Dynamics in clusters of organisation routines and the logic of complementarity: the case of schedules of Dutch secondary schools

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1. Introduction

The (re)definition of organisation routines as 'recognizable, repetitive patterns of interdependent action carried out by multiple actors', and the idea that routines are fundamental to both stability and change in organisations (Feldman & Pentland 2003), are at the heart of what has become a very productive field of research. This definition entails that routines must be understood as embedded in an organisational context, and actions must be understood as situated action (Becker 2004). In correspondence with this conceptualisation, longitudinal in-depth case-studies, observations and ethnographies have been preferred methods of research. Up until now, most of the studies have focused on dynamics of change and stability of one routine in one organisation over time. This fine-grained work has contributed in significant ways to our knowledge base in organisation science (Becker 2004; Parmigiani & Howard-Grenville 2011).

Building on this groundwork, the research on organisation routines is now broadening its scope (Feldman et al. 2016). For example, by considering a routine as a set of subroutines connecting multiple layers of an organisation (Parmigiani & Howard-Grenville 2011). This perspective allows studying the selective - or even corruptive - translation of (sub)routines from one hierarchical layer to another (Den Nieuwenboer, Da Cunha & Trevino 2017). A

second extension stems from the notion that a routine is not necessarily confined to one organisation. This then opens up new ways to study how the interaction between multiple organisations is structured and enacted (e.g. Farrell & Coburn 2017). A third way is by expanding the work from a single routine to multiple, interrelated routines that shape organisations (o.a. Becker, Knudsen & March 2006). In this vein, Kremser and Schreyögg (2016) introduced the concept of clusters of routines. Their work suggests that dynamics in single routines are fundamentally different from dynamics in clusters of routines.
This paper builds on the concept of clusters of routines and has two aims. First, to expand the research on organisation routines by elaborating on the *logic of complementarity* and organisational change at the level of clusters of routines (Kremser & Schreyögg 2016). Second, to empirically explore different kinds of change that may occur at the cluster level of routines, and identify *determinants of different types of change*. We do this by comparing responses across multiple organisations and as multiple external demands.

The paper is structured as follows. First, we shortly clarify the concepts of clusters of routines and logic of complementarity, which is considered to be the driving force for dynamics of change and stability at the cluster level (Kremser & Schreyögg 2016). Our main research question is: how do clusters of routines respond to change challenges, and what are determinants for these different types of responses to clusters of routines? To answer these questions, we draw upon a detailed study on scheduling in Dutch secondary schools. Scheduling is arguably the most important cluster of routines in educational organisations. By systematically comparing responses to the schedules of thirteen different schools for three different external demands, we aim to disentangle determinants for different types of change at the cluster level. The findings confirm that the logic of complementarity is an important driver for routine dynamics at the cluster level. Organisations have a preference for types of change that pose the least risk of disrupting a cluster of routines and its established complementarities. However, characteristics of external demands appear to be strong determinants for the type of responses. In other words, policies shape the opportunity structure for clusters of routines to respond. Despite this more general pattern, our study also found examples of more radical changes. In all these cases, digital technology was the main driving force behind it. We end the paper by drawing conclusions and pointing to new directions for research.

2. Theoretical framework

Acknowledging that organisations have not one, but multiple routines which are connected to each other is anything but new (Nelson and Winter, 1982; Feldman and Pentland 2003). In a special issue on routine dynamics, researchers were explicitly invited to move 'beyond organizational routines as the unit of analysis and consider relations among routines and networks of routines' (Feldman et al. 2016, p. 511). The conceptualisation of this interrelatedness has proven to be a challenge, however. Becker, Knudsen and March (2006) point to a 'combinatorics' of routines, considering that a routine consists of multiple parts that can be combined and recombined in different ways (see also Cohendet & Simon 2016). In this approach, organisations can be modelled as 'configurations of interdependent routines' (Yi, Knudsen and Becker 2016). Gao, Squazzoni and Deng (2018) take a more evolutionary perspective, in which routines e thought of as organisational genes, and study 'networks of routines' aiming to create organisational fit with the environment. Their simulation suggests that connections between routines are particularly important in fast-changing and uncertain environments. Another approach is to make a distinction between a focal routine and an ecology of interrelated or intersecting routines in which it is embedded. Spee, Jarzabkowski and Smets (2016) follow this approach and illustrate the role of artefacts in the coordination of interdependent routines. From yet another angle, relations between routines can be seen as a form of hierarchical ordering, for which a distinction between meta-routines, routines and sub-routines has proven to be useful (D'Adderio 2014).

Regardless of how the interrelatedness of routines is conceptualised, all these approaches either argue or show that dynamics of stability and change at the level of a single routine must not be confused with dynamics at the level of a bundle, network or configuration of routines. A clear distinction between these levels of aggregation is crucial.

