff at the school to identify the girls in the survey. In other cases, such as in School B, deviations in datasets were interrogated by crosschecking results on several standardized mapping tests in Engage. By creating a student report, the school leaders select a specific student from a list and choose several data points of interest. In Figure 2, the options are data from mapping tests in literacy, data connected to learning modules and teaching material, and data from the Directorate's tests (national tests and support tests in literacy). The informants
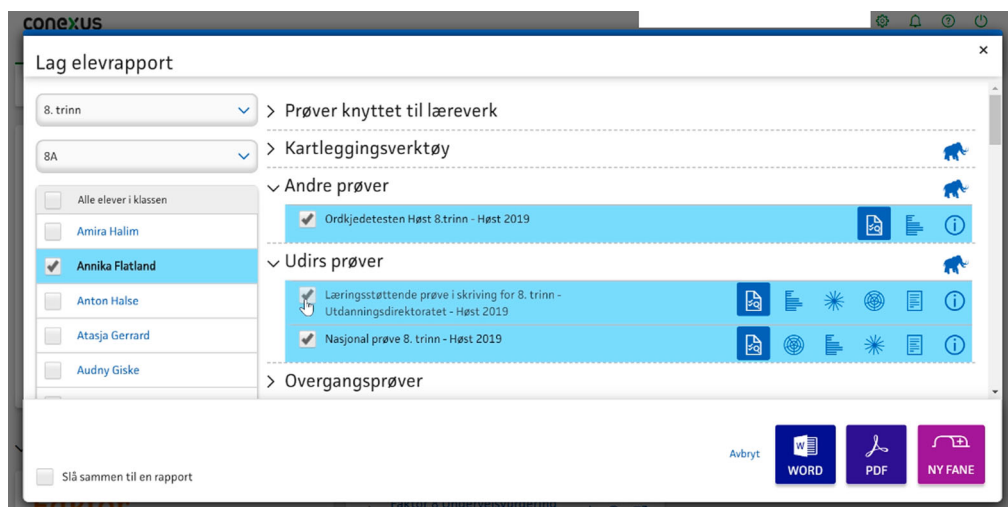

Figure 2. Shows how to select specific test reports (right hand side) for specific students (left hand side) in 8th grade on Engage. Screen shot is taken from demo-user, and all student names are fictional.

Insight total 8 grade (15-16)	English Writing	0,0
Insight total (14-15)	English Oral	4,3
Insight total (15-16)_1	English Oral	4,3
Insight total 8 grade (15-16)	English Oral	0,0
Insight total (14-15)	Mathematics	3,0
Insight total (15-16)_1	Mathematics	3,5
Insight total 8 grade (15-16)	Mathematics	0,0
Insight total (14-15)	Natural Sciences	4,2
Insight total (15-16)_1	Natural Sciences	4,2
Insight total 8 grade (15-16)	Natural Sciences	0,0
Insight total (14-15)	Social Sciences	4,2
Insight total (15-16)_1	Social Sciences	4,3
Insight total 8 grade (15-16)	Social Sciences	0,0
Insight total (14-15)	Religion and Ethics	0,0
Insight total (15-16)_1	Religion and Ethics	4,3

Figure 3. Colored data based on exam grades.

reported that they often wanted to check whether low results on literacy in national testing could be explained by equally low scores on standardized reading tests by comparing data in the student reports. Thus, anticipation is enacted by the school leaders, colors, benchmarks, digital reports in PDF files, and fabrications of the future, all of which contribute to students being assessed as risk subjects.

