Team Innovativeness in Nordic Schools: Do Distributed, Instructional Leadership and Teacher Professional Collaboration Matter?

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Masters of Assessment, Measurement and Evaluation

120 credits

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May 13, 2022

Popular abstract

Team innovativeness is defined as the openness to change as a collective characteristic of a team or a school climate. Team innovativeness has been studied from different perspectives and has recently received attention in educational settings, as it facilitates school improvement. It is therefore crucial to identify what promotes team innovativeness. School research indicates that principal leadership and teacher collaboration may be crucial factors in enhancing an innovative school climate. Yet, there is not much empirical evidence available to date. Therefore, this study aims to examine how distributed leadership, instructional leadership, professional collaboration, and team innovativeness are related. Large-scale data from the Nordic countries were utilized to investigate the relations. In light of these findings, implications for policy to enhance team innovativeness in schools are made clear.

Abstract

Team innovativeness in educational settings has recently received attention. Studies have shown that innovativeness facilitates school change by fostering the adoption of new educational ideas. It is therefore crucial to investigate the determinant factors that can promote an innovative school climate. We examined the relationship between team innovativeness and its determinants, namely principal leadership (i.e., distributed leadership and instructional leadership) and teacher professional collaboration, including contextual effects, at both the individual teacher and school levels. The TALIS 2018 data set, which comprises four Nordic countries (Denmark, Finland, Norway, Sweden) was investigated, using multilevel structural equation modeling. In particular, the mediating role of professional collaboration in the relationship between school leadership (i.e., distributed leadership, instructional leadership) and team innovativeness is examined. Results show that at the teacher level, the relations between distributed leadership, professional collaboration, and team innovativeness are positive. Further, professional collaboration mediates the effect of distributed leadership on team innovativeness at the teacher level. However, at the school level, the data did not fully support our hypotheses, and instead suggested greater variation between the Nordic countries exists at the school level than at the teacher level. Instructional leadership is not significantly associated with professional collaboration and team innovativeness. Contextual effects were found for Finland and Sweden, which showed variation between the nations. Overall, our study suggests implications for educational policy in the Nordic context that facilitates school innovativeness.

Keywords: Team innovativeness, Distributed leadership, Instructional leadership, Professional collaboration, Multilevel structural equation modeling, Nordic countries

Acknowledgement

This thesis would not have been possible today without the support of countless people, most importantly, my supervisors, Sigrid Blömeke, Ronny Scherer, and Trude Nilsen. None of this could have happened without their incredibly dedicated efforts and involvement in every step of the project. Sigrid Blömeke read my numerous revisions and offered insightful advice with her careful eye and knowledge. Her encouraging words and thoughtful feedback have been very important to me. Ronny Scherer provided me help with statistical techniques whenever I reached out to him. He always provided me with more than I asked for or needed. Trude Nilsen showed genuine interest in my research and offered invaluable comments to dispel any doubts I had. She gave me great motivation to keep going. Thank you all for being patient with me. I am proud of, and grateful for, my time working with all of you!

To the faculty members of CEMO, thank you so much for what you have taught me throughout this academic journey. You have all at some point offered me words of advice and strength to pushing forward. You deserve all the praise. Special thanks to Siri for always being there whenever I needed any administrative help.

Heartfelt thanks to my old friends for pushing me out of my comfort zone to reach this point in my life. Not least, a huge thank you to my fellow peers! I had great pleasure in working with you. Special thanks to my friends for being the best distraction whenever I needed it.

My family has always been my rock. I am forever grateful to have you by my side!

Innhold

Supplementary Material (Appendix C)

Team Innovativeness in Nordic Schools: Do Principal Distributed, Instructional Leadership and Teacher Professional Collaboration Matter?

Innovativeness has been studied from different perspectives in different fields where changes occur. In today's fast-paced society, organizations need to be open to change and innovation. Thus, innovativeness, defined as a willingness to change, is an important characteristic of successful organizations and a significant predictor of organizational performance (Damanpour, 1991; Deshpandé et al., 1993; Hult et al., 2004; Keskin, 2006). In the educational context, innovativeness is particularly essential, as it facilitates school improvements and changes by fostering the adoption of new ideas (Eyal & Inbar, 2003; Eyal & Kark, 2004). The concept of team innovativeness can thus be understood as the school's capacity to develop and adopt new ideas.

Team innovativeness in educational settings has not yet been given much attention. A review of the available literature reveals that important research gaps exist. First, to what extent school leadership supports an innovative school climate is largely an open question. Distributed leadership is supportive of an innovative school climate as addressed in the existing literature (Nguyen et al., 2021; Nilsen et al., 2021). However, with respect to instructional leadership, the findings about its relations to team innovativeness to date have been unexplored. Second, not much is written about the mechanism that links an innovative school climate to school leadership and professional collaboration between teachers. The associations between team innovativeness, school leadership, and professional collaboration were separately examined in previous research, which suggests that professional collaboration facilitated by school leadership could

promote an innovative school climate (Amels et al., 2020; Kilinc et al., 2020; Nguyen et al., 2021). Third, whether these results could be generalized to Nordic countries is an open question. To the best of our knowledge, no prior research has yet provided an overview of the Nordic model with respect to an innovative school climate. One study, which was conducted in Norway, reported positive associations between distributed leadership and team innovativeness (Nilsen et al., 2021).

The present study addresses the relationships between instructional and distributed leadership, professional collaboration, and team innovativeness in the four Nordic countries, Denmark, Finland, Norway, and Sweden, based on the Teaching and Learning Institutional Survey (TALIS) 2018 data set. The results of this research could contribute to providing an explicit answer regarding the empirical link between team innovativeness and its determinants. It could also contribute to a deeper understanding of team innovativeness in Nordic schools by examining similarities and differences across countries.

Conceptual Framework

Team Innovativeness

The term "team innovativeness" has been widely used in business research to describe an organizational culture that is open for change, group-level innovativeness, and an innovative organizational climate (Patterson et al., 2005). These definitions reflect a group's capability to adopt change by encouraging and supporting new ideas. In such a work environment, employees feel safe to take risks and implement new ideas. Likewise, this conceptual definition of team innovativeness can be transferred to schools. The term "team innovativeness" in the school context can be understood as referring to a school culture where

teachers are open to change and willing to take risks. However, until recently, little attention has been paid to team innovativeness as a precondition for innovation and school improvement in educational settings.

In the literature, "innovativeness" and "innovation" are often used interchangeably. Innovation, as a behavioral construct, can be seen as an outcome of teachers' and schools' willingness to change their educational processes. It refers to teachers' ability to generate new ideas or their efforts in developing an existing idea with added value (Vieluf et al., 2012). Innovativeness at an individual level refers to attitudes towards innovation and thus, innovativeness can be viewed as a precondition of innovative behavior. Innovation also has an organizational component that reflects the perceptions of team innovativeness that are shared by the teachers of the school (Anderson & West, 1998). Innovativeness as a precursor to innovation should therefore be viewed as the strategic orientation of an organization (Lynch et al., 2010; McGeown, 1979).

To date, innovativeness has been conceptualized from different perspectives in the extant literature (Blömeke et al., 2021; Nilsen et al., 2021; OECD, 2018). 1) a teacher's general orientation towards innovation, understood as an individual attitude related to personality traits (Hurt et al., 1977); 2) an individual teacher's perception of an innovative climate at their school, conceptualized as a psychological climate of an organization at the individual level of analysis (Anderson & West, 1998); 3) teachers' shared perceptions of a group's innovativeness, understood as a characteristic of the organizational climate measured at the individual level but aggregated at the organizational level of analysis. TALIS 2018 reports that team innovativeness measured by TALIS reflects a collective characteristic rather

than an individual one by combining psychological and organizational climate characteristics of school innovativeness (OECD, 2018).

In our study, team innovativeness is therefore operationally defined as a team's or school's openness to change as a collective characteristic of school climate measured at the teacher-level (i.e., psychological climate) and then aggregated at the school-level (i.e., organizational climate). Teachers working at the same school are more likely to develop shared perceptions of openness to change than teachers who do not engage in interactions at the same school (Anderson & West, 1998). Such shared perceptions of a group's innovativeness reflect an organizational component rather than individual attitudes.

To date, team innovativeness has attracted little academic attention. Thus, the main purpose of our study was to examine team innovativeness with respect to its determinants in Nordic schools.

Professional Collaboration

The term, "professional collaboration", has often been used with loosely defined concepts, including professional learning communities, collegiality, teacher collaboration, and teacher teams in educational research (Vangrieken et al., 2015). In this study, professional collaboration refers to deeper forms of collaboration between teachers for instructional purposes based on the conceptualization by TALIS (OECD, 2020a). TALIS distinguishes two different forms of teachers' collaborative activities based on the nature of interaction: 1) exchange and co-ordination for teaching; 2) professional collaboration. The first kind of activity refers to simple forms of teacher collaboration for sharing information

about teaching on a local level, whereas the second requires teachers to directly collaborate to improve instruction in classrooms (OECD, 2020a).

Teacher collaboration can be organized in a hierarchical structure in terms of the depth of the interaction processes: 1) preserving individualism and autonomy; 2) coordinating responsibility without discussion of the actual content of teaching; 3) cooperation by establishing a common ground with a focus on the process of classroom activity; 4) sharing pedagogical motives (Havnes, 2009; Moolenaar, 2010; Vangrieken et al., 2015). Professional collaboration differs from mere superficial collaboration in that it involves more cooperation and sharing, and thus, it is more directly related to teacher's instruction. However, OECD reports that professional collaboration is less prevalent than are simpler forms of collaboration (OECD, 2020a). The lack of professional collaboration stems from the fact that such deeper forms of collaboration require challenging teachers' autonomy and underlying beliefs (Achinstein, 2002; Gajda & Koliba, 2008; Gunn & King, 2003; Vangrieken et al., 2015).

Although professional collaboration seems to be less prevalent than are simpler forms of exchange, it has been shown to enhance teaching quality, student learning outcomes, and teacher efficacy (Bolam et al., 2011; Caena, 2011; Clement & Vandenberghe, 2000; James et al., 2007; Williams, 2010). Furthermore, professional collaboration is a precondition for actual school change and improvement, given that deeper forms of collaboration and interaction are related to teachers' underlying beliefs and facilitate high levels of interdependence between teachers (Clement & Vandenberghe, 2000; Doppenberg et al., 2012; Levine & Marcus, 2010; Plauborg, 2009; Vangrieken et al., 2015). The implementation

of innovative practices requires teachers to reflect on their instruction and change their underlying beliefs (Bakkenes et al., 2010; OECD, 2019a). Professional collaboration allows for deeper levels of interaction that are needed for school innovativeness.

Distributed Leadership

Distributed leadership has been understood and examined in the literature using two approaches: 1) a leader-plus aspect; 2) a practice aspect (Bellibaş et al., 2021; Devos et al., 2014; Y. Liu et al., 2021; Nilsen et al., 2021; Spillane, 2005).

The leader-plus aspect approach recognizes that distributed leadership actions are the aggregated actions of multiple individual leaders – namely, formally designated leaders and informal leaders (Devos et al., 2014; Harris et al., 2007; Spillane, 2005). Although this approach is essential and emphasizes the shared leadership responsibilities, it is incomplete in that leadership practice goes beyond the aggregated actions of individual leaders.

The practice aspect approach places more focus on the interactions than on the actions of individual leaders. The practice aspect defines distributed leadership as a product of the interactions between leaders, followers, and their situation (Spillane, 2005). This approach provides a more comprehensive understanding of distributed leadership (Devos et al., 2014). Our construct of distributed leadership is in line with the practice aspect and emphasizes leadership practices that involve the interactions between teachers, students and parents in school decisions (OECD, 2016, 2018)

Distributed leadership can be exercised collaboratively through the interactions between people (OECD, 2016). Organization theory identifies three types of interdependencies in leadership practice: reciprocal, pooled, and sequential interdependencies

between leaders and followers (Spillane, 2005; Thompson et al., 2017). This implies that distributed leadership requires people to collaborate collectively to accomplish tasks instead of delegating leadership tasks from one person to another in a non-interactive way (Devos et al., 2014; Rayner & Gunter, 2005). In general, distributed leadership consists of the three distinctive elements: 1) a collaborative decision-making process; 2) the involvement of teachers, students, and parents in school governance; 3) shared accountability for the academic development of students and the school (Hallinger & Heck, 2010; OECD, 2016).

The core aspects of distributed leadership are associated with a greater sense of purpose within a school by fostering teachers' sense of agency (OECD, 2020a). Teachers who feel a greater sense of autonomy through distributed leadership are more likely to perceive their work environment as innovative (OECD, 2020a).

Instructional Leadership

Instructional leadership refers to the actions of principals that are intended to improve the quality of teacher instructions (OECD, 2020a). This broad definition of instructional leadership can be further conceptualized along three dimensions of instructional leadership behavior, which are further divided into ten instructional leadership functions: 1) defining the school's mission: framing the school's goals, communicating the school's goals; 2) managing the instructional program: supervising and evaluating instruction, coordinating curriculum, monitoring student progress; 3) promoting a positive school learning climate: protecting instructional time, promoting professional development, maintaining high visibility, providing incentives for teachers (Hallinger & Murphy, 1985). Based upon this conceptual model, the fourth dimension – 4) developing a supportive work environment– was

added to stress the role of collaboration and the involvement of stakeholders in instructional leadership practices (Murphy, 1990).

Instructional leadership has evolved over time from a direct and hands-on approach that is, focused on instruction to a more indirect approach that involves active collaboration between the principal and teachers (Hallinger, 2011; Klar, 2012; Marks & Printy, 2003). This trend aligns with the idea that a direct instructional leadership approach has shown to be time-consuming for principals and encroaches on teacher autonomy (Horng & Loeb, 2010; OECD, 2020a).

The construct of instructional leadership measured by TALIS is based on an indirect form of instructional leadership practice, given that an indirect approach facilitates a collaborative school climate, where teachers share schools' goals and adopt them to improve teaching (Hallinger, 2015; Hallinger & Heck, 2011; OECD, 2020a). In our study, instructional leadership is defined with the three indirect instructional leadership practices to ensure : 1) teachers' accountability for their students' learning outcomes (Hallinger & Murphy, 1985); 2) teachers' accountability for their teaching skills (Bridges, 1967); 3) co-operation among teachers in developing new teaching practices (Brieve, 1972). Instructional leadership to facilitate teacher collaboration has been shown to be related to a school's openness to innovation (Leithwood & Riehl, 2003; OECD, 2020b).

Professional Collaboration and Team Innovativeness

There is growing recognition in the literature that teacher collaboration can benefit a school in terms of the implementation of new ideas or change. However, the current state of the research is primarily concerned with a broader conception of collaboration (i.e.,

collaborative school culture) and individual innovativeness. Teacher collaboration is generally deemed critical to a school's readiness to examine new ideas and methods (Inger, 1993; Vangrieken et al., 2015). One study further delineated the relationship between the density of teachers' collaborative networks and an innovative school climate (Moolenaar et al., 2010). An increased number of collaborative activities was shown to be associated with the extent to which teachers were open to change. In addition, teachers who collaborated more often with their colleagues appeared to be more innovative, and innovative teachers tended to collaborate more often. These results suggest that the direction of their relationship remains an open question.(Cumming & Owen, 2001)

Recent efforts in the field have focused on the relationship between professional collaboration and innovativeness at a school level (Blömeke et al., 2021; Çoban & Atasoy, 2020). One particular example is the research by Blömeke et al. (2021), which used the data from TALIS 2018. Their study included 48 countries to examine the relationship between school innovativeness and teacher outcomes. The results showed that there was a significant and positive relationship between team innovativeness and professional collaboration. The more teachers perceived their school climate as innovative, the more often they collaborated with their colleagues in class (Blömeke et al., 2021). However, little research has been done to verify the extent to which professional collaboration as a contributing factor is associated with an innovative school climate. Our review of the current state of research suggests that the more often teachers engage in professional collaboration in class, the more likely they are to perceive their colleagues and the school as innovative.

Distributed Leadership and Team Innovativeness

The school improvement literature highlights the importance of distributed leadership practice as a contributor to positive change in schools (Graetz, 2000; Harris, 2008; Little, 1990a; Rosenholtz, 1989). In distributed leadership, the innovative vision of school leaders can be effectively stretched over teachers in the school by sharing responsibilities. This thus implies that distributed leadership can act as a channel for change (Hallinger & Heck, 2010; Nilsen et al., 2021).

Few available studies have examined the relationship between distributed leadership and an innovative school climate (Nguyen et al., 2021; Nilsen et al., 2021). Their results have consistently indicated that distributed leadership is positively associated with an innovative school climate. The study by Nilsen et al. (2021) that used the Norway data from TALIS 2018 presents distributed leadership as a significant factor that is associated with an innovative school environment. Their study further delineated the mediating effect of innovative school climate on teaching practices. In line with this, the study by Nguyen et al. (2021) suggests that a culture that values shared decision-making and teacher collaboration is positively associated with an innovative school climate, where teachers are encouraged to participate in professional learning activities. However, their study did not directly address the relationship between distributed leadership and team innovativeness. Hence, our study intends to fill that gap and to confirm previous findings.

Instructional Leadership and Team Innovativeness

The literature contains very few empirical studies that have examined the relationship between instructional leadership and team innovativeness as conceptualized in

the present study. Although we are not aware of any studies that have directly examined this association, there are indications in the literature that the instructional leadership of principals is an important factor that affects teacher innovativeness. First, a positive link between effective instructional leadership behaviors and teacher commitment, professional development, and innovativeness was reported (Sheppard, 1996). However, in the previous study, these associations were found for a direct form of instructional leadership practices and individual innovativeness. Second, one case study revealed that teachers' perceptions of principal instructional leadership enhanced teacher reflection, innovation, creativity, risk-taking, motivation, and self-efficacy (Blase & Blase, 2000). The instructional leadership practices that were found to be effective included the actions of principals that supported collaboration among teachers and, provided opportunities to learn new teaching methods, and that gave feedback.

Although their study provides insights into effective instructional leadership with respect to the innovative behaviors of teachers, it has limitations in terms of generalizability and a quantitative approach for providing empirical support. However, the hypothetical relationship between instructional leadership and team innovativeness was established, given that the increased instructional leadership of principals was shown to enhance teacher collaboration (OECD, 2016). Thus, this study addresses the need for testing their associations empirically.