Clusters of routines and the logic of complementarities

Kremser and Schreyögg (2016) clearly define the difference between a single routine and what they call a cluster of routines. From that definition follows that coordination and dynamics are fundamentally different for single routines and clusters of routines. They define a *cluster of routines* as consisting 'of multiple, complementary routines, each contributing a partial result to the accomplishment of a common task' (p. 698). In the case of a single routine, the dynamics of stability and change is the result of reflective action of actors performing the routine. Because the performative aspect of a routine is never exactly the same, coordination between different actors occurs in an ad-hoc fashion. Such ad-hoc

coordination can be observed as the exchange and processing of real-time information. The coordination between different routines in a cluster of routines is fundamentally different. Applying organisational theories on modularity in organisation design, Kremser and Schreyögg conceptualise the relations between routines as programmed interfaces. Such interfaces are built into routines - for example, in the form of rules or requirements - to ensure that (the results of) separate routines can be integrated. These programmed interfaces are non-reflective. So, while coordination at the level of a single routine relies on the exchange and processing of ad-hoc, real-time information, coordination at the level of clusters of routines relies on programmed interfaces.

As a consequence, the dynamics of stability and change for single routines and clusters of routines are also very different. 'In contrast to the dynamics in single routines which are primarily driven by reflective action, dynamics on the cluster level are primarily driven by a *logic of complementarities* that builds up behind the backs of the performing actors' (p. 699, emphasis not in original). At the cluster level, routines are connected in such a way that they complement each other to establish a fit. 'The more task interdependencies between routines of a cluster have already been resolved by programming in the past, the more complex it becomes to reprogram the established interfaces in the future without losing the complementarities already realized' (p. 702). Change at the cluster level can therefore best be seen as a process of integration into established complementarities. This does not mean that clusters of routines cannot change, but it does imply that these changes can only take place in specific directions and not in others. In other words, clusters of routines can only follow a path dependent trajectory of adaptation. Kremser and Schreyögg propose to analyse change at the cluster level by studying reactions to change challenges. In their case study, they found that an incremental innovation was integrated into a cluster of routines and that a new routine was rejected to preserve the established complementarities in the cluster as a whole.

Another aspect of clusters of routines that is worth noting here is that clusters differ in how closely routines are connected to each other. Kremser and Schreyögg call this feature the *density of structural relations* at the cluster level (p. 718). It seems reasonable to assume that this density is related to dynamics at the cluster level, but it is completely unknown what factors play a role in the density of structural relations between routines, nor do we know what the consequences of this density are, let alone when and why the density increases or decreases at the cluster level.

The questions that guide this research are: How do clusters of routines respond to change challenges? And what are determinants for different types of responses to clusters of routines?

To describe responses to change challenges at the cluster level, we take the conceptualisation of Kremser and Schreyögg one step further by suggesting that clusters of routines can respond to change challenges in several ways. It follows from the theoretical framework that *four types of change* can be distinguished at the cluster level. For every type of change, the potential impact for the organisation as a whole is likely to increase.

Type 1: no change. This type of response is most likely when the change challenge is perceived as either too small - so that the challenge can be ignored - or too big, which makes it too demanding or too complex for integration in established complementarities between routines.

Type 2: change of a single routine, no change at the cluster level. At the cluster level, there is no difference between this type and the former. It does seem relevant, however, to distinguish organisational responses to change challenges which do not result in any change, and responses that are restricted to single routines. Kremser and Schreyögg suggest that changes in single routines may push changes at the cluster level. The reverse may also occur: to preserve complementarities at the cluster level, adaptations may be 'pushed' to the level of single routines.

Type 3: change at the cluster level, no change in programmed interfaces. In these situations, changes are visible at the level of the cluster of interdependent routines. In the conceptualisation used here, this implies that at least one of the single routines that constitute the cluster is changed as well. Change at the cluster level does not automatically imply, however, that the nature of the interfaces that tie the routines together change as well.

Type 4: change at the cluster level, and change in programmed interfaces. At the cluster level, the coordination between complementary routines takes the form of programmed interfaces. At least in theory, how these interfaces are programmed, or the nature of the interfaces, can also be adapted. Changing the nature of interfaces is likely to be a risky business for organisations. Because interfaces are programmed into single routines, adapting the nature of an interface is likely to affect many routines in a cluster. Established complementarities between routines may be lost in the process. Considering the potentially major impact on the organisation, one would only expect to observe this type of change when other types of change don't suffice.

To answer the second question, about *determinants for different types of change*, we start by making a very rough distinction between determinants which are related to the cluster of routines (more internal to the organisation) and determinants who are related to change challenges (more external to the organisation) (Howard-Grenville 2005). If features of the routine cluster determine the type of response, one would expect that an organisation responds in similar ways to different kinds of challenges. If on the other hand, features of change challenges determine the type of response, the expectation is that different organisations respond in similar ways to the same challenge, despite their diverging cluster of routines. Several comparisons must be made to disentangle these broad categories of determinants, either related to clusters or challenges. First, the responses of one and the same cluster of routines to different challenges must be compared. Second, responses of different clusters to the same challenge must be compared. It is evident that the latter comparisons only make sense, when the organisations whose clusters of routines are compared, are somehow comparable as well. For example, because they are in the same business or produce a similar product or service. Schedules of secondary schools fit these conditions.

