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Relationships between change management, knowledge sharing, curriculum coherence and school impact in national curriculum reform: a longitudinal approach

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ABSTRACT
It has been suggested that the outcomes of curriculum reform depend on the implementation strategy and coherence making between the reform and school practice. This study examined how teachers perceived a national core curriculum reform implementation in terms of change management and knowledge sharing, and how these contributed to the perceived curriculum coherence and to school-level impact of the reform process over time. Survey data (N = 2447) were collected from teachers during the recent core curriculum reform in Finnish basic education. The longitudinal data were collected at three time points during the first three years of curriculum implementation. A cross-lagged path model was utilized to explore longitudinal relations between the variables. The results showed that knowledge sharing practices and perceived curriculum coherence had reciprocal effects over the first year. Moreover, both predicted the extent to which the reform process was considered to promote school impact in terms of meaningful development and teacher commitment, which facilitated higher levels of curriculum coherence and knowledge sharing later on. Change management did not seem to predict the other constructs – yet, knowledge sharing facilitated evaluations of successful change management. The results provide new insights on supporting meaningful school development in large-scale curriculum reform.

Introduction
The impact of a large-scale curriculum reform on school practice is highly dependent on the extent to which the school’s professional community engages in shared sensemaking (März & Kelchtermans, 2001; Spillane et al., 2002; Smith & O’Day, 1991). For instance, teachers’ involvement in shared sensemaking regarding curriculum reform has shown to influence the ways of transforming it into school practice (e.g. Coburn, 2001; Kondakci et al., 2017; März & Kelchtermans, 2013). However, research on the conditions that
support shared sensemaking about new curriculum, in terms of constructing coherent understandings of the reformed curriculum, and facilitating commitment to school development, is still scarce.

It has been proposed that intentional shared sensemaking in curriculum reform can be facilitated by combining effective change management, such as clarity in the distribution of tasks and information (i.e. top-down approach), and knowledge sharing in terms of participatory and collaborative development work (i.e. bottom-up approach) (e.g. Pietarinen et al., 2017). It was recently shown that these factors were related to the school impact of the curriculum reform, in terms of teachers’ commitment to continuous development work (Tikkanen et al., 2019). Moreover, constructing coherent understanding of the curriculum has shown to regulate the extent to which the reform is perceived to have an impact on the development of school practice (Sullanmaa et al., 2019a). Yet, little is known about how teachers’ experiences of change management and knowledge sharing within the school community connect to their perceptions of curriculum coherence and school impact over time during the reform work. Examining the dynamics between these constructs can provide new insights into supporting intentional and active sensemaking that promotes meaningful development by school communities in reform contexts. Overall, longitudinal research on the processes of school development is still rather scarce (e.g. Heck & Hallinger, 2014; Kyriakides et al., 2010), although it has been shown that a school’s capacity for development, including leadership and participatory decision-making practices, can develop over time (Thoonen et al., 2012).

This study contributes to the literature on large-scale reform by examining how change management, knowledge sharing, curriculum coherence and impact of the reform work on teacher commitment and meaningful development, are related to each other over time. Dynamics between these determinants were explored from the perspective of teachers, using a longitudinal design in the context of the most recent large-scale core curriculum reform in Finland. More precisely, it was explored whether 1) effective change management and 2) participatory knowledge sharing regarding the reform work in the school community, 3) perceived coherence of the national core curriculum and 4) evaluations of the reform having a positive impact in terms of meaningful and committing school development, were connected over a three-year follow-up. The study provides insights into how administrators and school leaders could better support intentional sensemaking by facilitating participatory knowledge sharing and to direct the development work at building coherence between the curriculum and school practice.

**Literature review**

**Top-down and bottom-up approaches to curriculum reform**

Change management and knowledge sharing together reflect the aimed balance between the top-down and bottom-up approaches that is crucial in the school-level development work (Pietarinen et al., 2017; Tikkanen et al., 2019). Prior research has identified two primary school reform implementation strategies; top-down and bottom-up (e.g. Darling-Hammond, 1998; Fullan, 2007; Petko et al., 2015). While top-down reform strategies have been shown to have potential to scale-up curriculum reform, they often tend to fail
to engage teachers in shared sensemaking (see Elmore, 1996; Fullan, 2007) and, as a result, may reduce the opportunities to promote the experience of coherence and sustained school development. On the other hand, although bottom-up strategies engage teachers in the shared sensemaking in terms of the reform work, they rarely result in large-scale change or provide equal opportunities for school improvement (e.g. Darling-Hammond et al., 2006; Elmore, 1996; Fullan, 2007; Smith & O’Day, 1991). It has been suggested that the combination of top-down and bottom-up approaches integrates the strengths of both. Change management implies clarifying the direction and effectively distributing tasks and resources (see Amels et al., 2020; Darling-Hammond, 1998; Petko et al., 2015; Smith & O’Day, 1991), while collective knowledge sharing (Pietarinen et al., 2017; Tikkanen et al., 2019) supports facilitating teachers’ involvement and shared sensemaking in the change effort (see Mason et al., 2005; Petko et al., 2015; Ramberg, 2014).

**Change management**

In this study, change management refers to clear leadership practices in orchestrating school-level curriculum reform work (Pietarinen et al., 2017; Tikkanen et al., 2019), emphasizing the participation and involvement of the school community. It includes clarity about responsibilities, clear division of work, broad participation and transparency in the provision of information (see Hallinger & Heck, 2011; Hannay & Earl, 2014; Harris, 2003; Heck & Hallinger, 2009; Leithwood et al., 2020). Change management in terms of clarifying a shared direction and supporting the distribution of resources is suggested to be a central means for supporting meaningful teacher learning (Darling-Hammond, 1998; Fullan, 2007; Petko et al., 2015; Smith & O’Day, 1991). Effective leadership for school improvement has been suggested to be distributed in the school community (Harris, 2003; Spillane et al., 2004; Leithwood et al., 2020). Teachers’ professional development and commitment to school development can be promoted through change management characterized by shared capacity building, free flow of information, and a supportive organizational culture for teacher initiative (Geijsel et al., 2003; Hallinger, 2003; Hannay & Earl, 2014; Heck & Hallinger, 2009; Lai & Cheung, 2015; Ramberg, 2014; Stoll & Kools, 2017). Thus, it is important that teachers’ experience the distribution of tasks and information to be clear and successful in the curriculum reform work. This is central in constructing an environment in which teachers can engage in shared sensemaking in terms of how to transform the curriculum reform into everyday school practices (see Amels et al., 2020; Day et al., 2010; Ganon-Shilon & Schechter, 2019; Geijsel et al., 2003; Hannay & Earl, 2014).