Distributed Leadership and Professional Collaboration

Distributed leadership builds the organizational conditions that hold the school community together. It is collective activity of educators, which engages multiple individuals

in shared decision-making. The collective work of leaders and teachers through distributed leadership facilitates a learning community where teachers develop a shared sense of purpose through collaboration (DuFour & Eaker, 2009; Harris et al., 2007; Y. Liu & Watson, 2020). That said, the idea of professional collaboration is underpinned by the concept of distributed leadership. Further, there is also modest empirical support for associations between distributed leadership and professional collaboration based on the U.S. data from TALIS 2013 (García Torres, 2019). In this previous study, a positive relationship was found between distributed leadership and professional collaboration.

Instructional Leadership and Professional Collaboration

Although a large body of literature supports a positive relationship between instructional leadership and teacher collaboration, little empirical research has been done with respect to a deeper form of collaboration. Previous studies showed that principal instructional leadership practices are important in fostering teacher collaboration (Bellibaş et al., 2021; Blase & Blase, 2000; Duyar et al., 2013; Miller et al., 2010; Mora-Ruano et al., 2021; Robinson et al., 2008). In line with the research, instructional leadership is more common in schools where teachers frequently collaborate, which suggests that when principals enact leadership practices to support co-operation between teachers for professional development, teachers tend to collaborate more often (OECD, 2016). In our study, we used an indirect form of instructional leadership to facilitate a collaborative school climate. Thus, our study addresses the association between instructional leadership and professional collaboration.

Mediating Role of Professional Collaboration

Professional collaboration is thought to have a mediating effect on the relationship between school leadership and an innovative school climate. Although the findings in the literature are limited in scope, they indicate that teachers working in a school where principals foster professional learning opportunities are more likely to change their teaching practices (Amels et al., 2020; Kilinc et al., 2020; Nguyen et al., 2021). However, in the extant literature, the mediating role of professional collaboration has been investigated separately for two different leadership styles. For instructional leadership, positive indirect relationships were found with teachers' change in teaching practices through increased teacher collaboration (Amels et al., 2020). Likewise, teacher collaboration mediated the relationship between distributed leadership and teachers' willingness to change (Kilinc et al., 2020; Nguyen et al., 2021). On the basis of the existing literature, we anticipate that the two different leadership styles, namely distributed and instructional leadership, exert an indirect effect on team innovativeness, mediated by professional collaboration.

Contextual Effects

Teachers working in the same school are more likely to be similar than teachers from different schools. This means that the observations of teachers within the same school are not necessarily independent, and may be the result of similarity in the school context (Feaster et al., 2011). Investigating contextual effects provides more information about the group context. In line with this, collaborative school culture has been presented as a key enabler for individual teachers' achieving innovativeness and openness to change (Nguyen et al., 2021). Thus, we address school culture factors that promote innovative school climate by

investigating the contextual effects of school-level distributed leadership and collaboration on individual perceptions of team innovativeness.

Control Variables

Teacher age has been shown to negatively relate to individual innovativeness. Previous research has documented that younger teachers are more willing than are older teachers to adopt new ideas for teaching (Goodson et al., 2006; Thurlings et al., 2015). Likewise, team innovativeness is associated with teacher age. Younger teachers report relatively low levels of innovativeness among their older colleagues, whereas older teachers perceive their younger colleagues to be innovative (OECD, 2019a). One possible explanation given by the TALIS is that team innovativeness is a construct that reflects the shared perceptions of a group's innovativeness, as measured by asking teachers their opinions about their peer's innovativeness (OECD, 2019a). Hence, we need to control for teacher age in our study.

Additionally, gender differences were shown to be significantly associated with team innovativeness, which suggests that female teachers perceive their male counterparts as innovative (Blömeke et al., 2021). However, there have been mixed results regarding the effects of gender on actualized innovative behavior. Some studies have shown that males have a greater tendency to adopt innovation than do females (Arts et al., 2011; Bartels & Reinders, 2011; Im et al., 2003). Other studies found no statistically significant difference for the gender effect (Carmeli et al., 2006; Runhaar, 2008). The available literature reveals there is a need to control for teacher gender in addition to teacher age in our study.

The Present Study

Research Aims

The current study examined the relations between team innovativeness and its determinants, namely principal leadership (i.e., distributed leadership and instructional leadership) and teacher professional collaboration at both the individual teacher and school levels. Our review of the research revealed a need to examine the potential empirical links between team innovativeness and its determinants in the Nordic countries. The present study contributes to the research by filling gaps in the previous research on three points.

First, we examined to what extent teachers agree on the shared perception of team innovativeness within a school by aggregating teacher perceptions of team innovativeness. Our examination of between-school variation in organizational school climate allowed for identifying factors that affect an innovative school climate, which could be of interest to policymakers. In school settings, innovativeness has been primarily conceptualized as the behavior or openness to change of individual teachers, with less emphasis on a school's organizational climate. However, the innovative behavior of individual teachers is significantly influenced by their perception of the school climate towards innovativeness (McGeown, 1980). In this context, team innovativeness was examined as the shared perception of teachers of an innovative school climate in relation to school leadership and teacher collaboration at the school level, in addition to those at the teacher level.

Second, school principal leadership styles were examined as determinants of team innovativeness. We examined to what extent distributed leadership and instructional leadership were associated with team innovativeness, both at the teacher level and at the

school level. Instructional leadership did not receive as much attention as distributed leadership; hence, we examined how instructional leadership was associated with team innovativeness. Although there is little empirical literature available, there are some theoretical arguments for the benefits of instructional leadership in enhancing team innovativeness mediated by professional collaboration among teachers.

Third, we examined the mediating role of professional collaboration in the relationship between principal leadership (i.e., distributed leadership and instructional leadership) and team innovativeness. This allows for a more holistic understanding of how innovative school climate is related to its determinants. Teachers' gender and age were controlled in our study.

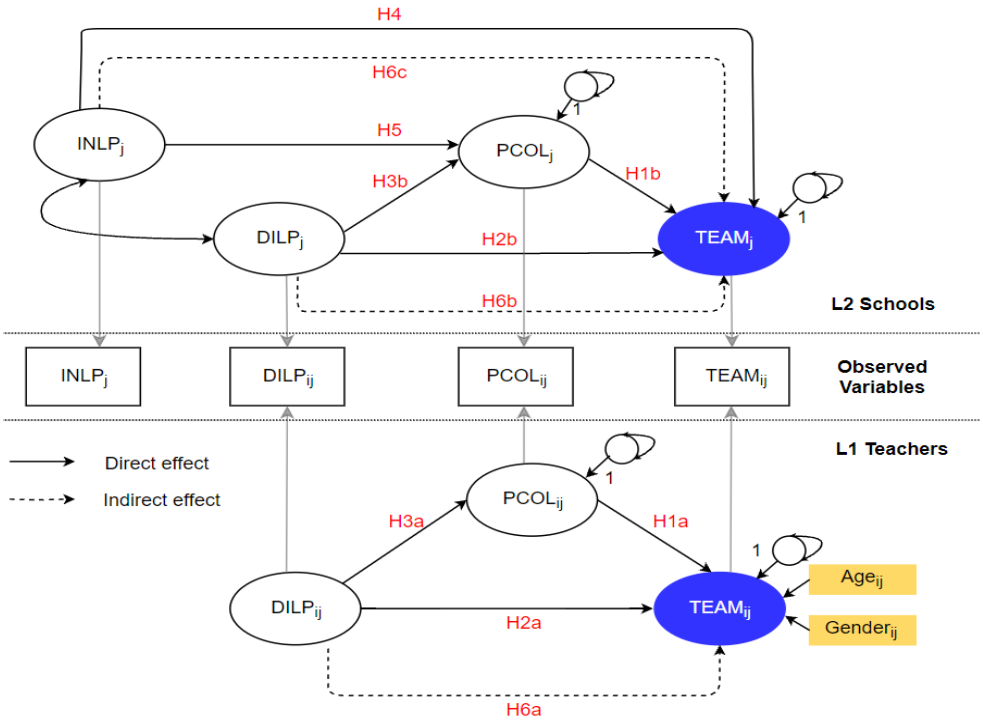
Lastly, contextual effects were examined to identify to what extent school-level distributed leadership and professional collaboration have effects on individual teachers' perceptions of team innovativeness. Although the previous research showed that teacher collaboration and shared responsibilities were significant determinants of team innovativeness, the relations between innovativeness, leadership and collaboration were examined at different levels (i.e., teacher, schools). However, by investigating the contextual effects, the present study contributes to an assessment of the school-level effect of collaboration and distributed leadership on individual perceptions of team innovativeness.

Research Hypothesis

In the present study, we assume professional collaboration, and distributed and instructional leadership to be determinants of team innovativeness. The model that was used to test our hypotheses is depicted in Figure 1.

Figure 1

Multilevel structural equation model representing the relations between team innovativeness, distributed leadership, instructional leadership and professional collaboration



Note. TEAM = Team innovativeness, PCOL = Professional collaboration, DILP = Distributed leadership, INLP = Instructional leadership. Teachers *i*, Schools *j*.

Hypothesis H1 (PCOL → TEAM): Professional collaboration is positively associated with team innovativeness at the teacher level (H1a) and at the school level (H1b).

Hypothesis H2 (DILP → TEAM): Distributed leadership is positively associated with team innovativeness at the teacher level (H2a) and at the school level(H2b).

Hypothesis H3 (DILP → PCOL): Distributed leadership is positively associated with professional collaboration at the teacher level (H3a) and at the school level(H3b).

Hypothesis H4 (INLP → TEAM): Instructional leadership is positively associated with team innovativeness at the school level.

Hypothesis H5 (INLP → PCOL): Instructional leadership is positively associated with professional collaboration at the school level.

Hypothesis H6 (Mediating role of professional collaboration): Professional collaboration mediates the relationships between distributed leadership and team innovativeness at the teacher level (H6a) and at the school level (H6b). It also mediates the relationship between instructional leadership and team innovativeness (H6c).

Hypothesis H7 (Contextual effects): There are additional direct and indirect contextual effects between professional collaboration, distributed leadership and team innovativeness. More specifically, L2 professional collaboration has direct contextual effects on L1 team innovativeness (H7a: L2-L1: PCOL → TEAM); L2 distributed leadership has direct contextual effects on L1 team innovativeness (H7b: L2-L1: DILP → TEAM) and L1 professional collaboration (H7c: L2-L1 DILP → PCOL). It is also assumed that there are indirect contextual effects of L2 distributed leadership on L1 team innovativeness mediated by professional collaboration (H7d: L2-L1: DILP → PCOL → TEAM).

Method

Sample

This study was conducted by using the Teaching and Learning International Survey (TALIS) 2018 data. The target populations included teachers and their school leaders at the lower secondary school education level, which corresponds to ISCED Level 2 – International Standard Classification of Education, in 48 countries (OECD, 2019b). The sample for this study was taken from Denmark, Finland, Norway, and Sweden. We used both the teacher data and the principal data. The final sample size was reduced to N = 11,706 teachers and N= 654 schools with an average cluster size of 17.74 due to the matching of teacher data to school data in the multi-level model, and this accounts for a loss of 0.49 % and 2.68% of the total sample of teachers and schools, respectively (Table 1). It can be also noted that the sample sizes of total schools and clusters were relatively smaller in Denmark.

A two-stage probability sampling design was used for TALIS 2018. First, approximately 200 schools were randomly drawn for each country. Second, approximately 20 teachers were randomly drawn from each school sample (OECD, 2019b). In order to accommodate differing selection probabilities, the sampling weights suggested by Rutkowski et al.(2010) were used in all analyses. Thus, we used final teacher weights at the teacher level and final school weights at the school level, and these weights were provided by the TALIS data set. The overall response rates were 85.4% for the principals, ranging from 71.4% (Denmark) to 100% (Finland), and 78% for the teachers, ranging from 62.5% (Denmark) to 96.2% (Finland).

With respect to the age of teachers, the average age ranged from 43.8 (SD = 0.3, Norway) to 45.7 (SD = 0.2, Sweden), which were close to the OECD average age (44.1). Norway had the highest proportion of young teachers under 30 (12.5%). Of the teachers who took part in the TALIS 2018, more than half were female (65.2%), and male teachers accounted for 34.8%.

Table 1

Overall sample and cluster sizes for the TALIS 2018 Nordic countries

Country	Country code	Teachers(N)	% of missing	Schools(N)	% of missing	Average cluster size
Denmark	DNK	1,989	0.6	141	4.73	14.19
Finland	FIN	2,851	0	148	0	19.26
Norway	NOR	4,111	1.04	185	4.15	22.22
Sweden	SWE	2,755	0.97	180	1.64	15.30
Total		11,706	0.49	654	2.68	17.74

*Note. "*Percentage of missing" is equal to the percentage of missing data due to the matching of teacher data to school data

Variables and Measures

In this study, we used the TALIS scales given in the dataset for all the variables of interest. This allows for evaluating latent constructs that cannot be observed directly. In addition, OECD had tested and confirmed cross-country measurement invariance using multiple group confirmatory factor analysis (MGCFA), which ensured the validity of the TALIS scales across countries (OECD, 2019b). The scales that we used for our study reached at least metric level of invariance, which ensures that the strength of the associations between

scales are comparable across countries. Therefore, for all the analyses, we used continuous variables that represented latent constructs, which were provided in the TALIS study. The item wording included in this study is presented in Table C23. The following sections briefly describe the measures and their conceptual underpinnings. For a more detailed description of the scale validation procedures, please refer to OECD (2019b).

Distributed Leadership

Teacher ratings formed a distributed leadership scale for this study. OECD constructed two distributed leadership scales using principal data and teacher data, which were both measured with five items. Based on a technical report on internal consistency reliability, we decided to use the teachers' reports of distributed leadership because the teachers' perceptions had relatively high reliability coefficients that ranged from .762 (Denmark) to .814 (Sweden), whereas for the scale based on the principals' self-reports, the omega

coefficients ranged from .602 (Sweden) to .769 (Norway) (OECD, 2019b). Furthermore, the principals' self-reports were subject to social desirability bias. Therefore, teachers' ratings were selected for this study.

Teachers' perception of distributed leadership was assessed using a scale of participation among stakeholders, as suggested by OECD, which contains five items. The teachers were instructed to rate their agreement with each item on a 5-point Likert-type scale ranging from 1 "Strongly disagree" to 4 "Strongly agree". As an example, one of the items was "This school provides staff with opportunities to actively participate in school decisions." Teacher-perceived distributed leadership reflects the extent to which a teacher

perceives that school decision making is shared among stakeholders. The distributed leadership scale was validated by OECD, and all criteria indicated that metric invariance is supported (CFI =.982, TLI = .975, RMSEA = .049, SRMR = .079) (OECD, 2019b). The internal consistency reliability (omega coefficients) ranged from .762 (Denmark) to .814 (Sweden).

Instructional Leadership

The self-evaluations of principals were used for this scale. TALIS questionnaires did not include teachers' perception of principal instructional leadership in the teacher survey. Therefore, we used the responses from principals although they may address socially desirable responses from principals. Instructional leadership was measured using three items (e.g., I took actions to support co-operation among teachers to develop new teaching practices). Principals were asked to evaluate how frequently they engaged in different school leadership activities on a four-point frequency scale (1 = "Never or rarely," 2 = "Sometimes," 3 = "Often," 4 = "Very often) (OECD, 2019b).

OECD constructed this scale using only three items due to weak factor loadings (OECD, 2019e). The use of only three items to build a scale has limitations for model fit and model identification. OECD checked the model fits of this scale, and confirmed that a fair number of countries exhibited poor model fit, including Denmark (CFI =.877, TLI = .693, RMSEA = .141, SRMR = .058) (OECD, 2019b). The scale achieved metric invariance across countries (CFI =.993, TLI = .989, RMSEA = .044, SRMR = .088) (OECD, 2019b). The internal consistency reliability (omega coefficients) was acceptable across countries, and ranged from .602 (Sweden) to .769 (Norway).

Professional Collaboration

Professional collaboration scale includes four items that measure teachers' perception of professional collaboration. Teachers were asked to assess the frequency of their professional collaboration behaviors. The items were prompted by "On average, how often do you do the following in this school?" on a 6-point frequency scale (1 = "Never," 2 = "Once a year or less," 3 = "2-4 times a year," 4 = "5-10 times a year," 5 = "1-3 times a month," 6 = "Once a week or more") (OECD, 2019b). A sample item from the scale is "Teach jointly as a team in the same class." As mentioned, the scale was validated by OECD and reached metric invariance for all populations (CFI =.935, TLI = .921, RMSEA = .059, SRMR = .055) (OECD, 2019b). The reliability coefficients (omega) for this scale ranged from .560 (Sweden) to .661 (Finland) (OECD, 2019b).

Team Innovativeness

Team innovativeness was measured by teacher ratings on teaching innovation. The items were developed from the stem sentence "Thinking about the teachers in this school, how strongly do you agree or disagree with the following statements?". Teachers were asked to respond on a 4-point Likert-type scale ranging from 1 = "Strongly disagree" to 4 = "Strongly agree." There were four items that measured this construct (e.g., "Most teachers in this school strive to develop new ideas for teaching and learning). The items addressed the extent to which teachers perceived their colleagues as being open to innovative teaching practices. This construct reflects teachers' individual perception of innovative school climate on level 1, whereas on level 2, it indicates the shared perception of teachers at a school.

OECD confirmed that this scale has a good model fit for all populations, indicating that all items were strongly associated with the latent construct, with factor loadings above .70. This scale was validated by OECD, and it exhibited a scalar invariance with equal intercepts (11.07) for all populations (CFI =.958, TLI = .968, RMSEA = .071, SRMR = .082) (OECD, 2019b). The internal consistency reliability (omega) for the scale ranged from .794 (Norway) to .891 (Sweden).

Control Variables

The teacher-level demographics, gender (0 = Female, 1 = Male) and age were retained as control variables for the analyses. Previous studies have suggested that there are negative relationships between teacher age and their openness to innovation (Goodson et al., 2006), and have indicated that younger teachers are more willing to adopt innovative teaching practices than are older teachers. Therefore, at the teacher level, we included teacher age and gender to control for teacher characteristics. According to the TALIS, age was coded by age group (1 = “Under 25,” 2 = “25-29,” 3 = “30-39,” 4 = “40-49,” 5 = “50-59,” 6 = “60 and above”).