3. Research methods

Cluster of routines: schedules of secondary schools

According to the definition of Kremser and Schreyögg (2016), a schedule of a school is a good example of a cluster of routines. In a school, routines related to learning activities of students, teaching activities of staff, the content of the curriculum, and organisational resources such as time, staff and space are all closely connected (Spillane, Parise & Sherer 2011; Tubin 2015). These operations can be thought of as a cluster of routines that are interrelated to accomplish the core and common task of schools, which is to educate students. The most visible expression of this cluster of routines is the schedule. The schedule communicates to all actors involved who is to be where at what time to do what. The length and location of a class, or what teachers do exactly in class, is not communicated on an ongoing basis during the day. When teachers and students follow a schedule, no exchange and processing of real-time information are required. At the level of the schedule, coordination is not of an ad-hoc nature but relies on programmed interfaces like set localities, subjects and classes. Because schedules express such close connections between so many aspects of daily practices in schools, scheduling - known as the school timetabling problem - is a classic topic in the field of operations research (Abramson 1991; Burke et al. 2007; Veenstra & Vis 2016).

The fact that minor changes in a schedule can have major and disruptive effects in educational organisations further underscores the high interdependency of the organisational routines that make up this cluster of routines (Tate, Campbell-Meier & Sudfelt 2018).

Single routines are embedded in their context, and the same applies to the routine cluster of schedules. For example, specifics concerning the availability and distribution of spaces across locations are relevant, as they allow or restrict the movement of students between spaces for specific learning activities such as laboratories or sports facilities. A schedule also reflects which teachers are available during what hours, given the size of their contracts, arrangements for non-teaching tasks and also power relations and privileges (Riehl, Pallas & Natriello 1999). Schedules also reveal school policies and pedagogical visions. For example schools may want to ease first-year students in, by avoiding long days at school. Or they may propagate a promise of vast curriculum choices, by making every combination of courses possible. For all these reasons, schedules represent the most crucial cluster of routines in education organisations.

Up until now, only a few studies have looked at school organisations through the lens of organisation routines. In a review of three decades of research on the effectiveness of high schools, Preston and colleagues (2017) conclude that external demands can only be met and improvement can only take place when they ‘permeate' organisation routines. Others have come to similar conclusions in their studies on ways policies do or don't have an impact on school and classroom practices (Spillane, Parise & Sherer 2011; Woulfin 2015; Hubers et al. 2017). What's more, their in-depth case studies of schools illustrate the critical role of schedules in adapting to external demands. Schedules have more often been found to be at the heart of school responses to government policies (Koyama 2014; Tubin 2015). Considering that the schedule is the visible part of the most crucial cluster of routines in a school, these findings make perfect sense.

In all then, schedules of schools serve our purposes very well to study types of change in clusters of routines, and identify determinants for these different types of change. Most schools have a schedule of some kind, which allows for comparisons between schools. With an abundance of government policies, it is relatively easy to select specific demands that pose a change challenge for the routine cluster of schools. This allows us to compare how one school responds to different challenges. And because government policies usually apply to all

schools in equal measure, we can also systematically compare how different schools respond to the same challenge.

Research setting: secondary schools in the Netherlands

This study is set in the Netherlands, which has the additional advantage of great variety in the cluster of routines of schools. This variety stems from the long history of freedom of education in the Netherlands (Hooge 2017). The degree of comprehensive school autonomy is among the highest in the world (OECD 2016). The vast majority of secondary schools is publicly funded and privately governed. School funding is largely based on student numbers and takes the form of a block grant with a distinction between material and personnel costs. School fees are voluntary; parents are not required to pay for publicly funded schools. As a result of the long history of school autonomy, Dutch schools vary widely in many respects. Traditionally, schools differ in denomination (e.g. Catholic, Protestant, public), in pedagogical vision (e.g. Steiner, Montessori) and didactical methods (e.g. class-based or more personalised education). The law distinguishes seven different tracks in secondary education, ranging from a separate track for special needs students to pre-university education. Informally, pre-university education including Latin and Greek (the gymnasium) operates as a separate, eight track. Tracks differ in length and range from four years for the lower tracks to six years for the higher tracks. Schools need a license from the government for the tracks they offer. There is no national curriculum, but students must sit standardised subject based examinations at the end of their track. More recently, Dutch secondary schools also adopt profiles as a vehicle for educational innovation or to gain a competitive edge in local education markets (Van der Sluis, Hooge & Waslander 2017). Such profiles range from bilingual education to specific attention for art or technology, to special offerings for sport-loving students. Schools don't need a license to offer any (combination) of these profiles. It is up to schools whether they offer a profile as a separate stream (as if it were a track), as optional parts of the curriculum, as part of extra-curricular activities or in any other form.

School autonomy also applies to scheduling. There are only general rules for the number of hours students must be engaged in learning activities during their whole school career. It is up to schools how they want to allocate those hours across years, subjects and different kinds of learning activities. For example it is up to schools whether they wish to teach students a foreign language by immersing students during one period of one school year, or schedule the lessons over all periods and all school years, or anything in between. It is also up to schools

how they organise learning activities: they may offer separate subjects, combine subjects into projects or arrange the curriculum in any other way they see fit. The only restriction is that the compulsory examinations at the end of secondary school are all subject-based.

This makes schedules in Dutch secondary schools a very suitable cluster of routines for the aims of our research. Schedules, representing clusters of routines of schools, are similar enough to allow for comparisons across organisations, and different enough to disentangle the role of features of routine clusters and features of change challenges in different types of responses.