Students become risk subjects based on two scenarios. In the first scenario, they are enacted as 'needles in a haystack' through colored areas or by their level of mastery, where they are compared to other students' performance and qualifications. For instance, in Figure 3, red displays immediate danger, and orange and yellow students dwell in a danger zone; when they turn green, they are no longer considered a risk. In Figure 4, national test scores are presented according to level of mastery, one (gray) being the lowest and five (purple) being the highest. In the second scenario, once the
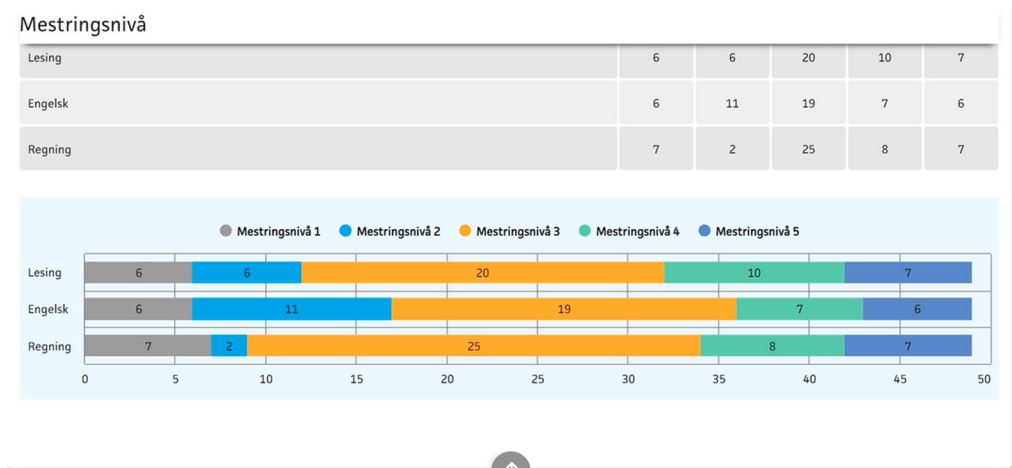

Figure 4. Colored data of mastery level from 1 (lowest) to 5 (highest) for literacy, numeracy and English as foreign language, based on national test results.

school leaders create an individual report, students at risk are emphasized with meticulous detail through digital reports (Figure 2). The once established network in the first mode of anticipation is now altered by a set of new relations: individual student reports, mapping tests, and other standardized tests. In the first mode of anticipation, the three 'doings' of time enacted groups of students, while this particular example enacts student groups as well as individual students as risk subjects, where the future is especially emphasized. The desired future gains new meaning in the present, as it is networked and brought to life in the present. Here, the actor-networks interact, as each gains new allies, and perform the same purpose to anticipate education and encourage school leaders in their daily practice (Fenwick & Edwards, 2012; Law, 1999).

The various elements and learning modules produced by the LAPs (student reports, visualized data, etc.) all connect to future predictions of exam results, school completion, and general life skills beyond school. The aim of anticipating risk focused on changing the course of chronological events that affected the students negatively, e.g., a yellow student turning red or staying red throughout the school. As one leader expressed; "if there are any red students, we tend to address these first and foremost". In other words, there has been an effort to optimize the future by underscoring what the school leaders can do now. The upcoming section will provide examples of how the school leaders acted to enroll the future in the present.

Possibilities for action: a desired future

An important tenet of studying platforms in practice is that they are what they *do*, or more precisely, platforms should be analyzed by the actions they encourage (Bratton, 2015). On the one hand, the Conexus platforms were relatively closed and bore few elements of a user-driven design (there are no edit and delete functions). Informants noted that they would have to make calls to the municipality or to Conexus' support to suggest even minor changes, and most of the time, such requests would not be considered. "We just have to trust them [the municipality and Conexus]," argued one principal. The following quotes show how the LAPs connect to such external processes with municipal superintendents and during in-house school development projects:

> We [the leadership team] get a response document based on results from Insight. We have a discussion on it and pick out things to say: this is something we have to take as a school, we have to work more with this area. And if there is a conclusion during the meeting that we have to do, then these are areas that will be targeted in school development projects. The response document is our basis. Maybe we have to work more with literacy, or numeracy, or to look at how we can engage the students more. (Therese, School B)

> We've used it to find areas for development, and we've incorporated it in our school development plan (Karina, School A). Yes, and it has consequences for the schools' development plan, what we prioritize, because we can't work with everything at once, you can't have too many focus areas in that plan. But that [Conexus data] is reflected there [school development plan]. (Lotte, School A)

The first quote refers to a quality development meeting with municipal superintendents. These meetings are usually held regularly in each municipality, where school principals and other members of the leadership team are invited to discuss school results. Here, Insight provides the school leaders and the municipal superintendents with data on school performance, and by connecting to the superintendent, Insight is generated by governing practices in which school leaders are held responsible for securing school results above a certain level. As one principal noted, "they really like it when it's green."