**Knowledge sharing**

Clear distribution of information and tasks through effective change management, however, is not a sufficient precondition to engage teachers in meaningful development work. Collective knowledge sharing (Pietarinen et al., 2017; Tikkanen et al., 2019) is crucial to support involvement in shared sensemaking, i.e. the bottom-up approach to reform work (see Fullan, 2007; Ganon-Shilon & Schechter, 2019; He & Ho, 2017; Mason et al., 2005; Petko et al., 2015; Ramberg, 2014). Knowledge sharing entails participatory
reform work based on distributed decision-making, open discussion and shared responsibility. Thus, intentional knowledge sharing supports collective sensemaking about the reform and its implications for school practice by drawing on the existing knowledge and experience of the school’s professional community (Coburn, 2001; Kondakci et al., 2017; März & Kelchtermans, 2013; Pietarinen et al., 2017; Tikkanen et al., 2019). Knowledge sharing also involves sharing responsibility through collective decision-making, which is suggested to be a determinant of teachers’ orientation toward change and the school’s capacity to improve (see Jimmieson et al., 2008; Lai & Cheung, 2015; Thoonen et al., 2012). Thus, to transform teachers’ professional beliefs and practice, participation in knowledge construction and sharing is crucial (Cheng et al., 2017; Geijsel et al., 2003; Hannay & Earl, 2014; Kondakci et al., 2017). For instance, research from the social network perspective has shown that social relationships among teachers in the school’s professional community are connected to teachers’ shared sensemaking, knowledge exchange and reform implementation (Coburn, 2005; Daly et al., 2010; Moolenaar, 2012). Although longitudinal research is scarce, prior research has suggested that the implementation of reform is influenced by the social structure in the school at the onset of the reform work (see Moolenaar, 2012), and the preexisting formal and informal relationships within the community (Siciliano et al., 2017). Accordingly, we presume that orchestrating reform work, in which all members of the community can engage in and bring forward their thoughts and ideas, will likely cultivate constructive social relationships within the professional community and result in a better fit between the reform and local needs of teachers and pupils over time. This, in turn, may potentially result in sustainable changes in classroom practices.

**Curriculum coherence**

In this study, perceived curriculum coherence is examined as the object of the teachers’ individual and collective sensemaking processes. Perceived curriculum coherence, including a holistic understanding of the meaning and function of the curriculum, can have a positive impact on pupils’ learning by promoting teachers’ professional development (Newmann et al., 2001). Curriculum coherence consists of three complementary elements (Sullanmaa et al., 2019a): **consistency of the intended direction, integrative approach to teaching and learning and alignment between objectives, content and assessment.** Firstly, the consistency of the intended direction establishes a clear long-term purpose toward which all of the curriculum’s elements are directed, by clarifying the goals and supporting the teaching of essential substance. Secondly, the integrative approach to teaching and learning promotes holistic and integrated learning experiences that connect to a larger whole by encouraging activating and engaging teaching. Thirdly, alignment between objectives, content and assessment creates connections between what is intended, taught and assessed, and promotes the continuity of learning across subjects and grades.

Constructing a coherent understanding of the curriculum occurs through continuous sensemaking that is influenced by the curriculum, the teachers’ practice and beliefs, and the context (Maitlis & Christianson, 2014; Spillane et al., 2002; Russell & Bray, 2013). The curriculum is not only interpreted or delivered, but re-constructed and developed in the local contexts (Priestley et al., 2021). There is evidence that
constructing a shared and holistic understanding of the purpose and meaning of educational reform is important for the impact of the reform (see Fullan, 2007; Lasky et al., 2005; Pietarinen et al., 2017). While perceived fragmentation and contradictions within the curriculum may compromise the teachers’ capacity to translate the reform into practice (Smith & O’Day, 1991; Van den Akker, 2003), it has been suggested that ambiguity and inconsistencies are possible triggers for questioning existing beliefs and practices (e.g. Allen, 2020; Gregoire, 2003). Coherent understanding of the curriculum can result from various processes, yet, sufficient coherence is needed in order to achieve alignment between the national curriculum framework and local school needs and resources.

**School impact as functional school development**

In this study, the school impact of curriculum reform has been explored in terms of the extent to which the reform work facilitates local commitment and functional school development. Thus, school impact is here considered to refer to teachers’ perceptions of the reform’s ability to solve challenges faced in schools, commit school communities to continuous development and direct the development work toward locally functional solutions (Pietarinen et al., 2017; Sullanmaa et al., 2019a). For instance, the ownership experienced by teachers over curriculum reform has been shown to increase when the reform is perceived to align with their needs, by enabling them to cope better with challenges faced in classroom practice (e.g. Coburn, 2003; März & Kelchtermans, 2013; Southerland et al., 2011). These positive outcomes of curriculum reform are assumed to require effective management, shared and coherent understandings about the goals of the reform, and active collaboration and learning in developing adaptable and functional pedagogical practices in schools (Datnow & Stringfield, 2000; Sleegers et al., 2014; Stoll & Kools, 2017).