Data Analysis

Analytic Strategy

Multilevel structural equation modeling (MSEM) was used to test our hypotheses because MSEM can best account for the hierarchical structure of our data with teachers (L1) nested within schools (L2). MSEM is used as an alternative method for assessing mediation in the multilevel data. Specifically, MSEM combines the advantages of both the traditional multilevel model (MLM) and the traditional structural equation model (SEM). In the MLM

model, group means are used at L2 using observed manifest variables, and measurement error is not accounted for in modeling, whereas MSEM includes traditional latent variables to account for measurement error. Another advantage of MSEM relative to MLM is that MSEM allows for a separate estimation of the *Within* and *Between* components, as well as an estimation of the contextual effects across levels, whereas MLM conflates the *Within* and *Between* effects (Preacher et al., 2011). We therefore adopted a two-level MSEM as the analysis procedure because the aim of our study was to examine the associations between latent constructs, including structural parameters (i.e., direct, indirect, and contextual effects).

Before adopting the MSEM approach, we performed the following procedures to validate the use of MSEM. First, we estimated the ICC1 (interclass correlation coefficients) for the outcome variables as a measure of clustering. The ICC1 quantifies the degree to which the data are nested in groups and, indicates the proportion of the total variance accounted for by the higher level (Hox, 2013). In our study, ICC1s explain the percent of variance at the teacher level due to school membership, and ICC2s measure the reliability of the shared construct at the school level. The recommended acceptable values are ICC1s $\geq .05$ (Geldhof et al., 2014), and ICC2s $\geq .70$ (Raudenbush & Bryk, 2002)

Second, the data were fitted to the within- and between- structural models and the model fits were examined. According to the recommendations provided by Ryu (2014), the total model fit statistics are likely to be dominated by L1 variables due to the larger sample at L1. Accordingly, given the limitations of the standard approach to the proposed model, Standardized Root Mean Square Residual for the between level ($SRMR_b$) was examined together with other fit indices. Multiple model fit indices were used to evaluate the model fit.

Acceptable values were suggested as follows: a Tucker-Lewis index (TIL) close to .95 and above (Tucker & Lewis, 1973); a comparative fit index (CFI) close to .95 or above (Bentler, 1990); a standardized root mean square residual (SRMR) close to .08 or below (Browne & Cudeck, 1992); chi-square statistics with the corresponding p-values. Due to the sensitivity of the large sample size, we did not heavily rely on chi-square statistics (Schermelleh-engel et al., 2003). Additionally, in light of the smaller sample size at L2, the criteria of SRMR (close to .08 or below) were not strictly applied at L2 (Asparouhov & Muthén, 2018). Subsequently, after we validated the use of MSEM, the structural parameters were examined to test our hypotheses. More specifically, L1 and, L2 direct and indirect effects, and contextual effects were estimated to investigate the path coefficients among the variables.

We also examined the variance explanations of team innovativeness with respect to its determinants. The acceptable values were suggested as .75 (substantial), .50 (moderate), and .25 (weak) (Henseler et al., 2009). The estimated squared coefficients between the variables were also evaluated based on the squared Cohen's suggestion of d = .04, .25, .64, respectively, which indicated small, medium, and large effects (Sawilowsky, 2009).

Multilevel Structural Modeling

Modeling the data in the MSEM framework allows for estimating structural parameters. The structural parameters included in this study were the direct L1 effects, the indirect L1 effects, the direct L2 effects, the indirect L2 effects, and the contextual effects. More specifically, the L1 direct and indirect effects included the three variables that were measured at L1 (i.e., distributed leadership, professional collaboration, team innovativeness). Then, we aggregated these variables as situational variables that represented the shared

perception of teachers in the school, which were then aggregated as school level variables (Zhang et al., 2009). On level 2, in addition to these aggregated variables, we added the variable directly measured in L2 (i.e., instructional leadership). Hence, the L2 parameters included these two types of L2 variables in our model.

Additionally, we estimated the contextual direct and indirect effects of L2 variables on L1 variables to examine the degree to which L2 characteristics contributed to outcomes (Marsh et al., 2009). Specifically, we estimated additional contextual effects derived from the difference between L2 effects ($\beta_{between}$) and L1 effects (β_{within}) (context = $\beta_{between} - \beta_{within}$). In our model, the additional parameters (contextual effects) included the contextual direct effects of DILP (L2) on PCOL (L1), the contextual direct effects of DILP (L2) on TEAM (L1), the contextual direct effects of PCOL(L2) on TEAM (L1), and the contextual indirect effects of DILP(L2) on TEAM (L1). The effect sizes were estimated as

$$ES_2 = 2 \times (\beta_{between} - \beta_{within}) * \frac{\sqrt{Var(between\_predictor)}}{\sqrt{Var(within\_predictor)^2 + Var\ (within\_outcome)}}$$

(Marsh et al., 2009).

Software, Estimator, Missing Data, and Weights

The data were prepared using IBM SPSS 27 and R version 4.0.3. Further MSEM analyses were conducted using M*plus* version 7.3 (Muthén & Muthén, 1998-2012). Maximum likelihood estimation using the robust standard errors (MLR) method was implemented to estimate the MSEM models and to, allow for corrected standard errors as recommended by Muthén & Muthén (2017). The amount of missing data per variable in this study ranged from 4.25 % to 9.67 %. By default, M*plus* version 7. 3 with MLR did not

include 974 missing cases of the predictors and 12 missing cases of the outcome variables using full information maximum likelihood (FIML).

Results

Descriptive Statistics

At the teacher level, the correlations between team innovativeness and the other study variables were significant, indicating weak positive correlations ranging from .03 to .34. (Table C1) However, in Finland and Norway, no significant correlations were found between instructional leadership and team innovativeness (Table C3, C4). At the school level, significantly positive correlations existed between team innovativeness and the other variables, except for instructional leadership, and indicated weak to moderate relationships that ranged from .23 to .51. (Table C6). In other words, the higher the shared perception of distributed leadership and professional collaboration, the higher the shared perception of team innovativeness at the school level. The full descriptive statistics, including the correlation matrices at the respective teacher- (L1) and school- levels (L2) are presented in Tables C1 - C10.

For all the scales, ICC1s and ICC2s were acceptable, and they ranged from .063 (DEN, FIN) to .263 (DEN) for ICC1s, and from .491 (DEN) to .836 (DEN) for ICC2s (Table C11). Consequently, the intraclass correlations (ICC1 and ICC2) suggested the suitability of multilevel modeling. It is of note that the team innovativeness scale indicated a low level of clustering in Denmark (ICC1 = .063) and Finland (ICC1 = .063), which subsequently resulted in low reliability at the school level (ICC2s = .491 and .563, respectively). The intraclass correlations (ICC1s and ICC2s) across countries are provided in Table C11.

Multilevel Structural Equation Model

Teacher-Level (L1) Relations of Team Innovativeness to its Determinants (H1a -H1c)

Professional Collaboration and Team Innovativeness (H1a). Professional collaboration was positively associated with team innovativeness at the teacher level for the entire Nordic sample (β = .081, p = .012, SE = .081) (Table C12). The estimated model diagram with all standardized coefficients is presented in Figure C1. (For country-specific diagrams, see Figures C2-C5). The same significant L1 effects were found in the four Nordic countries with relatively small coefficients ranging from .056 (SWE, p = .010, SE = .022) to .116 (NOR, p=.000, SE = .019), which suggested that within-school teachers who reported high levels of professional collaboration were more likely to perceive their colleagues as innovative than those who did not engage in professional learning activities often (For country-specific effects, see Table C13). Thus, the positive relations of professional collaboration to team innovativeness were fully supported at the teacher level (H1a).

Distributed Leadership and Team Innovativeness (H2a). Distributed leadership had a significantly positive relationship with team innovativeness at the teacher level (β = .285, p = .000, SE = .014) for the total Nordic sample (see Table C14). With respect to country-specific effects, the same significant and positive relationships were found in the four Nordic countries, with coefficients that ranged from .192 (DEN, p = .000, SE = .030) to .340 (SWE, p = .000, SE = .024), which imply that teachers who report high levels of distributed leadership have a greater tendency to perceive their school climate as innovative at the teacher level. Furthermore, the variance explanations of team innovativeness ranged from 8.1% (DEN) to 13.8% (SWE), which indicated that at the teacher level, relatively small

proportion of total variance in team innovativeness was explained by distributed leadership and professional collaboration (for variance explanations, see Table C18). Hence, the significant and positive L1 relations of distributed leadership to team innovativeness were fully confirmed (H2a).

Distributed Leadership and Professional Collaboration (H3c). The relation between distributed leadership and professional collaboration was positive and significant at the teacher level for the entire Nordic sample (β = .176, p = .000, SE = .012) (see Table C15). The same findings were obtained in the four Nordic countries with varying coefficients that ranged from .133 (FIN, p = .000, SE = .022) to .204 (SWE, p = .000, SE = .023), which implies that teachers who perceived stronger distributed leadership reported more frequent engagement in professional collaboration. Additionally, the results revealed that distributed leadership significantly contributes 3.1 % of the total variance in professional collaboration (for variance explanations, see Table C18). The variance explanations for professional collaboration ranged from 1.8% (FIN) to 4.2% (SWE), which indicates that distributed leadership explains a relatively small proportion of total variance in professional collaboration. Thus, the positive L1 relations of distributed leadership to professional collaboration were fully supported (H3c).

School-Level (L2) Relations of Team Innovativeness to its Determinants (H1b- H5)

Professional Collaboration and Team Innovativeness (H1b). The relation of professional collaboration to team innovativeness was not significant at the school level for the total Nordic sample (β = .124, p = .080, SE = .071) (see Table C13). The country-specific results revealed that the only significant relation found was for Finland (β = .355, p = .000,

SE = .098), and the relations were not significant in the other countries. Notably, at the school level, no significant relations were found except for Finland, which was not consistent with the findings at L1 that showed significant relations for all the Nordic countries. Thus, the positive relations of professional collaboration to team innovativeness at the school level were not fully confirmed for the entire sample, but were supported by the Finland data (H1b).

Distributed Leadership and Team Innovativeness (H2b). The relation of distributed leadership to team innovativeness was significant and positive at the school level (β = .575, p = .000, SE = .047) (see Table C14). Notably, this relationship was supported for all four Nordic countries, with the corresponding coefficients ranging from .485 (DEN, p = .000, SE = .129) to .745 (SWE, p = .000, SE = .052). The findings suggest that schools with high levels of shared perception of distributed leadership exhibit high levels of an innovative school climate. Thus, the data fully supported the evidence for positive relations between distributed leadership and team innovativeness at the school level (H2b).

Distributed Leadership and Professional Collaboration (H3b). There was a significant and positive relationship between distributed leadership and professional collaboration at the school level for the full Nordic sample (β = .211, p = .009, SE = .081) (see Table C15). However, significant relations were found only for Denmark (β = .314, p = .001, SE = .095) and Finland (β = .451, p = .000, SE = .102). Additionally, distributed leadership explains 5.9% of the total variance for professional collaboration at the school level (Table C18). These findings indicate that schools with higher levels of the shared perception of distributed leadership are more likely to exhibit collaborative school culture between schools for professional development. Thus, the hypothesized positive relations of

distributed leadership to professional collaboration were supported for the Denmark and Finland samples (H3b).

Instructional Leadership and Team Innovativeness (H4). Instructional leadership was not significantly associated with team innovativeness at the school level for the total Nordic sample (β = .097, p = .056, SE = .051) (see Table C17). The country-specific results also revealed that none of the Nordic countries exhibited significant relations between the two, which implied that the perception of instructional leadership by principals has no significant effect on the shared perception of an innovative school climate. Thus, the hypothesis of a relation between instructional leadership and the shared perception of team innovativeness was not supported by the data (H4).

Instructional Leadership and Professional Collaboration (H5). The relation of instructional leadership to professional collaboration was not significant at the school level for the total Nordic sample (β = .112, p = .094, SE = .067) (see Table C17). The relations were not significant for any of the four Nordic countries, which indicated that the instructional leadership of principals has no significant relation with the shared perception of professional collaboration. Thus, the relation of instructional leadership to professional collaboration was not supported (H5).

The Mediating Role of Professional Collaboration (H6a – H6c)

Indirect L1 Effect of Distributed Leadership on Team Innovativeness (H6a). Distributed leadership had a positive and significant indirect effect on team innovativeness through professional collaboration at the teacher level for the total Nordic sample (β = .014, p = .000, SE = .002) (see Table C19). The same relationships were found in all four Nordic

countries with the corresponding coefficients ranging from .009 (FIN, p = .006, SE = .003) to .021 (NOR, p = .000, SE = .004), which indicated that there were small but positive and significant mediating effects of professional collaboration on the relationship between distributed leadership and team innovativeness at the teacher level. Thus, the mediating effect of professional collaboration was confirmed for the relationship between distributed leadership and team innovativeness at L1 (H6a).

Indirect L2 Effect of Distributed Leadership on Team Innovativeness (H6b). At the school level, the indirect effect of distributed leadership on team innovativeness via professional collaboration was not significant for the total Nordic sample (β = .026, p = .149, SE = .018) (see Table C20). The same results were obtained in Denmark, Norway, and Sweden, whereas Finland showed a positive indirect effect of distributed leadership on team innovativeness via professional collaboration (β = .160, p = .003, SE = .054). Notably, the findings indicate that the mediating effect of professional collaboration was not significant in most of the Nordic countries at the school level, whereas at the teacher level, the mediating effect existed in all the Nordic countries (H6a). Hence, the data supported the hypothesis in Finland but not in other countries (H6b).

Indirect L2 Effect of Instructional Leadership on Team Innovativeness (H6c). The indirect effect of instructional leadership on team innovativeness was not significant at the school level. The country-specific results also did not provide evidence for the mediating effect of professional collaboration in the relationship between instructional leadership and team innovativeness (see Table C21). However, the total effects of instructional leadership, which corresponds to the direct effect plus the indirect effect, existed for Denmark (β = .229,

p = .035, SE = .109) and Finland (β = .170, p = .020, SE = .073), which indicated that there were significant yet small global effects of instructional leadership on team innovativeness. Hence, the indirect effects of instructional leadership on team innovativeness through professional collaboration were not supported (H6c).

Contextual Effects (H7a – H7d)

Contextual Direct Effect of Professional Collaboration (H7a). The contextual direct effect of professional collaboration (L2) on team innovativeness (L1) was not significant for the total Nordic sample (ES_2 = .018, p = .564, SE = .032) (see Table C13). Country-specific results revealed that a marginal but significant and positive contextual effect was found for Finland (ES_2 = .098, p = .005, SE = .035), whereas no contextual effect existed for the rest of the countries. The presence of the contextual effects of professional collaboration implies that individual differences in perceptions of team innovativeness can be accounted for by between-school differences of professional collaboration. Thus, the contextual effect of professional collaboration was supported only in Finland (H7a).

Contextual Direct Effects of Distributed Leadership (H7b, H7c). The contextual direct effects of distributed leadership were hypothesized for team innovativeness (H7b) and professional collaboration (H7c). For the total Nordic sample, no contextual effect existed for professional collaboration (ES_2 = .003, p = .936, SE = .041) (See Table C15), while for team innovativeness, a significant and positive contextual effect existed (ES_2 = .125, p = .000, SE = .032) (see Table A14). The country-specific results also revealed that contextual effects existed only in Finland and Sweden, for professional collaboration and team innovativeness, respectively. Specifically, in Finland, a positive contextual effect with a small effect size was

found for professional collaboration (ES_2 = .101, p = .028, SE = .046) (Table C15). Likewise, the contextual effect was positive for team innovativeness in Sweden (ES_2 = .214, p = .000, SE = .051) (Table C14). Thus, the contextual effect of distributed leadership on professional collaboration was confirmed only for the Finland sample (H7b). Additionally, the contextual effect of distributed leadership on team innovativeness was supported by the Sweden data, as well as for the entire Nordic sample (H7c).

Contextual Indirect Effect of Distributed Leadership (H7d). The contextual indirect effect of distributed leadership on team innovativeness was not significant for the full Nordic sample (ES_2 = .033, p = .352, SE = .035) (see Table C16). However, there was a positive and significant contextual indirect effect in Finland. The corresponding effect size was medium (ES_2 = .477, p = .050, SE = .243). Hence, the contextual indirect effect of distributed leadership on team innovativeness through professional collaboration was not supported for the full Nordic data but the additional contextual indirect effect existed for the Sweden sample (H7d).

Control Variables

The relation of teacher gender to team innovativeness at the teacher level was negative and significant for the entire Nordic sample (β = -.073, p = .000, SE = .011) (For the effects of the control variables, see Table C22). Significant gender differences were also found in each of the Nordic nations, with the coefficients that ranged from -.107 (DEN, p = .000, SE = .023) to -.077 (SWE, p = .001, SE = .023), providing evidence that female teachers are more likely to perceive team innovativeness among colleagues than are male teachers. In addition, teacher age was significantly and positively associated with team

innovativeness at the teacher level for the entire Nordic sample (β = .091, p = .000, SE = .012). The Norway data did not show a significant relationship between teacher age and team innovativeness (β = .037, p = .072, SE = .021). However, in the rest of the countries, teacher age was found to have significant and positive effects on team innovativeness, indicating that older teachers reported higher levels of team innovativeness among their colleagues than did younger teachers.

Discussion

The present study aimed to examine the effects of principal leadership and teacher professional collaboration on an innovative school climate using MSEM with the TALIS 2018 dataset for the Nordic countries. Specifically, we were interested in how and to what extent two forms of principal leadership, namely distributed and instructional leadership, are associated with teachers' shared perceptions of an innovative school climate, by taking into account the mediating role of professional collaboration among teachers. In this section, we present the key findings of our study by exploring similarities and differences between the Nordic countries in light of the literature and the implications of our findings.