Three change challenges

To find out how clusters of routines in schools respond to change challenges, responses to three government policies were studied. All three policies intend to impact on school and classroom practices, and all three policies call for changes in the school year of 2015-2016 (see also Waslander et al. 2018). The policies differ in degree of regulation and therefore in leeway for schools to develop their own responses.

New performance standards for *literacy* are introduced to improve student performance in four domains: oral skills, reading skills, writing skills, and basic skills including spelling and grammar. These domains are already incorporated in the curriculum and national exams, but the new standards make more explicit what is expected of students in each of these domains. It is up to schools to determine whether students master the required level of oral skills; the other domains are incorporated in the final national exams for Dutch language. Students in the lower tracks must pass the national exam for Dutch language to get their diploma; students in the higher tracks have some, albeit limited options to compensate in case they fail their national exam for Dutch language.

Concurrently new performance standards for *numeracy* are introduced. These standards are not incorporated in existing curricula or exams but come with a compulsory, separate test that all students have to take. After gradual implementation, 2015-2016 is the first school year all students must pass the test to get a diploma. The numeracy test is high stakes. For students, the test determines whether or not they pass their exams. If students fail the test after three attempts, they must retake the national exams for all their subjects in the following school year. The test is also high stakes for schools because the proportion of students passing the

test is to become part of the accountability framework of the Inspectorate. These new rules apply at the beginning of the school year of 2015-106. This is despite the fact that the policy is heavily disputed by mathematics teachers and other education professionals from the outset, and despite the fact that it has been delayed several times following disappointing results in pilot schools. While the test is implemented, resistance remains and under political pressure the Secretary of Education decides halfway the school year to adapt the policy. Students must sit the test, the results will be stated on their diploma, but the results will not be of any consequence. As will be clarified in the data collection section, we studied the responses of schools in anticipation of the full high stakes nature of this policy.

The *civic education* policy does not introduce something new but rather abolishes what was already in place. Going back in time, in 2011, community service for a minimum of thirty hours was introduced as a compulsory part of the curriculum. From that time onwards, schools were given additional subsidies to get these learning activities organised. After several years, a new government abolishes both the obligation of community service and the subsidy. From the school year 2015/2016 onwards, it is entirely up to schools whether they want to continue their established practices of community service, adapt their practices or abolish it entirely. Regardless of their choices, additional subsidies are no longer available, and any expenses must now be paid for out of their block grant.

Selecting schools

This study uses data that were collected as part of a larger research project for which we carefully selected Dutch secondary schools (Theisens et al. 2016; Waslander et al. 2018). We set out by composing a long list of school boards based on a number of criteria: number of schools, tracks offered, location, and pedagogical vision/identity. Next, we asked three experts in the field which combination of school boards would best serve our goal of maximum variety. This resulted in a short list, with for each school board an alternative (combination) in case they were not able or willing to participate. About half of the school boards agreed immediately to participate; for the other half backups were contacted. Within each of these boards, one or two schools were selected, depending on size, again based on maximum variety. We aimed for nine boards and fourteen schools but ended up with nine boards and thirteen schools due to practical difficulties while finishing the last case study. On top of the selection criteria, the case study schools differ in respects such as student numbers, student composition, number and kind of tracks offered, and organisation of the curriculum.

To protect their anonymity, participating schools are given the names of Dutch rivers. Schools of the same school board can be recognised by their similar second name: Oude Rijn and Kromme Rijn Colleges, for example, are schools of the same board.

Data collection

Organisational routines were not part of the original conceptual framework but emerged as an essential perspective for an adequate interpretation when we conducted inductive analyses on the extensive and rich qualitative data (Waslander et al. 2017). For the purpose of this paper, two data sources are used. The first source is the fully transcribed *interviews* from the original study. For each school, two group interviews with two or three teachers each were held, as well as individual interviews with people holding all relevant layers of leadership in the school. Most often these were team leaders, location leaders, school principals and chairpersons of the executive board. For all thirteen schools combined, interview data were collected from 54 teachers and 36 people in leadership positions in total.

The initial conceptual framework required detailed information on actual practices (Theisens et al. 2016). The interviews were semi-structured and included changes that had (not) been put in place in response to the three policies mentioned above. The interviews were conducted between September 2015 and May 2016. During this period, the implementation of the high stakes numeracy test was reversed (see above). In interviews that were conducted after this reversal, the main focus was on practices at the beginning of the school year. For this paper, the full transcriptions were re-coded in MaxQDA for any possible information on schedules and any changes that had (not) been made on schedules.

In addition, and for the particular purpose of this study on schedules representing a cluster of routines in schools, *school documents* were collected as a second data source. All Dutch schools are obliged to publish a yearly *school guide* to inform parents and students. These guides must adhere to several legal guidelines, among other things providing information on the tracks and specific programmes the school offers, what type of learning activities are an offer, the schedules, and when the school is closed (for holidays or otherwise). School boards must also publish yearly *reports and accounts* and must, among other requirements, also provide information on how they deploy block funding and additional subsidies. For the nine boards and thirteen case-study schools these documents were collected for the school year 2014/2015 and the school year 2015/2016: all these documents were publicly available.