**Relationships between the constructs**

In a previous cross-sectional study, change management was found to support knowledge sharing in the professional community (Tikkanen et al., 2019). In addition, we previously showed that local stakeholders’ knowledge sharing, and their perceptions of curriculum coherence were connected to their expectations of the potential impact of the reform on school-level development (Sullanmaa et al., 2019a; Tikkanen et al., 2019). The experienced opportunities to contribute to the reform work and the perceived coherence of the core curriculum were related to their beliefs of the reform having positive influence on school development work. Based on the findings we presume that teachers’ perceptions of curriculum coherence are transformed and constructed in shared sensemaking within the professional community. These, in turn, further relate to the perceived impact of the reform on school development over time (see Louis et al., 2005; Penuel et al., 2007; Priestley et al., 2014; Sullanmaa et al., 2019b; Yildirim & Kasapoglu, 2015). Hence, school impact, in terms of meaningful and functional school-level development, is likely to be promoted by change management, knowledge sharing and perceived curriculum coherence (see Allen & Penuel, 2015; Fullan, 1996; Newmann et al., 2001; Russell & Bray, 2013).
Conceptual framework

The conceptual framework draws on a situated cognitive perspective on school improvement in terms of teacher learning (see Greener et al., 1996; Putnam & Borko, 2000) and sensemaking theory (see Maitlis & Christianson, 2014; Spillane et al., 2002; Weick et al., 2005) in exploring the dynamics between teachers’ experiences of change management and knowledge sharing in the professional community, and their perceptions of the reformed curriculum’s coherence and impact of the reform work on commitment to school-level development. Sensemaking in the curriculum reform involves negotiating the meaning of the curriculum, its consequences and a plan for action in the school community (J. P. Spillane et al., 2002; Soini et al., 2021; Weick et al., 2005). It entails building shared understanding of school practice through reflecting on the curriculum and classroom practice together (McArdle & Coutts, 2010). The situative perspective implies that shared sensemaking in the professional community of the school, directed at transforming the curriculum reform into meaningful curriculum enactment and grounding it in the everyday school practice, is central to teachers’ professional development within the framework of the reform (Coburn, 2001; März & Kelchtermans, 2013; Spillane et al., 2002; Putnam & Borko, 2000; Soini et al., 2018; Weick et al., 2005). However, it is important to note that sensemaking as such does not always lead to school development that is in line with the aims, but can lead to a range of results including reinforcing existing practice or unintended changes (e.g. Gawlik, 2015; Ketelaar et al., 2012). Moreover, disruptive actions by individuals may interrupt and hinder the development process in the professional community. Yet, to construct sufficiently shared understandings of the aims and thus, to create locally functional practices, shared sensemaking is central (Soini et al., 2021). This requires opportunities for participation, hearing and considering different viewpoints and negotiating them in relation to the aims of the reform. Hence, in this study, change management and knowledge sharing are considered central means in everyday school practice that enable shared sensemaking directed at transforming the reform’s aims into meaningful local practices. In turn, meaningful sensemaking of the reform is assumed to be manifested in teachers’ perceptions of curriculum coherence and school impact of the reform.

Teacher learning in the reform context is understood to be distributed across the individual, collective, practice, tools and policy dimensions (Spillane et al., 2002; Putnam & Borko, 2000). Thus, teachers’ sensemaking is considered to occur in interaction between the individual, the social context of the professional community, experience in terms of classroom practice, and the object and instrument of the reform work – the reformed core curriculum. Teacher learning is considered as a social activity, meaning that teacher learning and sensemaking in the reform work occur in participatory interaction with colleagues, leaders and pupils (see Putnam & Borko, 2000; Siciliano et al., 2017; Weick et al., 2005). For instance, in the school’s professional community, intentionally triggered knowledge sharing in terms of teachers drawing upon each other’s expertise and discussing new knowledge can support gaining new insights into teaching and learning. In curriculum reforms teacher learning is also situational, depending on the situational factors and context, such as the phase of the reform work and other factors internal and external to the school (Putnam & Borko, 2000). For instance, schools’ improvement trajectories have shown to be dependent on the interaction between the school’s external context and internal factors such as collaborative leadership and instructional improvement capacity.
(Hallinger & Heck, 2011). Thus, this implies that the dynamics between change management, knowledge sharing, perceived curriculum coherence and school impact might differ over the phases of the curriculum development work in schools.

In this study, change management and participatory knowledge sharing in the professional community are considered to form distributed collective resources, reflecting the top-down and bottom-up approaches in the school-level reform work, that support shared sensemaking. Effective change management in terms of clarity of information and responsibilities, and intentional knowledge sharing and participation in the professional community are assumed to facilitate sensemaking as a social learning activity that is engaging, participatory and aims toward clear goals. Meaningful sensemaking, in turn, is assumed to be further reflected in perceived curriculum coherence, i.e. constructing a holistic interpretation of the reformed core curriculum through negotiating understandings and meanings collectively in the school community. Moreover, shared sensemaking is expected to promote experiences of the reform work’s impact on the school-level development work, through making meaning for the reform work, clarifying the effects of the curriculum at the school-level, and negotiating the school-level focus for the reform. Thus, we expect change management and knowledge sharing to support perceived curriculum coherence and school impact (see e.g. Geijsel et al., 2003; Hannay & Earl, 2014; Lai & Cheung, 2015; Pietarinen et al., 2017; Putnam & Borko, 2000; Ramberg, 2014; Tikkanen et al., 2019), as well as curriculum coherence to promote the school impact of the reform over time (Sullanmaa et al., 2019a; see also Newmann et al., 2001; Russell & Bray, 2013). Based on prior results, we also expect effective change management to support knowledge sharing in the professional community over time (Tikkanen et al., 2019; see also Amels et al., 2020; Hannay & Earl, 2014; Ramberg, 2014). Because of the situated and dynamic nature of the shared sensemaking process and the curriculum development work, we analyzed a cross-lagged path model with reciprocal relationships to explore curriculum reform implementation, and how the reform strategy contributed to the perceived curriculum coherence and to school-level impact of the reform process over the three-year follow-up period.