On the one hand, the two quotes above (and the previous screen shots) show how the LAPs encourage school leaders to target specific areas, which give certain direction to what school leaders can prioritize when engaging in important decision-making (i.e. targeting 'red' students, or students that have achieved the lowest level of mastery). According to the informants, certain tests on Engage provide school leaders with instructions and advice on how to help their students achieve higher levels (however, this feature was not available in the demo-users). This feature is called 'advice for measures', and suggests that Engage also works as an actor that offers packages of solutions to its users. The

network therefore extends in time by following the tasks and concerns of school leaders as they initiate, change, and coordinate their schools' priorities. In this sense, anticipation demands action in the present by carefully considering *how* the future can be acted upon (Adams et al., 2009).

On the other hand, while the LAPs emerged as 'closed' in the sense that users have little autonomy within the platforms, some autonomy can be found in practice. The way school leaders acted on the anticipated futures, unfolded in two ways. First, the school leaders emphasized their autonomy in purchasing learning modules within the platforms. In general, the choice to purchase and use Insight and Engage lies on a municipal level, but schools stand free to choose learning modules and which tests to focus on (except of course, the nationally mandated tests and surveys) (Gilje et al., 2016). In this sense, the school leaders selected data from the LAPs that would serve their schools' priorities. Second, the quotes above show that data and reports from the LAPs are used to negotiate school development projects, both on a municipal level and at the school level. When used in practice, the platforms thus invited connections to other actors; internally by connecting to teachers, in-house knowledge, and school priorities, and externally to municipal superintendents and their policies. As these interactions unfolded, the school leaders adapted practice to fit with their contextual concerns, connecting to the LAPs to put forward a set of actions that would secure educational quality. In this sense, the school leaders acted on the anticipated futures by being encouraged by the LAPs, *and* by adjusting the use of the platforms to real-life scenarios. Put differently: the interactions yielded fluid activities with LAPs that show how both actors act in practice.

Discussion

The analysis of school leaders' interaction with LAPs demonstrated how various actors move across time by attaching and detaching from the network and by interacting with actors that are presented in the past, present, and future. Thus, the relations unfolded fluidly according to the situations in practice (Fenwick & Edwards, 2012). In the first mode of anticipation, analyzing trends, the leadership team connected to results from national tests, student surveys, and completion rates across points in time. In the second mode of anticipation, calculating risk subjects, the digital elements inherent to the LAPs extended their relations by forging connections with individualized data. Such data include the student reports and standardized tests on Engage. During the third mode of anticipation, possibilities for action, the network expanded both in terms of the actors involved and across time. Municipal superintendents were attached to the network, and school improvement projects were initiated. The configuration of the LAPs was consequently also extended as school leaders performed activities that could span several weeks, months, and years, suggesting that other actors could be drawn in through future actions (Latour, 2005).

In agreement with Mol's (2002) notion of multiplicity, there were multiple modes of anticipation; therefore, they unfolded in multiple ways. Anticipation emerged as group data from the past, present, and future. Significant trends in the data enacted anticipation as both chronological and parallel events. The color red presents anticipation as a future risk for the schools, and green is anticipation as a the desired state. However, anticipation is also a highly personalized process; student reports enact anticipation by providing a set of benchmarks that can be compared. School leaders enact anticipation by managing the future (and the past) in the present. Municipal superintendents enact anticipation by holding school leaders responsible for school quality in the form of numerical data from Insight. Therefore, anticipation is personalized, visualized, numerical, digital, and social – moving fluidly between the different points in time and enacted multiply by its various actors.