Teacher-Level (L1) Relations of Team Innovativeness to its Determinants (H1)

As hypothesized, at the teacher level (L1), positive associations were found between team innovative and its determinants. These relations within schools indicate that teachers who reported high levels of principal distributed leadership and frequent engagement in professional collaboration perceived their colleagues as innovative. Moreover, we noted that overall consistency in this relationship existed at the teacher level across the Nordic countries. This homogeneity of our findings reinforces and extends previous research. The

comparisons between the Nordic countries allows for well-established findings as the educational systems of these countries share many features (Sten et al., 2016). Clearly, the Nordic countries have developed a model of education that consists of a comprehensive school for all children, curriculum plans defined by the state, and a culture where teachers are trusted (Imsen et al., 2017). Consequently, these shared features may result in similar effects in relation to team innovativeness at the teacher level.

The results are in line with the theoretical assumptions that teachers feel safer to try new ideas when they experience a greater number of collaborative networks and sharing of responsibilities within the school (Moolenaar & Sleegers, 2010). More specifically, teachers in dense social networks build trust; trust creates safer environment for teachers to experiment with new ideas and fosters an innovative school climate. Our findings confirm and extend previous empirical studies on the linkage between distributed leadership and team innovativeness by examining teacher professional collaboration as a stimulant of team innovativeness (Cobanoglu, 2021; Nilsen et al., 2021). Although one study examined the relations among these three variables in one model, our results substantially expand the current state of research where the data were limited to a single country (i.e., Turkey) and where multi-level structure in schools and between schools was not explored (Çoban & Atasoy, 2020).

However, a cautionary note needs to be made with regard to the relation between professional collaboration and team innovativeness. To the best of our knowledge, very few empirical studies have examined this linkage in educational organizations (Blömeke et al., 2021.; Nguyen et al., 2021; Xafakos et al., 2020). Although their findings confirmed

significant associations, the question of whether teacher professional collaboration is the outcome of team innovativeness, or vice versa, remains open. In the present study, we assumed that team innovativeness was the outcome of professional collaboration given the mediating role of professional collaboration. Our hypothesis is based on previous studies that revealed that there is a positive link between distributed leadership and professional collaboration (Forte & Flores, 2014; García Torres, 2019; Y. Liu & Watson, 2020). One of our aims was to extend the current state of research by exploring all the relations in one model, and therefore we argue that team innovativeness may be enhanced by frequent professional collaboration among teachers (Vangrieken et al., 2015). However, the pathways and influences of the relations can be reciprocal (Hedges & Schneider, 2005). It is also plausible that when teachers are more open to change, they are likely to collaborate with peers more often (Blömeke et al., 2021.).

Distributed leadership has been found to be positively associated with team innovativeness as it creates a greater sense of shared responsibility and leads to successful school change (Hallinger & Heck, 2010; Harris & Spillane, 2008; Nilsen et al., 2021; OECD, 2016). Although overall consistency was found across the countries, it is interesting to note the variation between countries in effect size. Upon comparing the effect sizes between the Nordic countries, the effect sizes of distributed leadership and professional collaboration in Denmark were relatively small with respect to team innovativeness. One interpretation of this is that Denmark provides relatively fewer opportunities for stakeholders to participate in school decisions than do any other Nordic countries. This could explain the smaller effect size in Denmark (OECD, 2016).

School-Level (L2) Relations of Team Innovativeness to its Determinants (H2)

We further examined the relations between team innovativeness and its determinants at the school level. At the school level, instructional leadership was added to the model as a determinant of team innovativeness.

Distributed Leadership, Team Innovativeness, and Professional Collaboration (L2)

The data did not fully support our hypotheses related to school-level (L2) relations, which suggests that greater variation between the Nordic countries exists at the school level than at the teacher level. Our findings concerning the relations of professional collaboration to team innovativeness (H1b) and concerning the relations between distributed leadership and professional collaboration (H3b) were less generalizable than those at the teacher level. However, we found overall consistency in the school-level relations of distributed leadership to team innovativeness across the countries (H2b). Overall, the findings suggest that higher levels of distributed leadership were associated with a more innovative school climate when the data were aggregated to represent the shared perception of distributed leadership. One result to note is that in Sweden, distributed leadership was associated with team innovativeness to a substantially larger extent than in the other countries. This indicates that in Sweden, a school culture conductive to generating shared leadership may be essential to an innovative school climate. When teachers feel a greater shared responsibility for school decisions, schools may be more open to new ideas (OECD, 2016).

These results expand previous research by examining the relations between the aggregated constructs, where more variation between countries existed (Çoban & Atasoy, 2020). The present study contributes to an understanding of the commonalities and

differences between the Nordic countries in the extent to which team innovativeness is explained by professional collaboration and distributed leadership at the school level.

It is noteworthy that effect sizes were substantially larger for the relations between team innovativeness and distributed leadership at the school level. One general explanation for these observations relates to the higher reliability of constructs on the between-level compared with the within-level in multi-level modeling. Yet another explanation could be that the two variables, distributed leadership and team innovativeness reflect the construct better when they are measured at the school level (Nilsen et al., 2021). Further, although team innovativeness was measured at the teacher level, it has an organizational component that mirrors the shared perceptions of school innovativeness (Anderson & West, 1998; OECD, 2019b). Taken together, these congruent results suggest robust findings and may explain to what extent the Nordic countries have common features.

Interestingly, the relation of professional collaboration was found to be significant for team innovativeness only in Finland, which indicates that schools with more prevalent teacher collaboration are more open to change (Vangrieken et al., 2015). In Norway, Sweden, and Denmark, this effect was found to be insignificant. These results could be attributed to the fact that in Finland, a relatively small variation in teacher collaboration was found at the school level (OECD, 2020a). This suggests that schools in Finland are more homogeneous groups than schools in the other Nordic countries, in that teacher collaboration for professional development is a norm shared between schools. Such results could also suggest that the variation could be explained by some cultural and country-specific contextual factors (Carlo et al., 2013; OECD, 2020b; Ostovar-Nameghi & Sheikhahmadi, 2016). One possible

explanation for this variation is that the extent of professional collaboration varies greatly between countries, depending on in what ways and how often teachers collaborate (OECD, 2020b). Teachers in different national contexts might collaborate in different forms that they find more valuable, signaling that country-level variation exists (OECD, 2014). Moreover, TALIS 2018 found that a great deal of variation in professional collaboration is found at the school level, suggesting that professional collaboration can be also driven by school culture (OECD, 2020b). Consequently, the collaborative school culture in Finland may be somewhat different from the other three countries.

Instructional Leadership, Team Innovativeness and Professional Collaboration (L2)

In addition, the present study provides results related to instructional leadership. Note that instructional leadership was measured at the school level, as TALIS used principals' perceptions to measure instructional leadership. In opposition to our hypotheses, instructional leadership was not significantly related to team innovativeness (H2d) or professional collaboration (H2e). To the best of our knowledge, the present study is the first empirical study that has examined to what extent instructional leadership was associated with team innovativeness. Although we did not find any evidence of significant relations, our results contribute to the literature by identifying potential relations between them.

Our findings are not in line with the previous studies that reported a positive linkage between instructional leadership and professional collaboration (Kilinc et al., 2020; S. Liu & Hallinger, 2018; Y. Liu et al., 2021; Y. Liu & Watson, 2020; Ma & Marion, 2021). First, one possible explanation relates to the construct underrepresentation of instructional leadership (Veletić & Olsen, 2021). More specifically, in TALIS, instructional leadership is

conceptualized as an indirect form of leadership practices that supports cooperation, teachers' accountability for improving teaching and students' learning. However, such conceptualization may not represent other dimensions of instructional leadership practices, such as managing the instructional programs and developing the school learning climate (Hallinger & Murphy, 1985). The construct underrepresentation may hamper us in finding significant associations between instructional leadership and professional collaboration.

TALIS used only three items to measure indirect forms of instructional leadership to promote a collaborative school climate (OECD, 2020b). However, the TALIS scale may not cover the concept of instructional leadership well using these three items. Another explanation is that principals' self-reports may be biased and imprecise. Incongruence has been found between principals' and teachers' perceptions, which suggests that teachers may perceive principal instructional leadership differently (Park & Ham, 2016). We also need to address the fact that principals in Nordic countries are less engaged in instructional leadership (OECD, 2016). In light of this, the findings might be somewhat different in other national contexts where instructional leadership practices are more prevalent.

Mediating Role of Professional Collaboration (H3)

We found that professional collaboration significantly mediated the relations between distributed leadership and team innovativeness at the teacher level (H3a), whereas at the school level, this additional indirect effect existed only in Finland (H3b). With regard to instructional leadership, our data did not support the mediating role of professional collaboration (H3c). Our findings suggest that individual teacher perceptions of distributed

leadership were positively associated with their collaboration with the colleagues, which in turn was positively related to their perceptions of their colleagues' openness to change.

The teacher-level results correspond to the previous study that reported that professional collaboration mediated the effects of distributed leadership on team innovativeness (Çoban & Atasoy, 2020). The mediating role of professional collaboration may explain the mechanism of how distributed leadership practices are associated with team innovativeness via increased teacher collaboration. This could be interpreted as that a greater sense of shared responsibilities in school decision-making creates a context that encourages a deeper form of collaboration among teachers, which in turn is conductive to teachers' openness to change. That said, sharing leadership opportunities in schools ensures trust in professionals and strengthens their collaborative networks. Teachers working in such environments would be more open to adopting new teaching methods.

Interestingly, when the data were aggregated at the school level, however, the indirect effect was found to be significant only in Finland. One explanation for the differing results in Finland may be due to the relatively low between-school variation in professional collaboration. As noted earlier, although possible interpretations should be verified, this again indicates that country specific factors may relate to a collaborative school culture (OECD, 2014).

Contextual Effects (H4)

We further examined to what extent school-level variables, namely distributed leadership and professional collaboration, have effects on individual teachers' perceptions of team innovativeness by adding contextual effects. In general, the results showed some

inconsistencies in the contextual effects, suggesting variation between countries. The additional direct and indirect contextual effects existed in Finland. Interestingly, for distributed leadership and team innovativeness, the contextual direct effect was found to be significant only in Sweden (H7b).

These inconsistencies may relate to different patterns in school-level relations. For example, in Finland, professional collaboration was significantly associated with distributed leadership and team innovativeness at the school level. Likewise, in Sweden, the shared perceptions of distributed leadership were very high among the countries. Although there were some inconsistencies across the countries, our results highlight a school culture conductive to individual teachers' innovativeness in light of principal leadership and teacher collaboration.

Our findings are in line with the previous research that has pointed to the importance of school culture towards team innovativeness by examining the contextual effects of professional learning and teacher autonomy on team innovativeness (Nguyen et al., 2021). To date, very few studies have investigated the contextual effects of organizational climate on team innovativeness in educational field. In this respect, our findings provide novel insights into to what extent leadership and collaboration at the school level are associated with team innovativeness at the teacher level in Nordic context.

Control Variables

The present study also found that the control variables, namely teacher's gender and age were significantly associated with team innovativeness, suggesting that teachers' perceptions of their colleagues' openness to change can vary depending on their own

demographic factors. The results indicate that with only an exception of Norway, older teachers were more likely to perceive their colleagues as innovative, whereas younger teachers reported lower levels of innovativeness among their colleagues. The existing literature also includes consistent results, suggesting that younger teachers with less experience are more willing to change and implement new teaching methods (Blömeke et al., 2021; Goodson et al., 2006). This may be also interpreted as older teachers' tendency to rely on their experience and well-proven approaches rather than implementing new methods (OECD, 2019b). With respect to gender factor, female teachers reported higher levels of team innovativeness among their peers, suggesting that female teachers perceived their male counterparts as more innovative, which corresponds to the previous study (Blömeke et al., 2021). One possible explanation may be that females' risk taking behaviors remain invisible, and therefore their male counterparts may perceive female teachers as less innovative (Kör et al., 2021).

Limitations and Directions for Future Research

One of the limitations of this study relates to the cross-sectional design of TALIS. Any causal inferences cannot be drawn from this study with respect to the associations between the variables (Levin, 2006). For example, the direction of the relationship between professional collaboration and team innovativeness can be reversed. Likewise, with respect to the mediating effect, team innovativeness can mediate the relationship between distributed leadership and collaboration. The responses capture the individual teachers' and principals' perceptions at one single point, not over a longer time period. This suggests that the directions of associations may differ within another timeframe. Our findings cannot therefore

be used to provide any empirical evidence on the influence school leadership and professional collaboration have upon team innovativeness as causal relations should be avoided. The robustness of our findings would be strengthened with longitudinal data in future studies.

Another limitation is that TALIS used teacher and principal self-report data. In our study, all the variables were measured as perceptions. We do not know the actual levels of school leadership, collaboration, and innovativeness. More specifically for distributed leadership, the previous research revealed that the significant variations existed for the extent to which teacher perceptions were different from principal self-reports (Y. Liu et al., 2018). That said, principals generally reported a higher level of distributed leadership than teachers. Likewise, we also recognize the limitations of principal self-reports of instructional leadership. Teachers and principals may give socially desirable answers, which might be inconsistent with the response gained from alternative resources. This can be problematic when there is incongruency in the perceptions of teachers and principals, which may hamper validity (Y. Liu & Watson, 2020). OECD itself reports its limitations and suggests the TALIS video study and small-scale observational studies to reduce any biased results (Price & Carstens, 2020).

As noted earlier, there is also a limitation in the construct of instructional leadership. Firstly, from a methodological point of view, using only three items to measure the construct may hamper the model fit and model identification (OECD, 2019b). Another limitation, from a conceptual point of view, is that the instructional scale in TALIS may not include comprehensive construct relevant features. The construct underrepresentation is due to using

the biased self-reports of principals with only three items (Veletić & Olsen, 2021). We hope future studies address these issues and examine the relations of instructional leadership by using the scale built on teachers' perceptions of instructional leadership.

Conclusion and Implications

In conclusion, the present study reveals that team innovativeness generally relates to more frequent teacher collaboration and higher levels of principal distributed leadership. Furthermore, it supports the idea that on the school level, the implementation of new ideas requires organizational preconditions conductive to professional development through collaborative activities and shared leadership among the stakeholders.

Despite certain limitations, our findings significantly contribute to our understanding of the role principals and teachers have for innovative school climate, specifically in the Nordic countries. Further, the relations of aggregated teacher perceptions of team innovativeness provide valuable insights into innovative school climate in the Nordic countries by examining the extent to teachers agree on innovative school environment within a school.

The implications of this study for policy makers are two folds. First, when developing policies to enhance school innovativeness, it is important to assure the availability of the resources and opportunities to engage teachers regularly in deeper form of collaboration among peers. Professional collaboration promotes teacher interdependence and enhanced shared responsibility for the class, which would be facilitative to teachers' openness to change (Johnston & Tsai, 2018; Little, 1990b; OECD, 2020b). That said, a deeper level of collaboration, such as observing other teachers or team teaching involves more

interdependence between teachers. Consequently, professional collaboration creates a support mechanism for teachers to rely on each other by mutual support and share responsibility and accountability for student learning and professional development. OECD reports that professional collaborative activities such as team teaching are less prevalent than simple exchanges and co-ordination between teachers in general, specially pointing to the substantially less frequent observation-based feedback to teachers than any other forms of professional collaboration in Finland and Denmark (OECD, 2020b). Therefore, policies towards school innovativeness need to address professional collaboration as a precondition.

Second, the role of school leaders is vital in fostering collaboration and team innovativeness, which points to the importance of distributed leadership. Teachers who felt a greater sense of agency over their classes and other aspects of school life perceived their schools to be more innovative and more frequently engaged in collaborative activities with their colleagues (OECD, 2020a). Consequently, we could argue that school leaders and policy makers should consider ways to grant more responsibility and autonomy to teachers through greater distributed leadership in schools. OECD (2020a), for instance, suggests a practical advice to facilitate distributed leadership by engaging teachers in establishing student assessment policies, student disciplinary policies or hiring teachers. As leaders within the school, principals should continuously endeavor to engage teachers, students and parents in decision making to create school culture towards innovativeness.

Our goal of this study was to examine to what extent team innovativeness was associated with distributed, instructional leadership, and professional collaboration in Nordic context. Although our study contributes to the literature by exploring the Nordic model in

light of team innovativeness, it was beyond the scope of our study to explain all the country-specific factors attributable to innovative school climate with precision. However, for future study, it would be interesting to investigate the sources of inconsistent findings by examining any country-specific factors in the Nordic countries.

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Appendix A

GDPR documents & Ethical approval

NOTIFICATION FORM (ENGLISH TRANSLATION) – NSD

 Personal data

 Types of data

 Project Information

 Responsibility

 Sample and Criteria

 Third Persons

 Documentation

 Other approvals

 Processing

 Information Security

 Duration of project

 Additional Information

 Send in

Which personal data will be processed?

Personal data are any data about an identified or identifiable natural person (data subject).

Pseudonymised data are also considered personal data.

"Pseudonymisation" means processing collected data in way that the data can no longer be

linked to individual persons, without the use of additional information. This usually involves removing identifiable information such as name, national ID number, contact details etc. from the collected data and giving each data subject a code/number. A scrambling key is the file/list of names and codes that makes it possible to identify individuals in the collected data. The scrambling key should be stored separately form the rest of the data. NB: processing pseudonymised data is still considered processing personal data, even if you do not have access to the scrambling key, and even if the scrambling key is being stored by an external party, such as SSB, the National registry etc.

Name

First name and surname

No

National ID number or other personal identification number

11-digit personal identifier, D number, or other national identification number

No

Date of birth

No

Address or telephone number

No

Email address, IP address or other online identifier

An email address is a unique address that is assigned to the user of an electronic mail service. An IP address is a unique address that is assigned to a device (e.g. a computer) in a computer network like the Internet. Dynamic IP addresses may also be considered personal data in certain cases. Cookies are an example of an online identifier. NB! If you are going use an online survey, and the service provider (data processor) will have access to email addresses or IP addresses, you must indicate this here.

No

Photographs or video recordings of persons

Photographs and video recordings of faces are usually considered to be personal data

No

Audio recordings of persons

Audio recordings where personal data are recorded and/or where there exists a scrambling key that links the audio recordings to individual persons on the recordings. The voice of the person speaking may be considered personal data in combination with other background information.

No

GPS data or other geolocation data

Data which indicate the geographical location of a person

No

Demographic data that can identify a natural person

E.g. a combination of information such as municipality of residence, workplace, position, age, gender etc.

Gender

Age

Country

Genetic data

Personal data relating to the inherited or acquired genetic characteristics of a natural person, which give unique information about the physiology or health of that person.