The 2014 core curriculum reform in Finland

The Finnish educational system, including curriculum reforms, relies on school and teacher autonomy. It emphasizes trust in local educational experts in developing the non-standardized, large-scale national curriculum reform into meaningful local practices (see Sahlberg, 2015; Vitikka et al., 2016). The reforms aim to foster commitment to continuous development (Mølstad, 2015; Vitikka et al., 2016). The public basic education system in Finland is also highly valued by parents. The national core curriculum is reformed approximately every ten years. Stakeholders from all levels of the educational system are involved in the core curriculum reform. The national core curriculum sets the general aims, principles and core content for schoolwork and acts as a framework for constructing local curricula (Finnish National Board of Education, 2014), which are constructed by education providers, usually municipalities. Finnish teachers have pedagogical autonomy in deciding on their teaching methods, and there are no school inspections. Education providers are responsible for the quality and evaluation of basic education (Kumpulainen & Lankinen, 2016). Accordingly, the municipalities, schools and teachers, have a relatively high level of autonomy in organizing education in Finland. Teachers in Finland hold a master’s degree and most
teachers are qualified (Paronen & Lappi, 2018). Typically, primary school teachers major in educational sciences, while lower secondary school teachers major in one or two teaching subjects and complete pedagogical minor studies. Principals in Finnish schools are qualified teachers and act as pedagogical leaders. The majority of principals regularly teach in their schools.

The most recent core curriculum reform began with the Finnish National Agency for Education developing the new national core curriculum document, which is based on the Basic Education Act and lesson hour distributions set by the government. The core curriculum was constructed in working groups in which administrators, researchers, representatives of associations, teacher educators, principals, teachers and other school staff were invited to participate. The aim of the renewed core curriculum is to promote active involvement of pupils, instruction with an integrative approach, versatile learning environments and assessment that supports learning (Finnish National Board of Education, 2014). Transversal competence areas to be developed across all subjects were also introduced. After the renewed core curriculum was published in 2014, the districts and municipalities started local curriculum development, generally involving working groups that included municipal administrators and school staff. The national implementation of the curriculum in schools started in fall 2016 in primary schools and continued in phases during 2017–2019 in lower-secondary schools.

The present study

This study explored the dynamics of large-scale curriculum reform by analyzing the interrelation between 1) change management, 2) knowledge sharing, 3) the coherence of the reformed core curriculum, and 4) the impact of the reform process on functional school development, from the perspective of teachers with a longitudinal design. Based on previous research the following hypotheses were examined:

H1. Teachers’ perceptions of effective change management (CM) increase knowledge sharing (KS) over time.

H2. Teachers’ perceptions of effective change management (CM) and participatory knowledge sharing (KS) in the school-level reform work will positively predict their experiences of curriculum coherence (CC) and school impact over time.

H3. Perceived curriculum coherence (CC) will increase teachers’ positive evaluations of the reform’s school impact (SCI) over time.

Method

Sample

The participants of the study consist of Finnish comprehensive school teachers from 75 case schools around Finland. The selection of the schools started with selecting six districts, representing variation in terms of geographical location (both urban/rural)
and the size of the network in which the most recent curriculum reform work was carried out (see also Soini et al., 2018). Next, a SES index was calculated for each school based on six different socio-economic indicators of the school neighborhood. After this, schools in both the upper and lower quartiles of the SES index were included in the final sample of schools. These schools were invited to participate in the study, and a total of 75 schools participated at the first time point. The case schools thus vary in terms of socio-economic status of the school neighborhood, urban or rural setting, and size (3 to 100 teachers). The focus of this study was on the teacher’s perspective in terms of the large-scale national core curriculum reform implementation, and hence, the principals, vice and assistant principals that participated in the national survey were excluded from the data set for this study.

The final longitudinal sample consisted of 2447 comprehensive school teachers from 75 case schools around Finland. Some of the teachers had identifiable responses at only one or two time points, while 532 teachers responded at all three time points. The descriptive sample statistics in terms of the type of school, gender and teaching experience are reported in Table 1. The distributions of gender and working experience were similar over the three time points. The observed gender distribution (see Table 1) was compared with the expected distribution of Finnish teachers (77% female, 23% male; Paronen & Lappi, 2018) using a Chi-square test, which showed that the observed gender distribution did not significantly differ from the expected gender distribution (T1: \(x^2 = .304, df = 1, p > .05\); T2: \(x^2 = .246, df = 1, p > .05\); T3: \(x^2 = .005, df = 1, p > .05\)).

### Data collection and instruments

The data were collected annually at three time points during the fall school terms (T1 (2016): \(N = 1390\); T2 (2017) \(N = 1425\); T3 (2018) \(N = 1367\)). Members of the research team collected the data from teachers in the case schools at school staff meetings using paper surveys. All teachers in the case schools were invited to respond. The response rates, calculated out of all teachers in the case schools, were 80 per cent at T1, 79 per cent at T2, and 77 per cent at T3.

The study was conducted following the guidelines for responsible conduct of research and the ethical principles of research with human participants by the Finnish Advisory Board on Research Integrity (2012, 2019). Participation in the study was based on informed consent and ethical review was not required (Finnish Advisory Board on Research Integrity, 2019).

<table>
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<th>Table 1. Descriptive sample statistics at each time point.</th>
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<td>School type</td>
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<td>Primary (grades 1–6)</td>
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The Curriculum Reform Inventory, developed by Pietarinen et al. (2017) for the research project, included scales for measuring the change management and knowledge sharing practices in school-level reform work, curriculum coherence within the reformed core curriculum document, and school impact of the reform process.

The change management and knowledge sharing scales have been designed by Pietarinen et al. (2017) as part of the top-down-bottom-up strategy scale. The change management scale (CM, three items, $\alpha_{T1-T3}^{CM} = .80–.81$) measures effective and clear management in the reform work, including successful dissemination of information and clear distribution of work (e.g. ‘Management has been a success’; ‘A clear division of work has been performed’). The knowledge sharing scale (KS, ten items, $\alpha_{T1-T3}^{KS} = .90–.91$) measures distributed, social resources in the reform work, characterized by inclusively engaging stakeholders in reform work by facilitating their participation, utilizing their competence and expertise widely, and supporting open discussion and decision making (e.g. ‘The competence of various actors has been utilized in an optimal manner’; ‘Construction of an interactive atmosphere has been successful’) (Pietarinen et al., 2017). The shorter version of the knowledge sharing scale (Tikkanen et al., 2019) was utilized in this study.