Data analyses

The data were analysed in four consecutive steps. First, a *detailed description* was made of the schedule of each school in the school year 2014/2015. This was primarily based on document analyses of the school guides and finetuned with data from the interviews. Second, for each school and each of the three policies separately, *any changes* that were made to the schedule for the year 2015/2016 were described as factual as possible. These descriptions of changes were primarily based on the detailed interview data, to obtain a description which was as detailed as possible. This description was then double checked against the school documents. The schedules do not only comprise courses - such as English language or geography - but also include other planned (learning) activities such as day-openings, projects or internships. The third step was to *categorise* all 39 responses (13 schools * 3 policies) to the routine cluster of schedules. It is important to note that these responses are based on factual descriptions of the changes - if any - that schools actually made; the categorisation does not refer to any reasoning interviewees may have given. The four types of change mentioned in the theoretical framework were used as a provisional coding list of possible responses. This list was slightly adapted during the coding process. The three authors double coded the responses independently. The initial coding was dissimilar in two cases. These were resolved by discussion and clarification of the different categories. In all, five distinctively different responses were found in the data. The fourth step was to *compare the responses,* both within schools for the three different policies, as well as across the thirteen schools for the same policy.

4. Main findings

Wide variety in clusters of routines: no schedule is the same

The first step of the data analyses resulted in a thick description of schedules, the visible part of a routine cluster, in each of the thirteen case study schools. The many differences between the clusters may serve as an indication that we accomplished our aim to select a maximum variety of schools. As a consequence of our selection process, the case study schools differ in the number of tracks they offer. Apart from that, many other differences came to the fore (See appendix). About half of the schools do not have any *additional streams*, while the other half offers up to eight separate streams. A stream represents a group of students who take all lessons in the same group, and whose curriculum differs from that of other students. Amstel College, for example, offers a separate sports-stream within each of its three tracks. Students

in these streams not only spend more time on physical education but the curriculum of other subjects - such as biology and English - is also geared towards their sporty interests. Another example is Gouwe College, which works with bilingual streams. Students in these streams not only spend more time on English but also use English as instruction language for a number - but not all - other subjects such as mathematics and geography. Obviously, not all teachers are equally equipped to teach such lessons, and for some streams teachers must have completed additional courses. A relatively large number of tracks and streams, each with an own lesson plan and spatial and teaching requirements, may add to the *degree of structural interrelatedness* between routines at the cluster level.

Following Becker's (2004) call to examine the processual nature of routines, we also looked into aspects of *time and rhythm* at the cluster level. While a lesson lasts 45" at Oude Rijn College, a lesson can be more than double that length (100") at Nieuwe Aa College. Partly, but not entirely, related to the length of lessons is the maximum number of different subjects that are scheduled on any given day, which varies between six and ten. Schedules also happen to differ in the steadiness of their rhythm. At Oude Aa College, for example, the first lesson is scheduled for 100" while the other lessons last half that time. This rhythm is similar for all days of the week. At Ooster- and Wester Schelde Colleges, lessons are 50" for four days of the week and 45" for one day of the week, with a rhythm that repeats itself every week. In contrast, Dommel College also works with days of shorter lessons, but does so only occasionally and without much of a rhythm.

Schools also have very different practices when it comes to learning activities such as *projects and internships*. While these learning activities are standard practice in some schools and show up as designated timeslots every week or every semester, they lack altogether in other schools. A good example here is community service during the 2014/2015 school year when it was still compulsory. Some schools schedule it as a project, in which case all students of a year group are engaged in community service at the same time. Other schools put it on the schedule, but allow students to choose when to conduct the service. Still, other schools make the service compulsory as required, but do not put it on the schedule, which means that students must conduct the service in their own free time.

All in all, the variety between the schedules of these thirteen secondary schools is so extensive that we cannot unequivocally distinguish specific features - such as the degree of

structural interrelatedness between routines - and use them to categorise clusters of routines further. The *first conclusion* that can be drawn is therefore that the most important cluster of routines in schools - visible in the form of schedules - differ widely between Dutch secondary schools. Nevertheless, all schools do use a schedule to coordinate multiple interrelated routines. In other words, despite the wide variety in single routines and clusters of routines, the nature of the programmed interfaces is strikingly similar.

Similar responses

Despite the wide variety in clusters of routines - schedules - the responses of schools to the change challenges posed by the three policies under study here, appear to be strikingly similar. Five distinctively different responses emerged from the data. The broad categories described in the theoretical framework can now be illustrated by concrete examples.

1. *No change,* meaning that already established practices are retained. Single routines do not change, nor is there any change at the cluster level.
2. *Symbolic change (gaming)* which was not part of our original framework. On paper and from the outside the routine cluster appears to have changed, but in actual practice nothing did change. This study found one example of a school where the resistance to the numeracy-test was so big that their initial response was no change. However, after the Inspectorate made critical comments on the lack of attention for numeracy, specific numeracy lessons were created. These added lessons were scheduled - on paper - during what used to be the lunch hour. Students were supposed to study for themselves during that hour. This adaptation satisfied the Inspectorate. The interviews left no doubt that the practices within the school remained exactly the same.
3. *Change of a single routine, without change at the cluster level.* In these cases the schedule did not change, but the activities carried out during the scheduled timeslots did change. For example, during the lessons in Dutch language more time was spend on grammar and spelling at the expense of drama, but the number and allocation of hours available for Dutch language remained the same. In these cases the documents do not show any change, while the interviews conducted in a school reveal consistently what did change during lessons. In a way, the change challenge was ‘contained’ to affect a single routine, without consequences for the routine cluster as a whole.
4. *Change of the cluster of routines, without change in programmed interfaces.* In these cases schedules change, for example lessons are added so that students must spend more time at school. Or substitutions are made so that one specifically scheduled learning activity is abolished in favour of another scheduled activity. Several schools have a practice in which