No

Biometric data

E.g. fingerprint, handprint, facial form, retina and iris scan, voice recognition, DNA.

No

Other data that can identify a natural person

If you think that you will be processing personal data but cannot find a suitable alternative above, indicate this here.

No

Will special categories of personal data or personal data relating to criminal convictions and offences be processed?

Racial or ethnic origin

This includes belonging to an ethnic group, population, cultural sphere or society that has common characteristics. For example, information that a person is Sami is not considered to say anything about race but it says something about ethnicity.

No

Political opinions

That a person is a member of a political party and/or what a person voted in an election, including political opinions and beliefs. However, this does not include information that a person is a conservative, radical or labour party supporter.

No

Religious beliefs

That a person is a member of a religious organisation/congregation. This does not include information that a person has a subscription to a religious newspaper.

No

Philosophical beliefs

That a person is a member of a philosophical association, or that a person believes that knowledge is acquired through logical speculation and observation.

No

Trade Union Membership

That a person is a member of a trade union that organises employees within the same industry/subject area, e.g. LO, NTL, NAR etc.

No

Health data

Personal data concerning a natural person's physical or mental health, including use of healthcare services.

No

Sex life or sexual orientation

A person's sexual orientation (homosexual, lesbian, bisexual etc.) and/or sexual behaviour (e.g. that a personal has been unfaithful, indecent exposure, offensive gestures/language)

No

Criminal convictions and offences

Personal data concerning convictions and offences, or related to security measures.

No

Project Information

Title

Team Innovativeness in Nordic Schools: Do Distributed, Instructional Leadership and Teacher Professional Collaboration Matter?

Project description

Give a description of the project's scientific purpose/research question

The current project examines the relations of team innovativeness to its determinants, namely principal leadership (i.e., distributed leadership and instructional leadership) and teacher professional collaboration at both the individual teacher and school levels controlling for teacher age and gender, including contextual effects. The TALIS 2018 data set comprising four Nordic countries (Denmark, Finland, Norway, Sweden) are investigated, using a multilevel structural equation modelling. In particular, the mediating role of professional collaboration in the relationship between school leadership (i.e., distributed leadership, instructional leadership) is examined.

Subject area

- Social sciences
- Technological sciences

Will the collected personal data be used for other purposes, in addition to the purpose of this project?

Personal data should only be processed for specified, explicit and legitimate purposes. This means that each purpose for processing personal data must be identified and described clearly and accurately. In order for a purpose to be considered legitimate, it must also be in accordance with ethical and legal norms.

No

Explain why it is necessary to process personal data.

Explain why the personal data are adequate, relevant and limited to what is necessary for the purposes for which they are being processed. This includes limiting the amount of collected data to that which is necessary to realise the purposes of data collection.

The personal data related to teacher age and gender is adequate for the purpose of controlling for gender and age that might influence team innovativeness in our study

External funding

- **The Research Council of Norway (Norges forskningsråd - NFR)**

  N/A

- **Public authorities**

  N/A

E.g. research commissioned by a ministry

- **Other**

  N/A

E.g. funding from a pharmaceutical company or from private actors

Type of project

- Student project, Master's thesis

Responsibility for data processing

Data controller

The institution responsible for the processing of personal data. The data controller

determines the purposes for which, and the manner in which, personal data are processed.

University of Oslo, CEMO - Centre for Educational Measurement

Project leader (research assistant/ supervisor or research fellow/phD candidate)

The person responsible for the project.

Name: Sigrid Blömeke

Position: Center director (Center for Educational Measurement)

Email address: sigrid.blomeke@cemo.uio.no

Name: Ronny Scherer

Position: Professor (Center for Educational Measurement)

Email address: ronny.scherer@cemo.uio.no

Name: Trude Nilsen

Position: Researcher (Department of Teacher Education and School Research)

Email address: ronny.scherer@cemo.uio.no

Name: Trude Nilsen

Position: Researcher (Department of Teacher Education and School Research) Email address: trude.nilsen@ils.uio.no

Will the responsibility for processing personal data be shared with other institutions

(joint data controllers)?

No

If two or more institutions together decide the purposes for which personal data are processed, they are joint data controllers.

Joint data controllers

N/A

Whose personal data will be processed?

You must describe each group of people whose personal data you will be processing. Add and describe each sample individually.

N/A

Sample 1

Describe the sample

N/A

Recruitment or selection of the sample

Describe how the sample will be recruited and how initial contact with the sample will be made. For example, whether you will make initial contact during field-work or via your own network, or whether a school, hospital or organisation will contact its pupils, patients or members on your behalf. If the sample will not be recruited but will be selected from a registry or an administrative system etc., describe how the selection will be carried out and

what the selection criteria will be.

N/A

Will you include adults (18 år +) who do not have the capacity to consent?

i.e. the person has reduced capacity or lacks capacity to consent. For example, the person may have mental/cognitive impairment, significant physical/emotional ailments, or may be unconscious, conditions which make it difficult or impossible for the person to gain sufficient understanding in order to give valid consent. The central aspect is whether the person is capable of understanding the purpose of the processing/project in question, and of understanding potential positive and negative consequences (immediate and long-term).

N/A

Types of personal data - sample 1

Name N/A

National ID number or other personal identification number N/A

Date of birth N/A

Address or telephone number N/A

Email address, IP address or other online identifier N/A

Photographs or video recordings of persons N/A

Audio recordings of persons N/A

GPS data or other geolocation data N/A

Demographic data that can identify a natural person N/A

Genetic data N/A

Biometric data N/A

Other data that can identify a natural person N/A

Methods /data sources - sample 1

Select and/or describe the method(s) for collecting personal data and/or the source(s) of data

Personal interview N/A

Group interview Online survey Paper-based survey N/A

Participant observation Non-participant observation N/A

Field experiment / field intervention N/A

Web-based experiment N/A

Tests for pedagogical research / psychological tests N/A

Medical examination and/or physical tests N/A

Human biological material N/A

Social media – open forum N/A

Social media – closed forum N/A

Discussion board/forum for online newspapers/online debates N/A

Big data N/A

Medical records N/A

Biobank N/A

Data from another research project N/A

Other N/A

Statistics Norway - SSB N/A

Criminal records (Det sentrale straffe- og politiopplysningsregisteret, SSP) N/A

Medical Birth Registry of Norway (Medisinsk fødselsregister, MFR) N/A

Norwegian Registry of Pregnancy Termination (Register over svangerskapsavbrudd) N/A

Norwegian Cardiovascular Disease Registry (Hjerte- og karregisteret) N/A

Norwegian Cause of Death Registry (Dødsarsaksregisteret, DÅR) N/A

Norwegian Prescription Database - NorPD (Reseptregisteret) N/A

Norwegian Immunisation Registry (Nasjonalt vaksinasjonsregister, SYSVAK) Norwegian N/A

Surveillance System for Communicable Diseases (Meldesystem for smittsomme sykdommer, MSIS) N/A

Norwegian Surveillance System for use of antibiotics and healthcare related infections (Norsk overvåkingssystem for antibiotikabruk og helsetjenesteassosierte infeksjoner, NOIS) N/A

Norwegian Surveillance System for Antimicrobial Drug Resistance (Norsk overvåkingssystem for antibiotikaresistens hos mikrober, NORM) Norwegian Surveillance System for Virus Resistance (Norwegian Surveillance System for Virus Resistance, RAVN) N/A

Norwegian Patient Registry (Norsk pasientregister, NPR) IPLOS-registeret Kommunalt pasient- og brukerregister (KPR) Cancer registry of Norway (Kreftregisteret) N/A

Genetic Mass Survey of Newborns (Genetisk masseundersøkelse av nyfødte) N/A

Reseptformidleren N/A

Forsvarets helseregister N/A

Helsearkivregisteret N/A

Helseundersøkelsen i Nord Trøndelag (HUNT) N/A

Tromsø-undersøkelsen N/A

SAMINOR N/A

Den norske mor og barn undersøkelsen (MoBa) N/A

Nasjonalt register for langtids mekanisk ventilasjon N/A

Nasjonalt kvalitetsregister for barnekreft N/A

Norsk Kvalitetsregister Øre-Nese-Hals –Tonsilleregisteret N/A

Norsk vaskulittregister & biobank (NorVas) N/A

Norsk Parkinsonregister & biobank N/A

Norsk karkirurgisk register (NORKAR) N/A

Norsk hjertinfarkregister N/A

Gastronet N/A

Norsk register for analinkontinens N/A

Nasjonalt barnehofteregister N/A

Norsk kvalitetsregister for artrittsykdommer (NorArtritt) N/A

Norsk nakke- og ryggregister N/A

Nasjonalt korsbåndregister N/A

Nasjonalt register for leddproteser N/A

NorKog N/A

Norsk MS-register og biobank N/A

Nasjonalt register for KOLS N/A

Nasjonalt kvalitetsregister for lymfom og lymfoide leukemier N/A

Nasjonalt kvalitetsregister for lungekreft N/A

Nasjonalt kvalitetsregister for føflekkreft N/A

Nasjonalt kvalitetsregister for brystkreft N/A

Nasjonalt kvalitetsregister for prostatakreft N/A

Nasjonalt kvalitetsregister for tykk- og endetarmskreft N/A

Nasjonalt register for ablasjonsbehandling og elektrofysiologi i Norge (ABLA NOR) N/A

Norsk register for invasiv kardiologi (NORIC) N/A

Norsk hjertesviktregister N/A

Norsk pacemaker- og ICD- register N/A

Nasjonalt kvalitetsregister for gynekologisk kreft N/A

Norsk register for gastrokirurgi (NoRGast) N/A

Nasjonalt kvalitetsregister for behandling av spiseforstyrrelser (NorSpis) N/A

Information - sample 1

Will you inform the sample about processing their personal data?

N/A

How? N/A

Written information (on paper or electronically)

Oral information

See what you must give inform about and preferably use our template for the information letter.

Information should be given in writing or electronically. Only in special cases is it applicable

to give oral information, if a participant asks for this. See what you must give information about.

Upload information letter N/A

Upload copy of oral information N/A

Explain why the sample will not be informed about the processing of their personal data.

+ Add sample

Third persons

Will you be processing personal data about third persons? This includes data about persons who are not included in the sample/are not participating in the project; information provided by a data subject that relates to another identified or identifiable natural person. Examples of this are when a data subject is asked about their mother's and father's education or country of origin, or when pupils are asked about their teacher's teaching methods.

No

Describe the third persons N/A

Types of personal data about third persons N/A

Name N/A

National ID number or other personal identification number N/A

Date of birth N/A

Address or telephone number N/A

Email address, IP address or other online identifier N/A

Photographs or video recordings of persons N/A

Audio recordings of persons N/A

GPS data or other geolocation data N/A

Demographic data that can identify a natural person N/A

Genetic data N/A

Biometric data N/A

Other data that can identify a natural person N/A

Which sample will provide information about third persons? N/A

Sample 1

Sample 2 etc.

Will third persons consent to the processing of their personal data?

N/A

Will third persons receive information about the processing of their personal data?

N/A

Upload information letter

Chose file...

N/A

Explain why third persons will not be informed.

Documentation

Total number of data subjects in the project

(Data subjects: persons whose personal data you will be processing)

- 1-99
- 100-999
- 1000-4999
- 5000-9999
- 10.000-49.999
- 50.000-100.000
- 100.000+

How can data subjects get access to their personal data or how they can have their personal data corrected or deleted?

Rights of data subjects (participants) include the right to access one's own personal data and to receive a copy of one's data if asked for. A data subject can request that their personal data are corrected if they feel that the information is wrong or lacking, and the data subject can withdraw consent and request that their personal data are deleted. Give a short description of the procedure for how a data subject can get access to their personal data, and how they can have their personal data corrected or deleted.

Subjects can get access to their data by contacting TALIS team

Other approvals

Will you obtain any of the following approvals or permits for the project? N/A

Indicate if you will obtain any of the following approvals or permits in order carry out the

project.

- Ethical approval from The Regional Committees for Medical and Health Research Ethics (REC)
- Confidentiality permit (exemption from the duty of confidentiality) from the Regional Committees for Medical and Health Research Ethics (REC)

REC has the authority to grant a confidentiality permit for the processing of health data, both for health research and other research.

- Approval from own management for internal quality-assurance and evaluation of health services (intern kvalitetssikring) (The Health Personnel Act § 26)
- Confidentiality permit (exemption from the duty of confidentiality) from the Norwegian Directorate of Health, for quality-assurance and evaluation of health services (kvalitetssikring) (The Health Personnel Act § 29b)
- Biobank
- Confidentiality permit (exemption from the duty of confidentiality) from Statistics Norway (SSB) Statistics Norway has the authority to grant a confidentiality permit for the data that they manage, e.g. data about population, education, employment and social security.
- Approval from The Norwegian Medicines Agency (Statens legemiddelverk, SLV) E.g. for a clinical drugs trial
- Confidentiality permit (exemption from the duty of confidentiality) from a department or directorate
- Other approval E.g. from a Data Protection Officer

Processing

Where will the personal data be processed?

"Processing" includes any collecting, registering, storing, collating, transferring etc. of data. You must indicate all processing of personal data that will take place in the project.

- Computer belonging to the institution responsible for the project

Computer owned/operated by the data controller. For example, processing data in a private or communal user area on the institution's server.

- Mobile device belonging to the data controller

Mobile device owned/operated by the data controller. A mobile device can be a laptop, camera, mobile phone etc.

- Physically isolated computer belonging to the data controller

Not connected to other computers or to a network, neither internally nor externally.

- External service or network

Such as providers of cloud storage, online surveys or data storage (such as TSD). Use of an external service or server requires that a data processor agreement is made between the data controller and the external party.

- Private device

Data collection or storage on private devices such as your own computer or mobile phone etc. is not recommended and must be clarified with the institution responsible for the project.

Data collection, storing or archiving on private devices such as your own computer, mobile phone, memory stick etc. is not recommended and must be clarified with the institution responsible for the project.

Who will be processing/have access to the collected personal data?

- Project leader
- Student (student project)
- Internal co-workers

Employees of the data controller

- External co-workers/collaborators inside the EU/EEA

Employees of other institutions that have formalised cooperation with the data controller, or employees of other institutions that are joint data controllers.

- Data processor

An external person or entity that processes personal data on behalf of the data controller, such as an online survey provider, cloud storage provider, translator or transcriber. There must be a data processor agreement or other legal agreement between the data controller and the external party.

- Others with access to the personal data

Which others will have access to the collected personal data?

Will the collected personal data be made available to a third party or international organisation outside the EEA?

This includes when personal data are sent to and stored in a country outside the EEA, or when persons outside this area are given access to personal data stored within the EEA. This means that you cannot use a service provider or outsourced supplier outside the EEA, unless there is a valid basis for the transfer of personal data.

No

Give the name of the institution/organisation N/A

Give the country of the institution/organisation N/A

On what basis will the collected personal data be transferred? N/A

Personal data can be transferred on the basis of an adequate level of protection (art. 45) or on the basis of appropriate safeguards (art. 46). Personal data can also be transferred on the basis of the exception for special situations, but only if the transfer is not repeated, concerns only a limited number of data subjects, is necessary for the purposes of compelling legitimate interests pursued by the data controller (which are not overridden by the interests or rights and freedoms of the data subject), and if the data controller has assessed all the circumstances surrounding the data transfer and has provided suitable safeguards with regard to the protection of personal data (art. 49).

Information Security

Will directly identifiable personal data be stored separately from the rest of the collected data (in a scrambling key)?

It is common practice to remove directly identifiable data (name, national ID number, contact details etc.) from the collected data and give each data subject a code/number. A scrambling key is the file/list of names and codes that makes it possible to directly identify data subjects in the collected data. It should be stored separately from the rest of the collected data. In practice, this means that the scrambling key cannot be stored in the same network as the rest of the data, unless the scrambling key is encrypted.

Yes

Explain why directly identifiable personal data will be stored together with the rest of the collected data. N/A

For reasons of information security we recommend the use of a scrambling key in most projects, especially in projects where special categories of personal data (previously "sensitive" personal data) or personal data relating to criminal convictions and offences will be processed.

Which technical and practical measures will be used to secure the personal data?

- Personal data will be anonymised as soon as no longer needed

Anonymisation involves processing the data in such a way that no individual persons can be identified in the data that you're left with, i.e. the data can no longer be linked to individual persons in any way.
*Anonymisation usually involves: *deleting directly identifiable personal data (including scrambling key/list of names) *deleting or rewriting indirectly identifiable personal data (e.g. deleting or categorizing variables such as age, place of residence, school etc.) *deleting or editing audio recordings, photographs and video recordings*

- Personal data will be transferred in encrypted form

Encryption is a mathematical method for ensuring confidentiality in that information cannot be read by unauthorized persons. For example, using an encrypted VPN tunnel or equivalent

measure for external login to work-place network.

- Personal data will be stored in encrypted form

Encryption is a mathematical method for ensuring confidentiality in that information cannot be read by unauthorized persons. For example, the encryption of a hard drive to ensure the confidentiality of data when the computer is turned off.

- Record of changes

Changes in the collected data are recorded/documented with the time of the change and information about the person who made that change.

- Multi-factor authentication

A method of access control where a user is granted access after presenting two or more separate pieces of evidence to prove their identity (e.g. password + code sent by text message)

- Restricted access

Blocking or restricting access to the collected data for unauthorized persons

- Access log

An access log shows who has accessed the collected data and when

- Other security measures

For example, locking away documents, automatic screen lock after a short time for mobile devices, partitioning of hard drive, checksum/integrity check etc.

Indicate which measures N/A

Duration of project

Project period

01.07.2020 – 30.06.2022

Will personal data be stored beyond the end of project period?

Personal data should not be further processed a way that is inconsistent with the initial purpose(s) for which the data were collected. Anonymous/anonymised data may be stored indefinitely, so long as nothing else has been agreed to by the data subjects.

- No, all collected data will be deleted
- No, the collected data will be stored in anonymous form

Stored in a form where the data can no longer be linked to individual persons in any way

- Yes, collected personal data will be stored until
- Yes, collected personal data will be stored indefinitely.