The curriculum coherence scale (CC, 17 items, $\alpha_{T1-T3}^{CC} = .92–.94$) measures teachers’ perceptions of the coherence of the core curriculum (i.e. a second-order factor model; Sullanmaa et al., 2019a). It includes 1) the consistency of the intended direction, such as perceiving the core curriculum to clarify the role and mission of schools and teachers (e.g. ‘Successfully sums up the most important goals for the operation of the school’); 2) an integrative approach to teaching and learning, characterized by developing the core practices of schools toward harmonized, active and engaging teaching (e.g. ‘Supports the harmonization of teaching’); and 3) alignment between objectives, content and assessment within the curriculum (e.g. ‘The goals are in line with the assessment criteria’). The mean score of the three elements was utilized to measure perceived curriculum coherence in the final cross-lagged model.

The school impact scale utilized in this study was the shorter version (reported by Sullanmaa et al., 2019a; Tikkanen et al., 2019) of the original scale (Pietarinen et al., 2017). It consists of one factor (SCI, six items, $\alpha_{T1-T3}^{SCI} = .90–.91$), measuring the reform work’s impact on meaningful school development. The school impact scale measures the reform work’s influence on committing teachers to active development work and directing the development toward locally functional solutions and meaningful development (e.g. ‘Directs development work to resolve problems observed in the daily life of the school’). All scales were rated on a 7-point Likert scale ranging from 1 (fully disagree) to 7 (fully agree).

As preliminary analyses, the measurement models of knowledge sharing, change management, curriculum coherence and school impact were examined with confirmatory factor analysis utilizing the MLR estimator to ensure that the models fit the data at each measurement point (see Appendix A). Two residual covariances were freed within the knowledge sharing scale and one within the school impact and curriculum coherence scales. Moreover, measurement invariance of the latent constructs over time was tested for these constructs separately. The configural model, metric invariance model and scalar invariance model were tested and a change over −.01 in CFI or a change over .010 in RMSEA were used as cutoff values showing decreased fit that would reject the more constrained model (see Chen, 2007; Cheung & Rensvold, 2002). Scalar invariance was
supported for each scale. Thus, the scales functioned well in measuring the same constructs over time. For the further cross-lagged path analysis, observed mean scores were calculated for each construct at each time point (see Table 2).

**Analysis**

The cross-lagged path model (Selig & Little, 2012) was analyzed using Mplus version 7.4 (Muthén and Muthén, 1998–2017). Due to the clustered data of teachers within schools, the intraclass correlation coefficients (ICC) were calculated to estimate the school-level variance in the examined variables (see Table 2). As the school-level variance was considerable in some scales, an approach for computing standard errors and a chi-square test that considered the non-independence of observations was utilized in Mplus (Type complex). The analyses were conducted using the Full Information Maximum Likelihood method (FIML), thus utilizing all available data without deletion of cases or imputation of data (Schafer & Graham, 2002).

The cross-lagged path model was utilized as an exploratory method to examine the directions of the relations between the variables over time. The focus of the cross-lagged path model is on the relations between the variables over time (Selig & Little, 2012). Auto-regressive effects were included to consider the baseline levels for each construct (Selig & Little, 2012). Based on prior research, cross-sectional associations were expected (Pietarinen et al., 2017; Sullanmaa et al., 2019a; Tikkanen et al., 2019) and thus, the independent variables at T1, and the residuals at T2 and T3, were allowed to correlate. Relations over time were first added between all variables and non-significant paths were deleted one by one. The model fit was evaluated with the following criteria for the goodness-of-fit indices: root mean squared error of approximation (RMSEA) below 0.07, comparative fit index (CFI) and Tucker–Lewis index (TLI) above 0.90, and standardized root mean square residual (SRMR) below 0.08 (Byrne, 2012; Hooper et al., 2008). The final model (with all non-significant paths

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KS = knowledge sharing; CM = change management; CC = curriculum coherence; SCI = school impact; ICC = intra-class correlation. All correlations are significant at p < 0.01. Mean differences between consecutive time points were tested for each scale. Means with the same superscript did not differ significantly (p > .05).
deleted one by one) was compared to the full model (with all paths) using the Satorra-Bentler scaled chi-square difference test for nested models, in which significance indicates a worsening of fit due to the restrictions (Satorra & Bentler, 2010).

**Results**

Table 2 presents the correlations between the scales and descriptive statistics and intraclass correlations for each scale at each time point. The mean scores of the constructs were close to the scale midpoint and seemed to have a slight decreasing trend over time. The correlations between the scales were significant and positive as expected. The strongest correlations occurred mostly within scale between time points, and between scales within each time point. The intraclass correlations showed that change management varied most between schools (9–13%), whereas school impact (5–6%) and curriculum coherence (5–8%) varied less between schools. The variance between schools in knowledge sharing had a broader range (6–12%) over the three measurements, the largest (12%) being at the first measurement when schools had just started to implement the curriculum.