students can work on their own chosen assignments, under the supervision of a mentor, during scheduled timeslots during the week. In several schools this practice was abolished in favour of regular compulsory lessons for numeracy. What these cases distinguish from the third category of responses, is that schedules do show change. The adaptations the school makes, do reach the level of the cluster of routines and affect the routines of the whole cluster. To schedule numeracy lessons, for example, a teacher with specific qualifications and teaching materials must be available at the given time. This teacher is not working on its own, so that joint meetings and consultations must also be adapted. At the cluster level the adaptations - adding, substituting and eliminating elements - still follow the logic of the schedule. In other words, the nature of the programmed interfaces is left untouched.

5. *Change in the cluster of routines and change in the programmed interfaces* is potentially the response with the most far-reaching consequences. In these cases, not only does a schedule change but so does the inherent logic behind the schedule itself. A detailed elaboration of this type of response is given in section 5.

Table 1: responses to clusters of routines (number of organisations)

Responses / policies	**Literacy**	**Numeracy***	**Civics**
1. No change	1		10
2. Symbolic change (gaming)		1	
3. Change of a single routine, no change at the cluster level	6	1	
4. Change at the cluster level, no change in programmed interfaces	6	6	3
5. Change at the cluster level, and change in programmed interfaces		5	

With these five categories, the changes the thirteen schools made in response to the three different policies could be categorised. Table 1 summarises these responses, and more details can be found in the Appendix. For the change challenges posed by policies on literacy and civics education, the figures in the table refer to the school as a whole and therefore to all tracks. The figures in the column for numeracy must be read differently, which requires an explanation. Schools respond to the numeracy policy in different ways for different tracks (see Appendix and section 5). To allow for comparisons across policies, but also make changes as visible as possible, the following procedure was used to categorise the school as a

whole in Table 1. The most common response to the numeracy policy was clearly a change at the cluster level, without changes in the programmed interfaces. If a school responded not in the common, but in a different way for one or more of its tracks, this different response was used to categorise the school as a whole for Table 1. For example, one of the schools - Zand Maas College - integrated the numeracy test into existing school subjects (change of a routine, without change at the cluster level) for one of its six tracks. In Table 1 this school is counted in the category 'change of a routine, without change at the cluster level', although the school responded in a similar way to most schools its five other tracks. Similarly, schools with changes in the programmed interfaces for at least one of their tracks were categorised as such. All these schools pursued the most common response for their other tracks.

5. Interpretation

Schedules are the most important cluster of routines in educational organisations. A schedule can be thought of as the most visible part of many different and closely intertwined routines such as allocating students over classes, organising the curriculum, deploying teachers, distributing resources, cycles of planning and control, and allocating the use of buildings and grounds. The density of structural relations between these routines is likely to be high, as even small changes at the level of the cluster of routines can be disruptive and have major impacts on daily practices and the functioning of the school organisation as a whole (e.g. Riehl, Pallas & Natriello 1999; Tate, Campbell-Meier & Sudfelt 2018).

Logic of (established) complementarity

The general pattern derived from the findings can be summarised in four points. The first thing that must be noticed is the intra-case differences: not one of the thirteen schools responded in a similar way to each of the change challenges that were posed by the three policies. The three responses to clusters of routines for about half (N=6) of the schools fell in two different categories, for the other schools (N=7) each response to the routine clusters was markedly different. This variation clearly indicates that responses are not determined by the characteristics of routine clusters alone. Secondly, there appear to be clear preferences for specific types of responses to each policy. This is despite the fact that clusters of routines vary widely between these schools. The combination of these two findings can best be understood as that each of the policies both enables and constrains particular responses. Worded differently, each policy comes with its own opportunity structure for clusters of routines to respond (see also Coburn 2016).

Third, given the opportunity structure provided by a particular policy, clusters of routines tend to respond in ways that demand the least amount of change and the least risk of losing established complementarities at the cluster level. Responses to the civic education policy are telling here: it was clearly more appealing to stick to established practices rather than to make any change, even when funding was cut. Fourth, at the level of the cluster of routines, a useful distinction could be made between changes in the cluster of routines as such, and changes in the programmed interfaces stitching the routines together. Changes in the routine cluster as such are preferred over changes in interfaces, most likely because changes in interfaces have (potentially) more far-reaching consequences for the organisation as a whole. These findings underscore once again how essential relations between routines are to understand patterns of change and stability.

To sum up: the general pattern of the findings is that change challenges have their own specific opportunity structures and that within these boundaries responses to clusters of routines are preferred that are the least demanding and pose the least risk for the organisation as a whole. These findings confirm the logic of complementarity as an explanatory mechanism for dynamics at the level of clusters of routines.