For what purpose(s) will the collected personal data be stored? N/A

- Research
- Other

Where will the collected personal data be stored? N/A

- At the institution responsible for the project (data controller)
- Other

Additional information

Will the data subjects be identifiable (directly or indirectly) in the thesis/publications for the project? *If personal data are to be published, there should be a scientific purpose for this. Data is usually published in anonymous form.*

No

Explain why N/A

Additional information

Here you can provide information that may have significance for our assessment of the project, including more detailed information about points covered in the form and information that is not covered by points in the form.

Other attachments

e.g. interview guide, questionnaire, information letter and consent form etc.

Appendix B

Data Management & Analysis Code

R code

```
################ Importing data ################
#1. Importing two data sets from TALIS2018
## TEATal18 (Teacher), PCATal18 (Principal)
TEATAL18 = read.spss(file="../data/BTGINTT3.sav", to.data.frame=TRUE) # Teacher
PCATAL18 = read.spss(file="../data/BCGINTT3.sav", to.data.frame=TRUE) # Principal

colnames(TEATAL18)
################ Inspecting data ################
#2. Inspecting data
#2.1. Function for inspecting data
inspect <- function(data){
  out <- c(
    structure = str(data), # data structure
    datasize = dim(data),   # data size
    numcntry = length(unique(data$IDCNTRY)), # number of countries
    norway = table(data$IDCNTRY == "Norway")) # Norway sample size
  return(out)
}

#2.2. Inspecting Teacher data
inspect(TEATAL18) # 153682,493, 47countries, Norway 4154 teacher sample

#2.3. Inspecting Principal data
inspect(PCATAL18) # 9247,448, 47countries, Norway 193 principal sample
```

```
#3. Subsetting data
#3.1. Inspecting variable names
varnames_tea <- c(colnames(TEATAL18)) # Teacher
varnames_pca <- c(colnames(PCATAL18)) # Principal

#3.1. Subsetting teacher data
## Country variable : IDCNTRY(5) DEN(12), FIN(14), NOR(40), SWE(30)
## ID variables: IDTEACH(1), IDSCHOOL(2)
## Gender: TT3G01(9) Female(1), Male(2)
## Teacher Age : TCHAGER(460)
# DILP : T3STAKE (482)
# PCOL : T3COLES (465)
# TEAM : T3TEAM (483)

NorTEA18 <-   subset(TEATAL18, select = c(1, 2, 5, 9, 460, 482, 465, 483)) %>%
  filter(IDCNTRY == "Denmark" | IDCNTRY == "Finland" | IDCNTRY == "Norway" |
IDCNTRY == "Sweden" )

################ Subsetting data ################
#3.1. Subsetting principal data
## Country variable : IDCNTRY(4) FIN(14), NOR(30), SWE(40), DEN(12)
## ID variable: IDSCHOOL(1)
## Item Variable (School Type): TT3G12(52) Public(1) Private(2)
## Principal Age: PRAGER (425)
## INLP : T3PLEADS (437)
## Gender: TC3G01 (8)

  NorPCA18 <-
  subset(PCATAL18, select = c(1, 4, 52, 437)) %>%
```

```
  filter(IDCNTRY == "Denmark" | IDCNTRY == "Finland" | IDCNTRY == "Norway" |
IDCNTRY == "Sweden" )

inspect(NorTEA18)
inspect(NorPCA18)

############### Data wrangling ###############
########### Teacher Data ###########
## Renaming columns
new_names <- c(
  'IdTea', 'IdSch', 'IdCntry', 'Gen_tea', 'Age_tea', 'DILP','PCOL', 'TEAM')
names(NorTEA18) <- new_names

## Converting data type from factor to numeric
new_tea <- unfactor(NorTEA18)

columns <- c ( 'IdCntry', 'Gen_tea', 'Age_tea')
new_tea[, columns] <- lapply(columns, function(x) as.numeric(NorTEA18[[x]]))

inspect(new_tea)

## Computing new UNISCHID (IdCntry * 100000 + IdSch)
new_tea$UniSchId <- new_tea$IdCntry * 100000 + new_tea$IdSch

## Computing new UniTchId (IdCntry * 1000000 + IdTea)
new_tea$UniTchId <- new_tea$IdCntry * 1000000 + new_tea$IdTea

## Recoding (female :0, male :1)
new_tea$Gen_tea <- ifelse(new_tea$Gen_tea == 1, 0, 1)
```

```
########### Principal Data ###########
## Renaming columns
new_names <- c(
   'IdSch', 'IdCntry', 'SchTyp', 'INLP')
names(NorPCA18) <- new_names

## Converting data type from factor to numeric
new_pca <- unfactor(NorPCA18)

columns <- c ('IdCntry', 'SchTyp')
new_pca[, columns] <- lapply(columns, function(x) as.numeric(NorPCA18[[x]]))
inspect(new_pca)

## Computing new UNISCHID (IdCntry * 100000 + IdSch)
new_pca$UniSchId <- new_pca$IdCntry * 100000 + new_pca$IdSch

## Recoding (public :0, private :1)
new_pca$SchTyp <- ifelse(new_pca$SchTyp == 1, 0, 1)
################## Merging data ###################
#7. Identifying the mismatching school IDs (Principal 193, Teacher 185)
#### Which SCHOOLIDs both datasets have in common
commonID<-intersect(new_tea$UniSchId,new_pca$UniSchId)

#### Restricting both datasets to the School IDs they have in common
TEAcommon<-new_tea[new_tea$UniSchId %in% commonID,]
PCAcommon<-new_pca[new_pca$UniSchId %in% commonID,]

length(PCAcommon$UniSchId) # 654 school IDs common in both datasets
length(TEAcommon$UniSchId)   # 11788 teachers with the common school IDs
```

```
## Merging
combined <- full_join(new_tea, new_pca) %>%
   select(-IdTea, -IdSch)    # removing the country column (All Norway)

inspect(combined) # 11863, 10
#inspnew(combined) # checking missing data
colnames(combined) # checking variable names

# Reordering columns
mydata <- combined[
   , c(1, 7, 8, 9, 2, 3, 4, 10, 5, 6)]
colnames(mydata) # Checking variable names

################ Descriptives ####################
# Descriptives : Total
Des_total <- describe(mydata[5:10])

# Descriptives : By Countires
Des_Nordic <- describeBy(mydata[5:10],
                group = list(mydata$IdCntry),
                fast = T)

## Correlations_total
stats <- statsBy(mydata[, c(7:10)], mydata$UniSchId, cors = TRUE)
print(stats,short=FALSE)

cor_total <-
   apa.cor.table(mydata[5:10], filename="APA_Corr_table_total(2804).doc",
table.number=1)
```

```
## Correlations_Den (12)
den_mydata <- mydata %>%
  filter(IdCntry == 12 )

inspect(den_mydata)

cor_denmark <-
  apa.cor.table(den_mydata[5:10], filename="APA_Corr_table_denmark(2804).doc",
table.number=1)

## Correlations_Fin (14)
fin_mydata <- mydata %>%
  filter(IdCntry == 14 )

inspect(fin_mydata)

cor_finland <-
  apa.cor.table(fin_mydata[5:10], filename="APA_Corr_table_finland(2804).doc",
table.number=1)

## Correlations_Nor (30)
nor_mydata <- mydata %>%
  filter(IdCntry == 30 )

inspect(nor_mydata)

cor_norway <-
  apa.cor.table(nor_mydata[5:10], filename="APA_Corr_table_norway(2804).doc",
table.number=1)
```

```
## Correlations_Swe (40)
swe_mydata <- mydata %>%
  filter(IdCntry == 40 )

inspect(swe_mydata)

cor_sweden <-
  apa.cor.table(swe_mydata[5:10], filename="APA_Corr_table_sweden(2804).doc",
table.number=1)

# Aggregated level correlations
school_level = aggregate(mydata[, c(2, 5:10)],
                         by = list(mydata$UniSchId),
                         FUN = mean)

## Total Nordic sample : level2 correlations
cor_total_level2 <-
  apa.cor.table(school_level[5:8], filename="APA_Corr_table_total_nordic(2904).doc",
table.number=1)

## DEN level2 correlation
den_school_level = aggregate(den_mydata[, c(2, 5:10)],
                             by = list(den_mydata$UniSchId),
                             FUN = mean)

den_cor_total_level2 <-
  apa.cor.table(den_school_level[5:8], filename="APA_Corr_table_den_level2(2904).doc",
table.number=1)
```

```
## FIN level2 correlation
fin_school_level = aggregate(fin_mydata[, c(2, 5:10)],
                             by = list(fin_mydata$UniSchId),
                             FUN = mean)

fin_cor_total_level2 <-
  apa.cor.table(fin_school_level[5:8], filename="APA_Corr_table_fin_level2(2904).doc",
table.number=1)

## NOR level2 correlation
nor_school_level = aggregate(nor_mydata[, c(2, 5:10)],
                             by = list(nor_mydata$UniSchId),
                             FUN = mean)

nor_cor_total_level2 <-
  apa.cor.table(nor_school_level[5:8], filename="APA_Corr_table_nor_level2(2904).doc",
table.number=1)

## SWE level2 correlation
swe_school_level = aggregate(swe_mydata[, c(2, 5:10)],
                             by = list(swe_mydata$UniSchId),
                             FUN = mean)

swe_cor_total_level2 <-
  apa.cor.table(swe_school_level[5:8], filename="APA_Corr_table_swe_level2(2904).doc",
table.number=1)
```

Mplus Syntax

```
TITLE: TALIS2018 Multilevel model
         GROUP 208 DEN 246 FIN 578 NOR 752 SWE

DATA: FILE IS TALIS2018NORDIC_2.dat ;

VARIABLE : NAMES ARE IDTEACH IDSCHOOL IDCNTRY GND_TCH SCHWGT TCHWGT
UIDTEACH USCHOOLID
            TCHAGEGR  PCOL DILP TEAM GND_PC PRAGEGR SCHTYP INLP;


  USEVARIABLES ARE
            PCOL DILP TEAM INLP
            SCHTYP TCHAGEGR GND_TCH;

BETWEEN = INLP SCHTYP;
! INLP is a variable only measured at the school level
! Restrict it to the between level

WITHIN= TCHAGEGR GND_TCH;

MISSING ARE ALL (-99);
        ! All missing are coded as -99

WEIGHT IS TCHWGT;
! Teacher weight (L1)

WTSCALE IS cluster;
! Scale the L1 weight to the cluster size

BWEIGHT = SCHWGT;
! School weight (L2)

BWTSCALE = sample;
! Scale the L2 weight to the sample

CLUSTER IS USCHOOLID;
! Clustering of the teacher data in schools
! Unique school ID

! GROUPING IS IDCNTRY (208=DEN 246=FIN 578=NOR 752=SWE);
! Introduce the grouping variable here


ANALYSIS:
        TYPE = TWOLEVEL;
        ESTIMATOR = MLR;
        PROCESSORS = 4;
        H1ITERATIONS = 10000;

MODEL:
        ! STRUCTURAL MODEL
        ! Direct L1 effects of PCOL, DILP on TEAM
```

```
%WITHIN%
! Teacher level
! Path coefficients
TEAM ON PCOL ;
TEAM ON DILP ;
PCOL ON DILP ;

! Control variables
TEAM ON TCHAGEGR GND_TCH;
!PCOL ON TCHAGEGR GND_TCH;
!DILP ON TCHAGEGR GND_TCH;


!Variances of the predictor
DILP ;

!Variances of the mediator
PCOL ;

!Variances of the outcome variable
TEAM ;



%BETWEEN%
! School level
! Path coefficients
! Direct L2 effects
TEAM ON PCOL ;
TEAM ON DILP ;
TEAM ON INLP ;
PCOL ON DILP ;
PCOL ON INLP ;


! Control variables
TEAM ON SCHTYP;
!PCOL ON SCHTYP;
!DILP ON SCHTYP;
!INLP ON SCHTYP;


! Variance of the predictor
INLP;
DILP;

! Variance of the mediator
PCOL;

! Variance of the outcome variable
TEAM;


! Covariance of the IVs
   DILP WITH INLP;
```

```
!MODEL DEN:
        ! STRUCTURAL MODEL
        ! Direct L1 effects of PCOL, DILP on TEAM

        %WITHIN%
        ! Teacher level
        ! Path coefficients
        TEAM ON PCOL (pw_den);
        TEAM ON DILP (dw_den);
        PCOL ON DILP (dpw_den);


        !Variances of the predictor
        DILP (PsiW_den);

        !Variances of the mediator
        PCOL (Psi_PW_den);

        !Variances of the outcome variable
        TEAM (Ttw_den);



       %BETWEEN%
        ! School level
        ! Path coefficients
        ! Direct L2 effects
        TEAM ON PCOL (pb_den);
        TEAM ON DILP (db_den);
        TEAM ON INLP (ib_den);
        PCOL ON DILP (dpb_den);
        PCOL ON INLP (ipb_den);

        ! Control variables
        TEAM ON SCHTYP;


       ! Variance of the predictor
       INLP;
       DILP (PsiB_den);

       ! Variance of the mediator
       PCOL (Psi_PB_den);

       ! Variance of the outcome variable
       TEAM (Ttb_den);


       ! Covariance of the IVs
          DILP WITH INLP;


MODEL CONSTRAINT:

NEW(tp_den td_den tdp_den
```

```
              Btp_den Btd_den Bt_dp_den
              inct_dw_den inct_db_den
       sinct_dw_den sinct_db_den
              Bt_inct_den sBt_inct_den
       );

! Denmark
! Contextual effects (estimated as the effect size)
              tp_den = (pb_den -
pw_den)*2*sqrt(Psi_PB_den)/sqrt(Psi_PW_den**2 + Ttw_den);
              td_den = (db_den - dw_den)*2*sqrt(PsiB_den)/sqrt(PsiW_den**2
+ Ttw_den);
              tdp_den = (dpb_den -
dpw_den)*2*sqrt(PsiB_den)/sqrt(PsiW_den**2 + Psi_PW_den);

! Unstandardized direct contextual effects
              Btp_den = (pb_den - pw_den);
              Btd_den = (db_den - dw_den);
              Bt_dp_den = (dpb_den - dpw_den);


! Unstandardized Indirect effects
              inct_dw_den = dpw_den * pw_den;
              inct_db_den = dpb_den * pb_den;

! Standardized Indirect effects
              sinct_dw_den = dpw_den * pw_den * (PsiW_den/Ttw_den);
              sinct_db_den = dpb_den * pb_den * (PsiB_den/Ttb_den);

! Unstandardized indirect contextual effect
              Bt_inct_den = inct_db_den - inct_dw_den;

! Indirect contextual effects (based on standardized indirect effects)
       sBt_inct_den = sinct_db_den - sinct_dw_den;



MODEL INDIRECT:
       !Estimate the indirect and total effects via PCOL
       TEAM IND INLP;
       TEAM IND DILP;


OUTPUT:
        STDYX;       ! Fully standardized solution
        !MOD(all);   ! Modification indices
```

Appendix C

Supplemental Material

Table C1

Teacher level (L1): ***Total Nordic Sample (N = 11,706)***

Means, standard deviations, and correlations with confidence intervals

Variable	*M*	*SD*	1	2	3	4	5
1. Gender	0.35	0.48					
2. Age	3.99	1.13	-.02* [-.04, -.00]				
3. DILP	11.20	1.64	-.02 [-.03, .00]	-.03** [-.05, -.01]			
4. INLP	10.78	1.90	-.01 [-.03, .01]	-.02* [-.04, -.00]	.01 [-.01, .03]		
5. PCOL	9.08	1.79	.07** [.05, .08]	.00 [-.01, .02]	.19** [.17, .21]	.04** [.02, .05]	
6. TEAM	11.40	1.66	-.05** [-.07, -.03]	.04** [.02, .06]	.34** [.33, .36]	.03** [.02, .05]	.16** [.15, .18]

Note. M and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014). * indicates $p < .05$. ** indicates $p < .01$. DILP = Distributed leadership, INLP = Instructional leadership, PCOL = Professional collaboration, TEAM = Team innovativeness. Gender and Age were measured at the teacher level.

Table C2

Teacher level (L1): *Denmark (N = 1,989)*

Means, standard deviations, and correlations with confidence intervals

Variable	*M*	*SD*	1	2	3	4	5
1. Gender	0.40	0.49					
2. Age	4.00	1.12	-.04 [-.09, .00]				
3. DILP	11.13	1.65	.03 [-.01, .08]	-.08** [-.13, -.04]			
4. INLP	10.54	2.51	.00 [-.04, .05]	.03 [-.01, .08]	-.07** [-.12, -.02]		
5. PCOL	9.07	1.87	.05* [.00, .09]	-.01 [-.06, .03]	.23** [.19, .27]	.05* [.00, .10]	
6. TEAM	11.49	1.86	-.08** [-.13, -.04]	.09** [.05, .14]	.25** [.21, .29]	.05* [.01, .10]	.18** [.13, .22]

Note. M and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014). * indicates $p < .05$. ** indicates $p < .01$. DILP = Distributed leadership, INLP = Instructional leadership, PCOL = Professional collaboration, TEAM = Team innovativeness. Gender and Age were measured at the teacher level.

Table C3

Teacher level (L1): *Finland (N = 2,851)*

Means, standard deviations, and correlations with confidence intervals

Variable	*M*	*SD*	1	2	3	4	5
1. Gender	0.30	0.46					
2. Age	4.04	1.06	-.00 [-.04, .03]				
3. DILP	11.29	1.71	.01 [-.03, .05]	.01 [-.03, .05]			
4. INLP	11.11	1.68	.01 [-.03, .05]	-.02 [-.06, .01]	-.02 [-.06, .02]		
5. PCOL	9.10	1.87	.08** [.04, .11]	.02 [-.02, .06]	.16** [.12, .19]	.04* [.01, .08]	
6. TEAM	11.08	1.72	-.03 [-.07, .01]	.11** [.07, .15]	.37** [.34, .40]	.03 [-.01, .07]	.15** [.12, .19]

Note. M and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014). * indicates $p < .05$. ** indicates $p < .01$. DILP = Distributed leadership, INLP = Instructional leadership, PCOL = Professional collaboration, TEAM = Team innovativeness. Gender and Age were measured at the teacher level.