The final cross-lagged path model (Figure 1) fit the data well ($\chi^2 [25, N = 2447] = 23.58, p = .54; CFI = 1.00; TLI = 1.00; RMSEA [90% CI] = .00 [.000–.015], SRMR = .018$). The fit of the final model was not worse from the fit of the full model including all cross-lagged paths ($\Delta \chi^2 = 10.38, \Delta df = 13, p = .66$) according to the Satorra-Bentler scaled chi-square

![Figure 1. The estimated cross-lagged path model of the relationships between knowledge sharing (KS), change management (CM), curriculum coherence (CC) and school impact (SCI) over three measurements (T1-T3). Correlations between the variables within time points are not depicted in the figure. The standardized estimates shown are statistically significant at the $p < .001$ level unless indicated otherwise. **$p < .01$, *$p < .05$.](image-url)
difference test. The autoregressive effects that represent the stability of the constructs over time were moderate to strong as expected. The perceived curriculum coherence at the beginning of the curriculum implementation especially strongly predicted the perceived coherence over the next year. Thus, it seems that the teachers’ perceptions of curriculum coherence did not alter much after the implementation of the new curriculum had been started. In addition, the autoregressive effects of knowledge sharing were rather strong between subsequent time points – implying that knowledge sharing was somewhat consistent in teachers’ perceptions of the participative curriculum making. In turn, school impact had slightly smaller autoregressive effects over time, meaning that there was more variance over the time points in how teachers experienced the effect of the reform on commitment and meaningful school development. Within each time point there were positive and statistically significant correlations between all constructs at T1 (.48–.76) and between the residuals at T2 (.36–.74) and T3 (.37–.71).

The results showed that the knowledge sharing experienced, in terms of inclusive participation in the curriculum development work, predicted effective change management, i.e. a clear division of work and dissemination of information, experienced by teachers at the subsequent time points. However, change management did not predict higher levels of knowledge sharing over time. Thus, the results did not support H1, which suggested that change management would predict knowledge sharing over time.

H2 assumed knowledge sharing and change management to support perceived curriculum coherence and school impact over time. This was partly confirmed in terms of knowledge sharing, which experienced at the beginning of implementation had positive relationship with school impact and perceived curriculum coherence at T2. The knowledge sharing experienced predicted the extent to which teachers considered the reform process to have an impact on schools, in terms of directing the development work toward functional solutions and maintaining active school development and commitment. Moreover, knowledge sharing at T1 had a small but significant effect on how coherent teachers perceived the curriculum to be at T2, but this effect was not evident later as the curriculum realization continued for its second year. The cross-lagged path model did not fully support H2, which also assumed that change management would be related to the perceived curriculum coherence and school impact at the subsequent time points. However, the correlations between knowledge sharing and change management were strong within each time point (.71–.77) and hence, these two determinants of the school-level reform work function closely together within time points.

The results did support H3, which suggested that curriculum coherence predicts teachers’ positive experiences about the reform’s school impact over time. Thus, the higher the curriculum coherence was perceived to be at earlier time points, the more powerful the reform’s impact was estimated to be at subsequent time points in terms of meaningful school development. Unexpectedly, the perceived curriculum coherence at the beginning of curriculum implementation also predicted higher experiences of change management and knowledge sharing at T2. However, these effects were non-significant between the second and third measurements. Moreover, the results unexpectedly showed that the school impact experienced at T2 predicted perceptions of curriculum coherence
and knowledge sharing at T3, although the effects were quite small. Overall, the \( R^2 \) statistics show that the autoregressive and cross-lagged effects accounted for 40–54 per cent of the variance in the dependent variables at T2 and 44–61 per cent at T3.

**Limitations**

There are limitations to this study regarding the research design and methods that need to be taken into account in interpreting the results. The study was conducted in the context of the Finnish core curriculum reform process. Thus, generalization of the results to other contexts should be carefully considered, and further studies on the relationships between change management, knowledge sharing, curriculum coherence and impact of the reform are needed in other national contexts. The longitudinal design can be considered to be a major strength of the study. The cross-lagged effects provide tentative information on the relationships between the variables over time, yet causal inferences should not be made based on the cross-lagged path model (Selig & Little, 2012). For instance, potential confounding variables were not included and thus, other variables might explain either the beginning levels of these variables or their changes over time. Moreover, it is important to note that the results may be specific to the one-year time-intervals used in the study. Thus, further research is needed in order to explore whether these relationships vary in shorter and longer time-intervals.

The longitudinal data used in this study were collected over a three-year period starting from 2016, which represented the transition into the new core curriculum. Yet, the period did not cover preparations into the transition and prior development work, which might have influenced the baselines of the measured constructs. However, the study provides tentative results on the longitudinal relationships between the constructs during the early stages of curriculum implementation. In order to explore the long-term effects of the reform on school development processes, longer follow-up is needed since educational reforms need several years to become institutionalized (Fullan, 2007).

This study relied on self-reported data from teachers and explored the reform’s impact in terms of support for functional and continuous development work from the perspective of teachers. Due to the self-report data, common method variance (Podsakoff et al., 2003) might have influenced the relations between the variables measured by the same survey and the same scale format. On the other hand, the self-report surveys provided information on teachers’ perceptions on a large scale in the longitudinal design. However, it would be important to also examine the relations between school-level conditions and teachers’ perceptions by combining different instruments and methods, as well as by exploring the dynamics of these variables in more depth, for instance, utilizing qualitative methods. Moreover, this study focused on the curriculum making from the teachers’ perspective and does not reveal school-level trajectories. This calls for longitudinal multi-level studies that would focus on identifying the stability or change of the school-level conditions, curriculum coherence and school impact that are collectively experienced by the professional community. Moreover, to understand the dynamics of school-level reform work more fully, especially in terms of change management, further studies exploring the viewpoint of school leaders and principals are needed. Further studies with different measures are also needed in order to explore the actual changes in classroom practices and pupil achievement.
The reliability of the scales was supported in this study by confirmatory factor analyses (see also Pietarinen et al., 2017; Sullanmaa et al., 2019a; Tikkanen et al., 2019). The scalar measurement invariance for the factor structures was also supported over the three measurements. Moreover, the sample schools varied in terms of size, location and socioeconomic status of the school neighborhood. The response rates out of all teachers in the case schools were high and thus, the sample can be considered representative of the case schools. However, due to the sampling method of including all teachers in the case schools at the time of data collection, there were also teachers that left or entered schools, and unidentifiable responses.