The findings also point to two instances that seem at odds with this general pattern. A focus on these irregularities can deepen our understanding. First, the responses to the policy change for civic education. The policy provided schools ample opportunities to respond in any way they liked. The vast majority of the case study schools responded by not making any changes at all, which fits the general pattern. Three schools did make changes, however, and not just to a single routine but to the schedule itself, that is, to the cluster of routines. At first sight, this seems to contradict the general pattern. All three schools reduced the number of hours students had to commit themselves to community service, but none of these schools abolished the practice altogether. Because the reduced number of hours took the form of a change in the schedule, strictly speaking, the cluster of routines did change and we coded these responses accordingly. This is a very particular case, however, since the reduction of hours for community service had very little impact on organisation routines. After all, characteristic of the learning activities of community service is that they take place outside of the school, do not involve teachers of the school, nor do they require any space within the school. These specific learning activities are thus not as closely connected to other routines than is the case

for most other learning activities. So, while the broad categorisation may seem to indicate otherwise, in actual fact, the findings support rather than dispute the general pattern of the findings. What this clarification also illustrates is a point already made by Kremser and Schreyögg (2016), that the density of structural relations between routines is a relevant feature in need of elaborate conceptualisation and further study.

A second irregularity can be found in responses to the numeracy policy. Most responses are classified as a change at the cluster level, without a change in programmed interfaces (see Table 1 and explanatory text). This type of response was clearly within the boundaries of the opportunity structure set by the policy. Nevertheless, in some schools more radical responses were identified. In these schools the nature of the programmed interfaces between routines did change. This is at odds with the logic of complementarity and raises the question whether another driving force may be at play.

Changes in programmed interfaces: the driving force of digital technology

According to our categorisation, changing the nature of programmed interface at the level of clusters of routines, is the most demanding and risky response of an organisation to a change challenge. In this study, such responses were only found concerning the numeracy policy, which came down to the introduction of a new high stakes test. The weight of the challenge is clearly relevant here: only one school took a brave stance by gaming a routine to satisfy the Inspectorate, all other schools responded by making one of the two most demanding types of change. Looking more closely into the responses of changes to the programmed interfaces, two things must be noted.

First, we are unable to grasp why some schools changed the programmed interfaces and others did not. We considered developing an indicator for the density of structural relations (see also Kremser & Schreyögg), but the immense variety in schedules in our selected case studies left is unable to categorise specific features somehow (see section 4). Concerning the features mentioned in the Appendix, not any pattern between these features of schedules and types of responses could be identified. For example, there is no pattern between any indicator of complexity of a schedule and type of response: while some relatively straightforward schedules saw no change in programmed interfaces (e.g. Waal College), other relatively complex schedules did (e.g. Dommel College), and vice versa.

Second, the kinds of changes in programmed interfaces are strikingly similar across schools, and what stands out even more is that they all rely heavily on digital technology. The background is relevant here. The numeracy test was intended as a national standardised test all student would need to take for many years to come. The size of the new market (all students) and the nature of the test (learning by rehearsal), made it worthwhile for commercial publishers to invest and develop digital learning material. Most case study schools worked with one of these digital methods. The learning software not only generates information to identify the students who have difficulty with the tasks, but also gathers information on whether and when students logged in, how many times they worked on a particular task and for how long. Likewise, information is collected on mentors who check on their student's progress. This concomitant information is used for close monitoring, ranging from students monitoring their own progress, mentors monitoring students and school principals monitoring mentors (see Waslander et al. 2018 for a more detailed analysis). This illustrates how digital technologies provide new forms of monitoring and surveillance (Williamson 2015; Souto-Otero & Beneito-Montagut 2016; Page 2017).

The combination of digital learning material and a focus on students passing the test, provoked that schools responded differently for different tracks. For lower tracks, all but one school responded by adding numeracy lessons for whole classes on the timetable. This response is categorised as a change at the cluster level of routines (the schedule changes), without a change in programmed interfaces (the nature of the schedule is the same). Five case study schools did change their programmed interfaces, but only for the higher tracks. Students of these schools are expected to improve their numeracy skills by using the software for self-study whenever and wherever they like. Therefore, no lessons are included in a schedule. This part of the response would qualify as ‘no change’ in routines. Students are not entirely left on their own, however. The information generated by the software is used to signal a lack of progress or lack of effort. Subsequently, teachers determine whether, and if so, what kind of additional instruction or supervision is offered to whom, when and where. As a result, students in a similar track no longer have the same schedule. Also, as progress and effort can change continuously throughout the year, so do the individualised schedules. In contrast to the lessons for other subjects, the obligatory lessons for specifically identified students are not planned months in advance but on short notice. For reasons of efficiency, the lessons for students who require additional instruction or supervision are group based. Students who are identified as requiring specific attention, are obliged to follow these lessons, regardless of the

track or stream they are placed in for all their other lessons. So these schools moved away from: a completely group based schedule by introducing individualised schedules; a full track- and stream-based schedule by introducing lessons across all tracks and streams; and the preplanning of schedules months ahead by introducing a feature of continuous change. This changes the logic behind the schedule itself, and so the relations between the routines that are involved. In other words, the nature of programmed interfaces changed. This has far-reaching consequences for the routine cluster. For example, it is no longer solely up to planners to draw student schedules, (numeracy) teachers become involved in the scheduling process as well. And while learning activities of separate tracks and streams used to be relatively independent of each other, they now must be coordinated more closely. This is a truly new way of organising, and digital technology is a key element of it (Puranam, Alexy & Reitzig 2014).