Table C4

Teacher level (L1): ***Norway (N = 4,111)***

Means, standard deviations, and correlations with confidence intervals

Variable	*M*	*SD*	1	2	3	4	5
1. Gender	0.36	0.48					
2. Age	3.88	1.21	.00 [-.03, .03]				
3. DILP	11.15	1.47	-.04** [-.07, -.01]	-.02 [-.06, .01]			
4. INLP	11.05	1.59	-.02 [-.05, .01]	-.03 [-.06, .01]	.08** [.04, .11]		
5. PCOL	9.09	1.68	.06** [.03, .09]	.03 [-.01, .06]	.18** [.15, .21]	-.03 [-.06, .01]	
6. TEAM	11.63	1.30	-.05** [-.08, -.02]	.00 [-.03, .03]	.34** [.31, .37]	-.00 [-.04, .03]	.19** [.16, .22]

Note. M and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014). * indicates $p < .05$. ** indicates $p < .01$. DILP = Distributed leadership, INLP = Instructional leadership, PCOL = Professional collaboration, TEAM = Team innovativeness. Gender and Age were measured at the teacher level.

Table C5

Teacher level (L1): *Sweden (N = 2,755)*

Means, standard deviations, and correlations with confidence intervals

Variable	*M*	*SD*	1	2	3	4	5
1. Gender	0.34	0.47					
2. Age	4.11	1.10	-.05* [-.08, -.01]				
3. DILP	11.22	1.79	-.04 [-.08, .00]	-.05* [-.09, -.01]			
4. INLP	10.23	1.85	-.00 [-.04, .04]	-.02 [-.05, .02]	.03 [-.01, .07]		
5. PCOL	9.06	1.79	.07** [.03, .11]	-.03 [-.07, .01]	.21** [.17, .25]	.08** [.04, .12]	
6. TEAM	11.31	1.84	-.07** [-.11, -.03]	.02 [-.02, .06]	.41** [.38, .44]	.06** [.02, .10]	.15** [.11, .18]

Note. M and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014). * indicates $p < .05$. ** indicates $p < .01$. DILP = Distributed leadership, INLP = Instructional leadership, PCOL = Professional collaboration, TEAM = Team innovativeness. Gender and Age were measured at the teacher level.

Table C6

School level (L2): *Total Nordic sample*

Means, standard deviations, and correlations with confidence intervals

Variable	*M*	*SD*	1	2	3
1. DILP	11.32	0.82			
2. INLP	10.66	1.99	.01 [-.10, .13]		
3. PCOL	9.13	0.88	.26** [.15, .36]	.09 [-.02, .19]	
4. TEAM	11.36	0.80	.51** [.42, .59]	.07 [-.04, .17]	.23** [.13, .33]

Note. M and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014). * indicates $p < .05$. ** indicates $p < .01$. DILP = Distributed leadership, INLP = Instructional leadership, PCOL = Professional collaboration, TEAM = Team innovativeness.

Table C7

School level (L2): *Denmark*

Means, standard deviations, and correlations with confidence intervals

Variable	*M*	*SD*	1	2	3
1. DILP	11.19	0.87			
2. INLP	10.38	2.55	-.04 [-.28, .20]		
3. PCOL	9.07	0.99	.22 [-.02, .44]	.08 [-.14, .29]	
4. TEAM	11.52	0.80	.33** [.10, .52]	.16 [-.06, .36]	.06 [-.16, .28]

Note. M and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014). * indicates $p < .05$. ** indicates $p < .01$. DILP = Distributed leadership, INLP = Instructional leadership, PCOL = Professional collaboration, TEAM = Team innovativeness.

Table C8

School level (L2): *Finland*

Means, standard deviations, and correlations with confidence intervals

Variable	*M*	*SD*	1	2	3
1. DILP	11.32	0.80			
2. INLP	11.09	1.66	-.08 [-.27, .11]		
3. PCOL	9.08	0.70	.32** [.13, .48]	.07 [-.10, .24]	
4. TEAM	11.11	0.71	.61** [.48, .72]	.10 [-.08, .28]	.39** [.22, .53]

Note. M and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014). * indicates $p < .05$. ** indicates $p < .01$. DILP = Distributed leadership, INLP = Instructional leadership, PCOL = Professional collaboration, TEAM = Team innovativeness.

Table C9

School level (L2): ***Norway***

Means, standard deviations, and correlations with confidence intervals

Variable	*M*	*SD*	1	2	3
1. DILP	11.44	0.76			
2. INLP	11.04	1.71	.20 [-.04, .42]		
3. PCOL	9.18	0.94	.37** [.15, .55]	.04 [-.19, .26]	
4. TEAM	11.63	0.66	.50** [.30, .65]	.07 [-.16, .29]	.31** [.09, .49]

Note. M and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014). * indicates $p < .05$. ** indicates $p < .01$. DILP = Distributed leadership, INLP = Instructional leadership, PCOL = Professional collaboration, TEAM = Team innovativeness.

Table C10

School level (L2): *Sweden*

Means, standard deviations, and correlations with confidence intervals

Variable	*M*	*SD*	1	2	3
1. DILP	11.33	0.89			
2. INLP	10.13	1.83	-.01 [-.29, .26]		
3. PCOL	9.20	0.94	.11 [-.16, .37]	.24 [-.01, .46]	
4. TEAM	11.26	0.95	.71** [.54, .82]	-.07 [-.32, .18]	.23 [-.02, .45]

Note. M and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014). * indicates $p < .05$. ** indicates $p < .01$. DILP = Distributed leadership, INLP = Instructional leadership, PCOL = Professional collaboration, TEAM = Team innovativeness.

Table C11

Intraclass Correlations (ICC1 and ICC2)

	DEN		FIN		NOR		SWE		Total Nordic	
	ICC1	ICC2	ICC1	ICC2	ICC1	ICC2	ICC1	ICC2	ICC1	ICC2
DILP	.263	.836	.184	.813	.209	.857	.191	.786	.215	.832
PCOL	.204	.785	.081	.631	.125	.764	.184	.778	.164	.779
TEAM	.063	.491	.063	.563	.134	.779	.104	.643	.117	.706

Note. ICC1 (intraclass correlation 1) measures clustering and ICC2 (intraclass correlation 2) measures reliability of the group average rating at the school level respectively. Values of ICC1 ≥ .05 are considered to be non-trivial (Geldhof et al., 2014). Values of ICC2 ≥ .70 indicates an acceptable level of group reliability (Stapleton et al., 2016).

Table C12

Selected parameters of the multilevel structural equation model for the Nordic TALIS 2018 sample

Parameter	β	*SE*	*p*-value
Structural model parameters			
Teacher level (L1)			
Direct effects of DILP *(β)*			
DILP → TEAM	0.285	0.014	0.000
DILP → PCOL	0.176	0.012	0.000
Direct effect of PCOL *(β)*			
PCOL → TEAM	0.081	0.012	0.000
School level (L2)			
Direct effects of DILP *(β)*			
DILP → TEAM	0.575	0.047	0.000
DILP → PCOL	0.211	0.081	0.009
Direct effects of PCOL *(β)*			
PCOL → TEAM	0.124	0.071	0.080
Direct effects of INLP *(β)*			
INLP → TEAM	0.097	0.051	0.056
INLP → PCOL	0.112	0.067	0.094
Derived model parameters			
Contextual direct effects (ES_2)			
L2-L1: DILP → TEAM	0.125	0.032	0.000
L2-L1: DILP → PCOL	0.003	0.041	0.936
L2-L1: PCOL → TEAM	0.018	0.032	0.564
Contextual indirect effects (ES_2)			
L2-L1: DILP → PCOL → TEAM	0.033	0.035	0.352
Indirect L1 effects *(β)*			
DILP → PCOL → TEAM	0.014	0.002	0.000
Indirect L2 effects *(β)*			
DILP → PCOL → TEAM	0.026	0.018	0.149
INLP → PCOL → TEAM	0.014	0.009	0.140
Total effects *(β)*			
Total L1 effects of DILP	0.299	0.014	0.000
Total L2 effects of DILP	0.601	0.043	0.000
Total L2 effects of INLP	0.111	0.052	0.032
Variance explanations (R^2)			

Teacher level (L1)			
PCOL	0.031	0.004	0.000
TEAM	0.110	0.009	0.000
School level (L2)			
PCOL	0.059	0.040	0.145
TEAM	0.392	0.054	0.000

Note. TEAM= Team innovativeness, DILP = Distributed leadership, INLP = Instructional leadership, PCOL = Professional collaboration. The direct and indirect effects are fully standardized.

Table C13

Contextual Effects (PCOL → TEAM)

Country	Within Effect			Between Effect			Contextual Effect		
	β_w	*SE*	*p*	β_b	*SE*	*p*	ES_2	*SE*	*p*
DEN	0.096	0.025	0.000	0.187	0.155	0.228	0.008	0.051	0.878
FIN	0.065	0.022	0.003	0.355	0.098	0.000	0.098	0.035	0.005
NOR	0.116	0.019	0.000	0.198	0.131	0.130	0.043	0.055	0.434
SWE	0.056	0.022	0.010	0.082	0.129	0.523	0.014	0.067	0.834
Nordic Sample	0.081	0.012	0.000	0.124	0.071	0.080	0.018	0.032	0.564

Note. β_w = Within-group (teacher-level) regression coefficeints, β_b = Between-group (school-level) regression coefficeints, SE = Standard Errors, ES_2 = Effect sizes (Marsh et al., 2009).

Table C14

Contextual Effects (DILP → TEAM)

Country	Within Effect			Between Effect			Contextual Effect		
	β_w	*SE*	*p*	β_b	*SE*	*p*	ES_2	*SE*	*p*
DEN	0.192	0.030	0.000	0.485	0.129	0.000	0.049	0.069	0.475
FIN	0.314	0.021	0.000	0.548	0.087	0.000	0.070	0.042	0.097
NOR	0.310	0.023	0.000	0.539	0.128	0.000	0.108	0.078	0.165
SWE	0.340	0.024	0.000	0.745	0.052	0.000	0.214	0.051	0.000
Nordic Sample	0.285	0.014	0.000	0.575	0.047	0.000	0.125	0.032	0.000

Note. β_w = Within-group (teacher-level) regression coefficeints, β_b = Between-group (school-level) regression coefficeints, SE = Standard Errors, ES_2 = Effect sizes (Marsh et al., 2009).

Table C15

Contextual Effects (DILP → PCOL)

Country	Within Effect			Between Effect			Contextual Effect		
	β_w	*SE*	*p*	β_b	*SE*	*p*	ES_2	*SE*	*p*
DEN	0.180	0.028	0.000	0.314	0.095	0.001	0.075	0.071	0.291
FIN	0.133	0.022	0.000	0.451	0.102	0.000	0.101	0.046	0.028
NOR	0.178	0.021	0.000	0.235	0.125	0.060	0.000	0.073	0.995
SWE	0.204	0.023	0.000	-0.013	0.162	0.937	-0.116	0.081	0.151
Nordic Sample	0.176	0.012	0.000	0.211	0.081	0.009	0.003	0.041	0.936

Note. β_w = Within-group (teacher-level) regression coefficeints, β_b = Between-group (school-level) regression coefficeints, SE = Standard Errors, ES_2 = Effect sizes (Marsh et al., 2009).

Table C16

Contextual Effects (DILP → PCOL → TEAM)

Country	Within Effect			Between Effect			Contextual Effect		
	β_w	*SE*	*p*	β_b	*SE*	*p*	ES_2	*SE*	*p*
DEN	0.017	0.006	0.002	0.059	0.054	0.274	0.124	0.145	0.393
FIN	0.009	0.003	0.006	0.160	0.054	0.003	0.477	0.243	0.050
NOR	0.021	0.004	0.000	0.047	0.032	0.152	0.064	0.069	0.354
SWE	0.011	0.005	0.013	-0.001	0.014	0.940	-0.015	0.031	0.629
Nordic Sample	0.014	0.002	0.000	0.026	0.018	0.149	0.033	0.035	0.352

Note. β_w = Within-group (teacher-level) regression coefficeints, β_b = Between-group (school-level) regression coefficeints, SE = Standard Errors, ES_2 = Effect sizes (Marsh et al., 2009).

Table C17

Effects of INLP on TEAM and PCOL (Between Effects)

	Between Effect (INLP →TEAM)			**Between Effect (INLP →PCOL)**		
Country	β_b	*SE*	*p*	β_b	*SE*	*p*
DEN	0.199	0.107	0.063	0.159	0.101	0.117
FIN	0.110	0.071	0.121	0.171	0.097	0.080
NOR	-0.003	0.100	0.973	0.100	0.101	0.323
SWE	0.029	0.099	0.767	0.141	0.133	0.291
Nordic Sample	0.097	0.051	0.056	0.112	0.067	0.094

Note. β_b = Between-group (school-level) regression coefficeints, SE = Standard Errors.

Table C18

Variance Explanations (R^2)

			Within-level Variance Explanation		**Between-level Variance Explanation**	
Country	NCluster	AvgCS	PCOL	TEAM	PCOL	TEAM
DEN	141	14.106	0.032** (0.010)	0.081** (0.016)	0.117 (0.067)	0.362** (0.136)
FIN	148	19.257	0.018** (0.006)	0.125** (0.014)	0.217** (0.087)	0.606** (0.095)
NOR	185	22.216	0.032** (0.008)	0.125** (0.015)	0.075 (0.066)	0.384** (0.122)
SWE	180	15.289	0.042** (0.010)	0.138** (0.018)	0.020 (0.037)	0.567** (0.080)
Nordic Sample	654	17.891	0.031** (0.004)	0.110** (0.009)	0.059 (0.040)	0.392** (0.054)

Note. NCluster = Number of clusters, AvgCS = Average cluster size, TEAM = Team innovativeness, DILP = Distributed leadership, INLP = Instructional leadership, PCOL = Professional Collaboration. The values in the parentheses indicate standard error (SE). * indicates $p < .05$. ** indicates $p < .01$.

Table C19

*Indirect, Direct and Total L1 Effects (**Effects DILP – PCOL – TEAM**)*

	Indirect Effect DILP→PCOL→TEAM			Direct Effect DILP→PCOL			Direct Effect PCOL→TEAM			Direct Effect DILP→TEAM			Total Effect		
Country	β_w	*SE*	*p*	β_w	*SE*	*p*	β_w	*SE*	*p*	β_w	*SE*	*p*	β_w	*SE*	*p*
DEN	0.017	0.006	0.002	0.180	0.028	0.000	0.096	0.025	0.000	0.192	0.030	0.000	0.209	0.030	0.000
FIN	0.009	0.003	0.006	0.133	0.022	0.000	0.065	0.022	0.003	0.314	0.021	0.000	0.323	0.021	0.000
NOR	0.021	0.004	0.000	0.178	0.021	0.000	0.116	0.019	0.000	0.310	0.023	0.000	0.330	0.023	0.000
SWE	0.011	0.005	0.013	0.204	0.023	0.000	0.056	0.022	0.010	0.340	0.024	0.000	0.351	0.024	0.000
Nordic Sample	0.014	0.002	0.000	0.176	0.012	0.000	0.081	0.012	0.000	0.285	0.014	0.000	0.299	0.014	0.000

Note. β_w = Within-group (teacher-level) regression coefficeints, SE = Standard Errors, Total effect refers to the sum of the indirect and direct effects.

Table C20

*Indirect, Direct and Total L2 Effects (**Effects DILP – PCOL – TEAM**)*

	Indirect Effect DILP→PCOL→TEAM			Direct Effect DILP→PCOL			Direct Effect PCOL→TEAM			Direct Effect DILP→TEAM			Total Effect		
Country	β_b	*SE*	*p*	β_b	*SE*	*p*	β_b	*SE*	*p*	β_b	*SE*	*p*	β_b	*SE*	*p*
DEN	0.059	0.054	0.274	0.314	0.095	0.001	0.187	0.155	0.228	0.485	0.129	0.000	0.543	0.113	0.000
FIN	0.160	0.054	0.003	0.451	0.102	0.000	0.355	0.098	0.000	0.548	0.087	0.000	0.708	0.074	0.000
NOR	0.047	0.032	0.152	0.235	0.125	0.060	0.198	0.131	0.130	0.539	0.128	0.000	0.586	0.120	0.000
SWE	-0.001	0.014	0.940	-0.013	0.162	0.937	0.082	0.129	0.523	0.745	0.052	0.000	0.744	0.054	0.000
Nordic Sample	0.026	0.018	0.149	0.211	0.081	0.009	0.124	0.071	0.080	0.575	0.047	0.000	0.601	0.043	0.000

Note. β_b = Between-group (school-level) regression coefficeints, SE = Standard Errors, Total effect refers to the sum of the indirect and direct effects.

Table C21

*Indirect, Direct and Total L2 Effects (**Effects INLP – PCOL – TEAM**)*

	Indirect Effect INLP→PCOL→TEAM			Direct Effect INLP→PCOL			Direct Effect PCOL→TEAM			Direct Effect INLP→TEAM			Total Effect		
Country	β_b	*SE*	*p*	β_b	*SE*	*p*	β_b	*SE*	*p*	β_b	*SE*	*p*	β_b	*SE*	*p*
DEN	0.030	0.031	0.333	0.159	0.101	0.117	0.187	0.155	0.228	0.199	0.107	0.063	0.229	0.109	0.035
FIN	0.061	0.039	0.116	0.171	0.097	0.080	0.355	0.098	0.000	0.110	0.071	0.121	0.170	0.073	0.020
NOR	0.020	0.025	0.423	0.100	0.101	0.323	0.198	0.131	0.130	-0.003	0.100	0.973	0.016	0.098	0.867
SWE	0.012	0.012	0.350	0.141	0.133	0.291	0.082	0.129	0.523	0.029	0.099	0.767	0.041	0.100	0.684
Nordic Sample	0.014	0.009	0.140	0.112	0.067	0.094	0.124	0.071	0.080	0.097	0.051	0.056	0.111	0.052	0.032

Note. β_b = Between-group (school-level) regression coefficeints, SE = Standard Errors, Total effect refers to the sum of the indirect and direct effects.

Table C22

Effects of Control Variables

	Teacher Gender → TEAM *(0 = Female, 1 = Male)*			Teacher Age → TEAM		
Country	β_w	*SE*	*p*	β_w	*SE*	*p*
DEN	-0.107	0.023	0.000	0.125	0.025	0.000
FIN	-0.039	0.020	0.047	0.124	0.019	0.000
NOR	-0.046	0.020	0.021	0.037	0.021	0.072
SWE	-0.077	0.023	0.001	0.071	0.023	0.002
Nordic Sample	-0.073	0.011	0.000	0.091	0.012	0.000

Note. β_w = Within-group (teacher-level) regression coefficeints, SE = Standard Errors.