**Discussion**

This study explored the dynamics of curriculum reform by analyzing how teachers’ experiences of school-level reform strategy, in terms of change management and knowledge sharing, interacted with perceived curriculum coherence and school impact during a three-year longitudinal follow-up in the context of the national core curriculum reform. It was expected that knowledge sharing and change management would facilitate meaningful sensemaking regarding the reform and thus support coherence making in terms of constructing a coherent understanding of the curriculum, and facilitate perceptions of positive impact on commitment to school development (Sullanmaa et al., 2019a; Tikkanen et al., 2019).

The results showed that the relationship between knowledge sharing and perceived curriculum coherence was reciprocal over the first year of realization of the new curriculum in schools. This suggests that in this early phase the coherence experienced was constructed through teachers’ engagement in collective knowledge construction as a social learning activity (see Allen & Penuel, 2015; Spillane et al., 2002; Putnam & Borko, 2000), which in turn was further facilitated by a clear and aligned understanding of the curriculum, i.e. the object of the development work. Accordingly, as expected, intentional knowledge construction, opportunities for participation and being heard, and shared negotiations supports coherence making regarding the reformed curriculum through facilitating meaningful collective sensemaking (see März & Kelchtermans, 2013; Spillane et al., 2002). Yet, at the same time, coherent understanding of the curriculum further enabled teachers’ participation in collective knowledge construction within the professional community. This might imply that coherent understandings of the reformed curriculum act as a shared tool for teachers, which is essential in the early phase of implementation for their further collaboration on the development of practice (see Spillane et al., 2002). In other words, coherent understanding of the curriculum at the local level may function as a common framework for the construction of locally shared visions and goals. Moreover, prior research has suggested that teachers with coherent perceptions of the reform might be more likely active in discussing implementation with colleagues and asking for help (Siciliano et al., 2017).

However, the relationship between curriculum coherence and knowledge sharing over time was not significant as the curriculum realization continued over the second year. This implies that supporting shared sensemaking both by constructing coherent understanding of the renewed curriculum and intentional knowledge sharing are especially crucial in the early phase of the curriculum realization in schools. Prior research has also
suggested that the social structure of the school at the onset of reform influences the implementation process (Moolenaar, 2012) and it has been suggested that teachers’ collaborative efforts are affected by prior professional relationships (see Coburn & Russell, 2008; Siciliano et al., 2017). Hence, an open and supportive school culture should be facilitated continuously to develop constructive social structures for knowledge sharing and coherence making. As the results also showed that knowledge sharing and curriculum coherence were quite consistent over time, these constructs might reflect practices or understandings that are not easy to change, but interact positively when achieved in an early phase.

Moreover, the results showed that the perceived coherence of the core curriculum and knowledge sharing in the professional community predicted the reform’s school impact over the early stages of curriculum enactment, and the effects remained through the three-year follow-up. Curriculum coherence had an effect on school impact over time, in terms of facilitating teachers’ commitment to the development work and supporting the finding of locally functional solutions in schools. In addition, knowledge sharing had a slightly smaller effect on the school impact. These results extend the findings of the cross-sectional studies (Sullanmaa et al., 2019a; Tikkanen et al., 2019). The results indicate that coherence (see Fullan, 2007; Newmann et al., 2001; Russell & Bray, 2013; Van den Akker, 2003) and knowledge sharing (see Cheng et al., 2017; Kondakci et al., 2017) do play a central role in the construction of large-scale curriculum reform’s meaningful school impact.

The findings are also in line with the literature on teachers’ social networks, which has suggested that shared sensemaking, collective learning and feasible adaptation of the reform can be enabled by continuous knowledge exchange in the professional community (Coburn, 2005; Daly et al., 2010; Moolenaar, 2012). Yet, it is important to note that strongly shared views can sometimes also work in opposition to the reform goals (see Coburn, 2001), for example, by buffering new initiatives. Moreover, incoherence or ambiguity can also function as a trigger for developing new understanding (see e.g. Allen, 2020; Gregoire, 2003). Thus, a balance between exchanging knowledge and welcoming different views while building sufficient coherence in the curriculum development is needed to achieve positive impact for the reform. While this study implies that curriculum coherence and knowledge sharing facilitate positive beliefs about the reform’s impact on schools, further qualitative research is needed for a deeper investigation of the processes through which coherence and knowledge sharing practices are first achieved, and the ways in which they interact with the network structures of the teacher communities during the curriculum development.

An unexpected finding was that the school impact experienced after the first year of curriculum realization at schools further increased the perceptions of curriculum coherence and knowledge sharing, implying a positive connection further on in the continuous development work. Hence, knowledge sharing and perceived curriculum coherence in the early phase of the development work seem to be crucial in facilitating meaningful school development in terms of directing the development work toward locally functional and sustainable applications – connecting the reform work to teachers’ experience in practice (Putnam & Borko, 2000). This, in turn, supports even higher levels of knowledge sharing and more coherent understandings of the curriculum later, when the reform proceeds toward institutionalization in schools (see Fullan, 2007). As
knowledge sharing and curriculum coherence were also interdependent during the early phase of implementation, the results imply that a successful combination of knowledge sharing and coherence making in the school’s professional community during the early phase of the development work could lead to a mutually reinforcing positive cycle that facilitates commitment to meaningful school development and further collaboration by the teachers.

The results unexpectedly showed that change management, in terms of clear information sharing and distribution of work, did not seem to function as a predictor of knowledge sharing when the cross-sectional relations were considered. In turn, the results showed that knowledge sharing contributed to the success of the change management experienced over time. This implies that a participatory and open professional community that utilizes an individual’s competence broadly and promotes open discussion would provide a precondition for successful change management from the teachers’ perspective in terms of the effective dissemination of information and clear division of work. This finding can be considered to be in line with school improvement research suggesting that building capacity for school development is a collective process, where change management has a reciprocal role with the collective capacity (see Hallinger & Heck, 2011).