The new, flexible elements to the schedule process are celebrated - by publishers, teachers and school principals alike - as personalised education made possible by digital technology. A more critical interpretation seems more appropriate. The traces students leave are used by commercial publishers to improve individual learning pathways through the software, and enhance the signalling function. The decision of whether a student must attend additional lessons, relies heavily on the signals and suggestions provided by the learning algorithms that companies build into the software. Our interviews suggest that teachers, due to lack of knowledge and time, hardly reflect on assumptions underlying these algorithms, nor on the pedagogical and educational implications of the new elements in their practices (see also Waslander et al. 2018). For them, the guidance given by the software is the result of a 'black-boxed performance' and there is little awareness of the transforming effects these technologies may have on their professional expertise (Faraj, Pachidi & Sayegh 2018).

6. Conclusions and discussion

Two questions guide this paper. The first question is: how do clusters of routines respond to change challenges? We aim to expand the field of research on organisation routines by elaborating on *clusters of routines and the logic of complementarity* (Kremser & Schreyögg, 2016). The second aim is to empirically explore different kinds and drivers of change at the cluster level of routines, by asking: what are *determinants for different types of responses*? In the definition of Kremser and Schreyögg (2016), the coordination between different actions of a single routine takes the form of ad-hoc exchange and processing of real-time information, while coordination between routines in a cluster of routines takes the form of programmed

interfaces. Our theoretical framework identified four different types of responses to change challenges. An empirical study was conducted in Dutch secondary schools. From the perspective of organisation routines, a school's schedule is the most visible part of the most important cluster of routines in educational organisations. We studied how the schedules of thirteen schools changed in response to change challenges posed by three different government policies. Systematic comparisons across policies and schools, allowed to disentangle determinants related to change challenges (policies) and determinants related to cluster of routines (schedules).

The conclusions can be summarised in four points:

1. The most important cluster of routines in schools is visible in the schedule. Schedules, and therefore clusters of routines, differ widely between Dutch secondary schools. In the case-study schools schedules differ, among other things, in the length of regular lessons (from 45" to 100"), the number of lessons per day (from 6 to 10), the number of formal tracks (from 2 to 6) and the additional number of streams (from none to 8). Despite these differences the programmed interfaces of the clusters of routines are very similar; the nature of the schedule is very much the same.
2. Five different types of responses to the routine clusters were identified in the data: no change; symbolic change (gaming); change of a single routine, without change at the cluster level; change of the cluster of routines, without change in programmed interfaces; and change in the cluster of routines and change in the programmed interfaces.
3. Clusters of routines respond in specific ways to specific change challenges. Each challenge comes with its own opportunity structure for clusters of routines to respond. Given this opportunity structure, responses of routines follow the logic of complementarity. That is, clusters of routines tend to respond in ways that pose the least risk of losing established complementarities at the cluster level.
4. The empirical study also identified responses to programmed interfaces. It is unclear why this was the response in some, but not in other cases. Nevertheless, these responses were very similar and the main driving force behind these truly new ways of organising was digital technology (Puranam, Alexy & Reitzig 2014). These new ways of organising align with demands of modern societies by holding the promise of individualisation and freedom, yet rest upon standard algorithms and modes of surveillance and control build into the software (e.g. Faraj, Pachidi & Sayegh 2018).

Discussion

[To work out: Can our understanding of the impact of digital technology on organisations be advanced by considering technology as a driving force behind new ways of coordinating multiple organisation routines in a cluster (programmed interfaces)? Does digital technology decrease transaction costs of coordination, allowing for closer connections between routines at the cluster level?]

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Appendix: Overview schools, characteristics of schedules and responses to challenges

SCHOOL	DOMMEL	GOUWE	NIEUWE AA	OUDE AA	AMSTEL	VECHT	OOSTER-SCHELDE	WESTER-SCHELDE	WAAL	OUDE RIJN	KROMME RIJN	BERGSE MAAS	ZAND MAAS
Char.													
Size	Middle	Large	Middle	Middle	Middle	Large	Large	Small	Small	Small	Large	Middle	Middle
Tracks	4	6	3	3	3	6 & 3	2	4	4	3	3	6	6
Streams	3	7	0	0	8	2	1	0	0	2	2	0	0
" / lesson	50 & 40	70 & 60	100 & 50	100 & 45	45 or 90	50 & 40	50 & 45	50 & 45	50	45	45	50	45
Strategies													
Literacy	Cluster	Cluster	Routine	Routine	Routine	Cluster	Routine	Cluster	Cluster	Routine	Routine	Cluster	No change
Numeracy	Interfaces	Cluster	Cluster	Interfaces	Cluster	Symbolic	Interfaces	Cluster	Cluster	Interfaces	Interfaces	Cluster	Cluster
Civics	Cluster	No Change	No change	No change	No change	No change	No change	No change	No change	Cluster	Cluster	No change	No change

No change = no change
Symbolic = symbolic change
Routine = change of a single routine, no change at the cluster level
Cluster = change at the cluster level, no change in programmed interfaces
Interfaces = change at the cluster level and change in programmed interfaces