The multiple modes of anticipation have implications for how time is understood in education. Time is de-linearized by the web of relations that drive the arrow of time to become obsolete, as the temporal effects follow the rhythm of the network (Hassan, 2017). This suggests that time is enacted by the network, and more specifically, through human-digital networks. The modes of anticipation presented in this study include real-time fabrications and scenarios from the past and future that emerge as present possibilities for action. These findings further indicate that anticipation is not

performed solely by projections of the future; conversely, the future (and the past) is made available in the present through surveillance, governing, and practice (Luckin et al., 2016; Williamson, 2016). This leads to a concern for the individualized and personalized, components that platforms can offer through their extensive use of learning analytics and support material. That is to say, LAPs structure the uncertain, the possibilities for action, and the solutions.

School leaders acted on the modes of anticipation by enacting time as *probable* or *presumed*, indicating that the future can be predicted and foreseen following a consequential logic. For example, if you ensure that your school targets literacy development, your results in national tests and your students will benefit equally. Thus, the LAPs and the school leaders, emerge as actors of contemporary educational values, governing targets that have been materialized and operationalized by determining what to problematize (Williamson, 2016). These findings illustrate the digital (data, visualizations), social (actions, school leaders, municipal superintendents), and temporal components (pasts, presents, and futures) of LAPs as the main mechanisms in which a wide range of actors, things, and values are assembled to act on educational anticipation.

The larger picture of anticipating and governing educational futures stems from various intrinsic, but external, actors connected through the LAPs. A valuable example is the different learning modules where students are made into risk subjects. On the one hand, these learning modules are presented as a production of the Conexus platforms. On the other hand, several of these stem from educational publishers (sometimes in cooperation with Conexus), meaning that the definitions between what is considered a public (Conexus through their cooperation with the Directorate for Teaching and Training) or private actor (Conexus themselves and through integrations with several commercial companies) are blurred for the informants. This is further demonstrated by questions of who to 'trust,' as exemplified by one principal, who illustrated that he, due to a lack of autonomy prescribed to the LAP, "just had to trust them". Questions of culpability and responsibility consequently became networked and black-boxed in practice, as 'them' refers to both municipal superintendents and Conexus. Rather than framing the platforms as working *in the service of governance*, however, the multiple modes of anticipation showed how the LAPs, and school leaders, work *as governance* (Bratton, 2015), as the events are not isolated or unrelated but form part of an entangled whole (Law & Singleton, 2014; Mol, 2002). The actor-networks have thus put into effect how LAPs and school leaders are part of a greater governing machine that feeds on the predicted and anticipated.

Conclusion

This study asked how two LAPs enact anticipation in practice, and how school leaders act on these modes of anticipation. The LAPs emerged as actors in school leaders' practice, as they connected to several presentations of time to anticipate, predict, and encourage action. The three anticipation regimes presented through the actor-networks showed how the platforms and school leaders connect to actors across time, in which time and anticipation were presentations of multiple events: chronological, parallel, and present activities. The LAPs enacted anticipation through colors, benchmarks, standards, and individual student reports by fabrications of the past, future, and present. The school leaders adjusted practice to fit with their own problematizations and new concerns that emerged from interacting with the platforms.

Existing research has debated the role of LAPs in anticipating education by discussions of digital policy, through the platform in-and-by itself, and by targeting students (Alirezabeigi et al., 2022; Decuypere & Simons, 2020; Webb et al., 2020; Williamson, 2016). While this body of research has made considerable contributions to how time and anticipation come to be *other things* in education (rather than mere chronological events), this article has expanded on this notion through evidence in schools and school leaders' mundane work-life.

Using a socio-material approach, such as ANT, can disclose how digital technologies and LAPs participate in and adapt to current educational practices. The notion of actor-networks that stretch

between networked times and spaces, producing various effects, could explain the governing forces of digital and material things in education. These are likely to affect various actors linked to schools, such as students, parents and legal guardians, teachers, municipal superintendents, and policy-makers. Therefore, further empirical research may examine multiple enactments of LAPs by following multiple actors that range in their roles and positions in schools. Such studies can preferably explore such enactments in other school contexts, within and beyond Norway. Further studies can also unpack the black box of LAPs, tracing the various external actors linked to such devices, and evaluating the origin of the ideas, values, and recommendations for action that stem from these platforms to further understand where, when, and how anticipatory governance is produced.

Disclosure statement

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