Curriculum coherence at the beginning of implementation also predicted successful change management after the first year of realization of the curriculum in schools. Accordingly, teachers were more likely to evaluate the change management as successful when they felt that they have been involved in knowledge construction and when their experience was that the curriculum formed a coherent framework. This suggests that a coherent and shared understanding of the object of the development work can provide a foundation for the successful change management, involving clarity of information and tasks. Thus, the more coherent the understanding of the new curriculum developed by teachers in the early stages of implementation, the easier it is for the school community to disseminate information and share work later on during the development work. However, this effect was not found between the second and third measurements. Moreover, the school-level variance of change management was higher than the school-level variance of the other constructs, suggesting that the nature of change management might differ more strongly between schools.

Change management, in terms of clear information sharing and distribution of work, did not seem to function as a predictor of curriculum coherence nor school impact. It can be considered that situational factors, in terms of the phase of the development work and the school settings, might have moderated the effects of the change management over time. Moreover, within the time points, change management in terms of distributing tasks and information in an efficient way was strongly connected with knowledge sharing in the development work. Especially in the Finnish context, where teachers have relatively high pedagogical autonomy, close interaction between these determinants is important. Dissemination of tasks and information is closely related to distributed capacity in intentional knowledge sharing. The intertwined nature of these constructs might have affected the lack of effect of change management over time. Moreover, as the reform process proceeded, intentional knowledge sharing promoted views of effective change management over time. As the development work proceeds, the leadership and capacity for improvement may become more broadly distributed in the school community (see Day et al., 2010; Hallinger & Heck, 2011).
Overall, successful change management seemed to act as an outcome in this process model. Although earlier research on change leadership has suggested that effective management is a direct or indirect determinant of school development (see e.g. Hallinger & Heck, 1998; Leithwood et al., 2004), recent research on school leadership has also found that collaborative leadership interacts reciprocally with other changes in the organizational processes (Heck & Hallinger, 2010). Thus, it could be considered that the results support the reciprocal view, in that change management can also be supported by knowledge sharing and facilitated by shared, coherent views of the curriculum. It is also important to note that although the change management scale reflects effectiveness in terms of distribution of tasks and information, specific leadership types were not examined in this study. Thus, more research is needed in order to explore which types of leadership would best support shared sensemaking. The results imply that change management was not a significant predictor of knowledge sharing, teachers’ experienced coherence, or perceived impact of the reform, thus highlighting the importance of distributed reform work in the professional community in terms of sharing knowledge and responsibilities, and coherence making regarding the curriculum as an instrument of development.

This study contributes to the research on the dynamics of curriculum reform by exploring how teachers’ perceptions of the top-down-bottom-up strategy in school-level reform work, core curriculum coherence, and the impact of the reform interacted during the first three years of curriculum implementation. The fact that the Finnish curriculum reform process aims to engage stakeholders from all levels of the system in the curriculum development work might be reflected in the results regarding the strong relations between sharing knowledge and building coherence (see Soini et al., 2021). Moreover, Finnish teachers have strong pedagogical autonomy, are highly educated (master’s degree) and are used to participating in the decision-making regarding their own work, school development and curriculum. Thus, they might have had a strong interest, curriculum competence and the skills necessary to participate in shared sensemaking, which might be reflected in the central role of knowledge sharing.

Although situated in the specific context of the recent Finnish national core curriculum reform, the results provided new insights on how to facilitate meaningful school development in large-scale curriculum reform. A shared and coherent understanding of the change requires intentional sensemaking in the reform process. The results imply that investing in enhancing knowledge sharing by promoting open dialogue, utilizing teachers’ expertise and experience, welcoming different opinions, facilitating discussions, and making decisions based on collective negotiations, can support meaningful school development. In addition, promoting curriculum coherence in terms of making sense of the intended direction, establishing an integrative approach to teaching and learning, and building alignment between objectives, content and assessment, especially in the early phase of curriculum realization in schools, can contribute to school impact in terms of committing teachers and directing the development work toward meaningful local solutions. Hence, efforts to increase knowledge sharing and curriculum coherence in intentional sensemaking in the early phase of large-scale curriculum reform can facilitate the kind of school development that enables the schools’ professional communities to identify their core mission and fit the reform to resolving problems faced at schools.

The study has implications for school leaders and administrators who have a central role in guiding teachers and schools engaged in curriculum reforms. The results imply that in school-level reform work, it is important to construct an open
and participatory working environment that supports knowledge sharing and broad collaboration in the school community. Participatory knowledge sharing has potential to support teachers’ experience of the clarity of tasks and information in terms of change management, coherent understanding of the object of reform work and commitment to the school-level development of practice. Moreover, it is useful to direct the shared sensemaking process toward issues that are relevant to the elements of curriculum coherence. Coherence making could include negotiating the long-term effects of the curriculum collectively and constructing connections and continuity within the curriculum. This supports shared understanding of the curriculum as the basis for collective learning, broad participation and knowledge sharing, and promotes utilizing the curriculum as a tool to work on school-level challenges and transforming the reform into meaningful school practice.

Disclosure statement

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## Appendix A. Fit indices and Cronbach’s Alphas of each scale at each time point

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<th>Scale</th>
<th>$\chi^2$</th>
<th>df</th>
<th>p</th>
<th>CFI</th>
<th>TLI</th>
<th>RMSEA [90%CI]</th>
<th>SRMR</th>
<th>$\alpha$</th>
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<td>.93</td>
<td>.065 [.060–.071]</td>
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<td>&lt;.001</td>
<td>.95</td>
<td>.94</td>
<td>.053 [.049–.058]</td>
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<td>.90</td>
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<td>&lt;.001</td>
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<td>.92</td>
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<td>&lt;.001</td>
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<td>.061 [.056–.065]</td>
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<td>.97</td>
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<td>.085 [.070–.101]</td>
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<td>.92</td>
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<td>.93</td>
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<td>.97</td>
<td>.94</td>
<td>.093 [.077–.110]</td>
<td>.03</td>
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</table>

*Due to the just-identification of the three-item change management factor, the change management and knowledge sharing scales were examined together in the CFA.*

*bItem Ali32 of the Curriculum coherence scale was missing at T1 due to technical reasons.*