Table C23

Item wording for all the scales used in the study

Team Innovativeness (TEAM): TT3G32A-D

Thinking about the teachers in this school, how strongly do you agree or disagree with the following statements? (4 options from "Strongly disagree" to "Strongly agree")

1. Most teachers in this school strive to develop new ideas for teaching and learning.
2. Most teachers in this school are open to change.
3. Most teachers in this school search for new ways to solve problems.
4. Most teachers in this school provide practical support to each other for the application of new ideas.

Professional Collaboration (PCOL): TT3G33 A, B, C, H

On average, how often do you do the following in this school? (6 options from "Never" to "Once a week or more")

1. Teach jointly as a team in the same class.
2. Provide feedback to other teachers about their practice.
3. Engage in jointly activities across different classes and age groups (e.g., projects)
4. Participate in collaborative professional learning.

Distributed Leadership (DILP): TT3G48 A-E

How strongly do you agree or disagree with these statements, as applied to this school? (4 options from "Strongly disagree" to "Strongly agree")

1. This school provides staff with opportunities to actively participate in school decisions.

2. This school provides parents or guardians with opportunities to actively participate in school decisions.

3. This school provides students with opportunities to actively participate in school decisions.

4. This school has a culture of shared responsibility for school issues.

5. There is a collaborative school culture which is characterized by mutual support.

Instructional Leadership (INLP): TC3G22 D, E, F

Please indicate how frequently you engage in the following activities in this school during the last 12 months. (4 options from "Never or rarely" to "Very often")

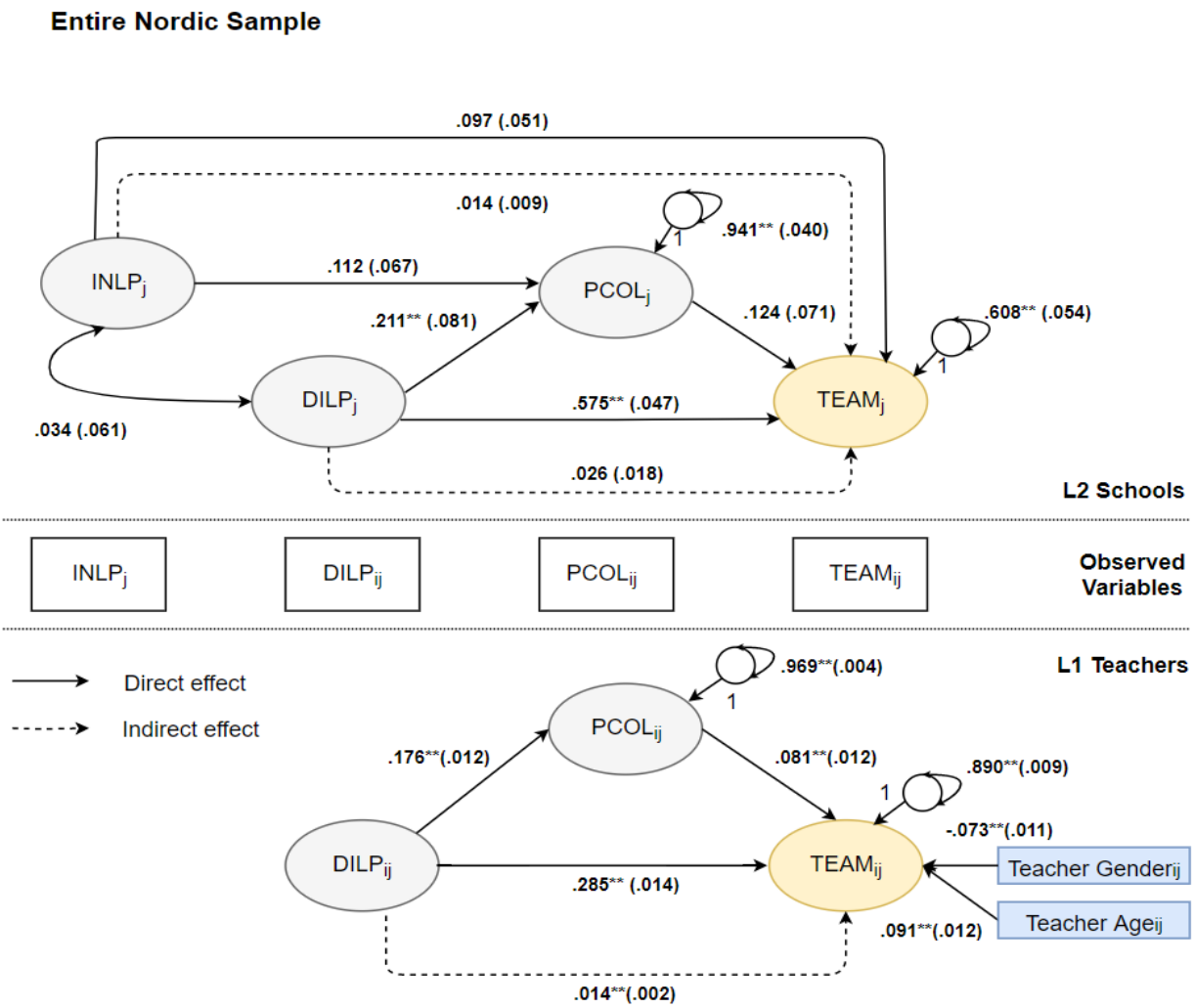
1. I took actions to support co-operation among teachers to develop new teaching practices.

2. I took actions to ensure that teachers take responsibility for improving their teaching skills.

3. I took actions to ensure that teachers feel responsible for their students' learning outcomes

Figure C1

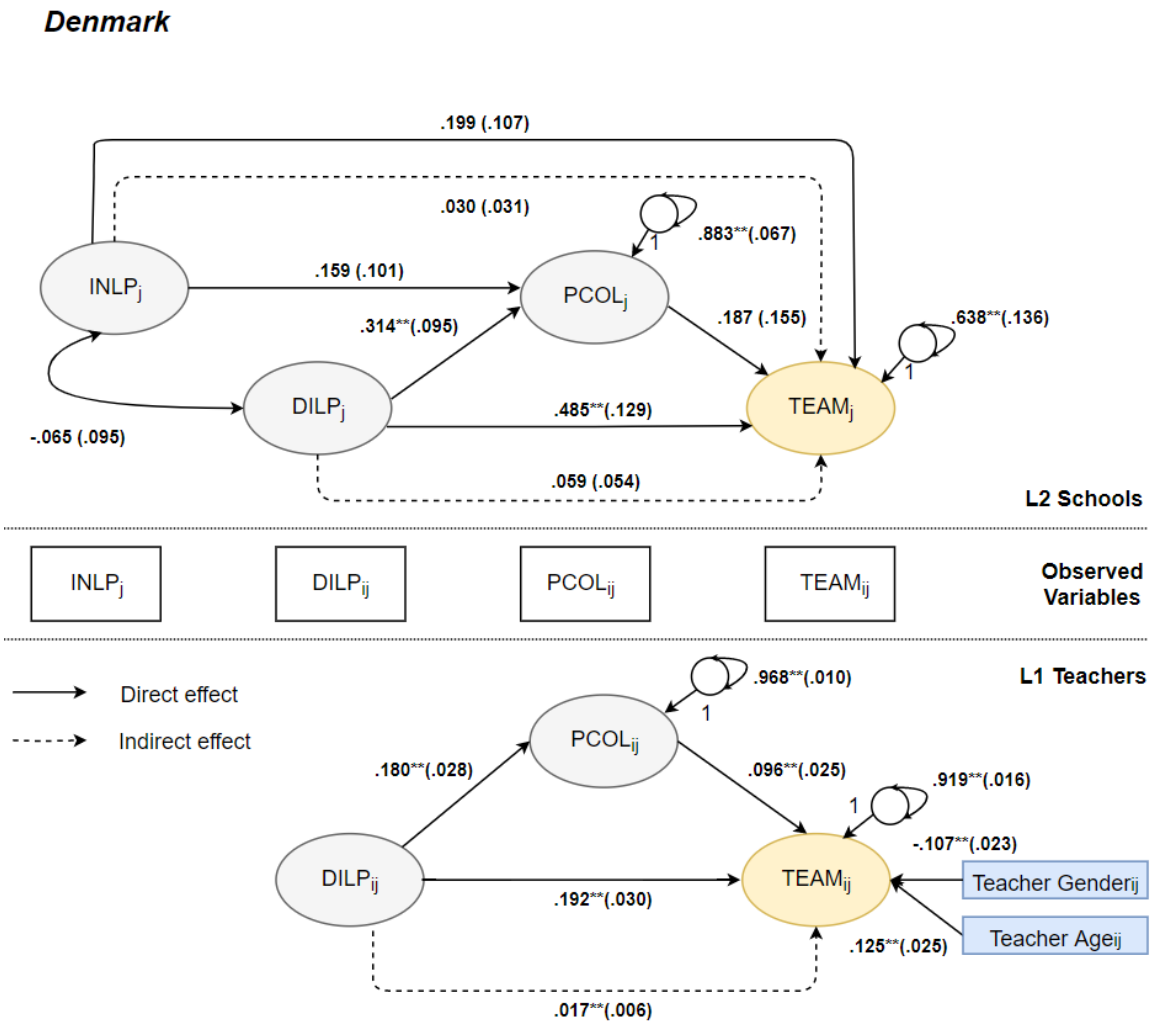
Multilevel structural equation model results representing the relations between distributed leadership, instructional leadership, professional collaboration and team innovativeness



Note. DILP = Distributed leadership, INLP = Instructional leadership, PCOL = Professional collaboration, TEAM = Team innovativeness. *i*= Teachers, *j* = Schools. * indicates $p < .05$. ** indicates $p < .01$.

Figure C2

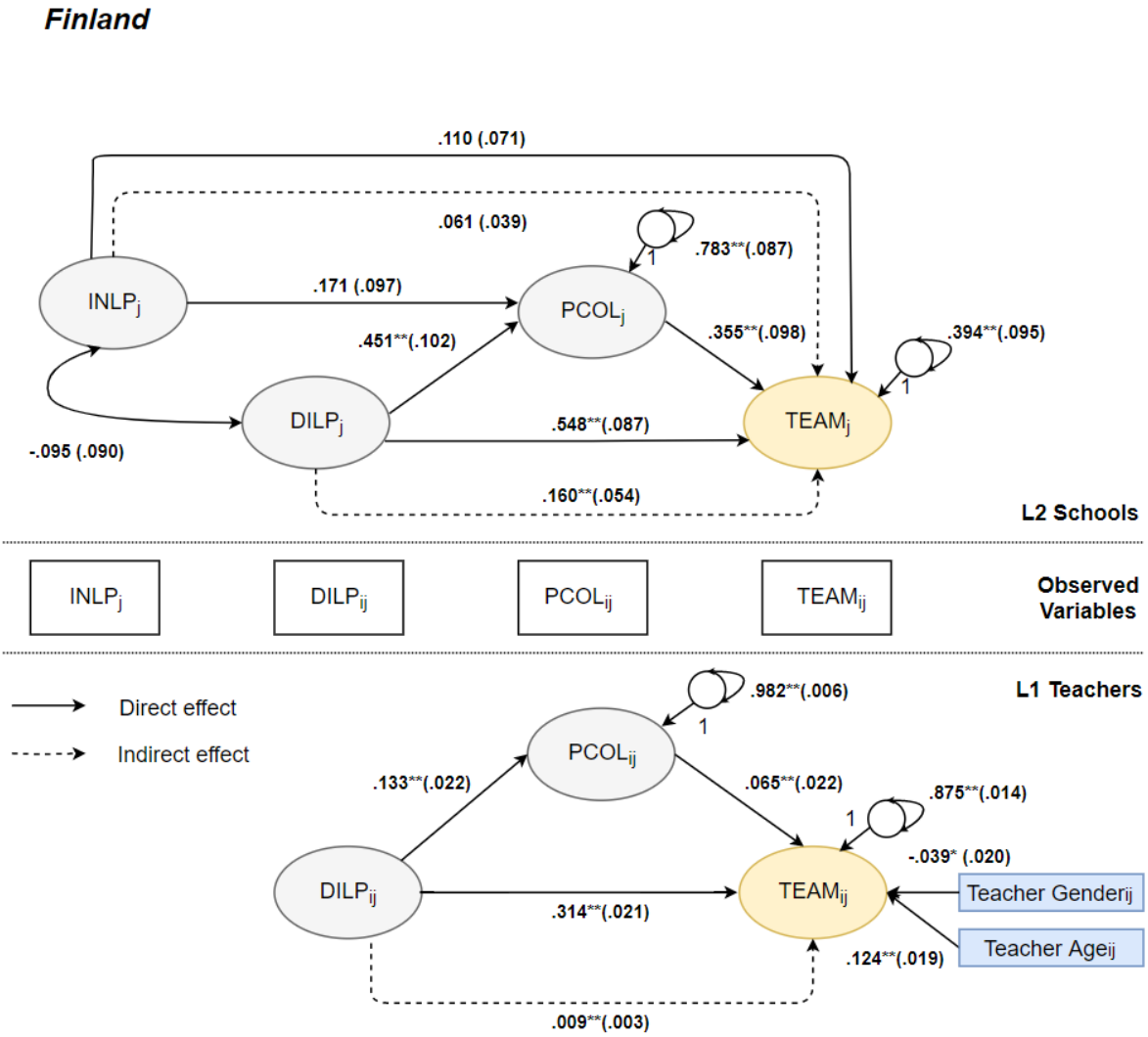
Multilevel structural equation model results representing the relations between distributed leadership, instructional leadership, professional collaboration and team innovativeness



Note. DILP = Distributed leadership, INLP = Instructional leadership, PCOL = Professional collaboration, TEAM = Team innovativeness. *i*= Teachers, *j* = Schools. * indicates $p < .05$. ** indicates $p < .01$, The standardized parameters were estimated.

Figure C3

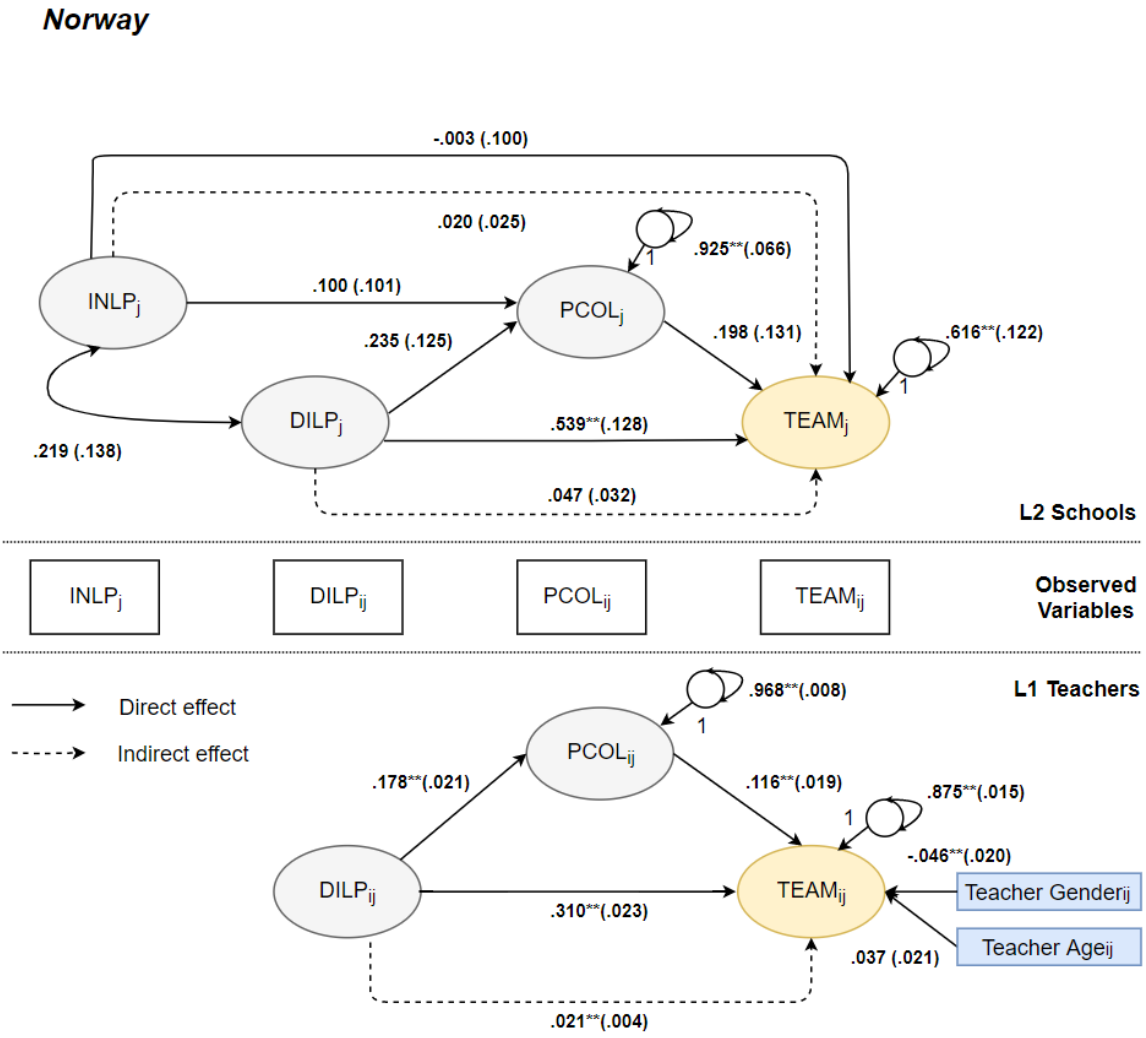
Multilevel structural equation model results representing the relations between distributed leadership, instructional leadership, professional collaboration and team innovativeness



Note. DILP = Distributed leadership, INLP = Instructional leadership, PCOL = Professional collaboration, TEAM = Team innovativeness. *i*= Teachers, *j* = Schools. * indicates $p < .05$. ** indicates $p < .01$, The standardized parameters were estimated.

Figure C4

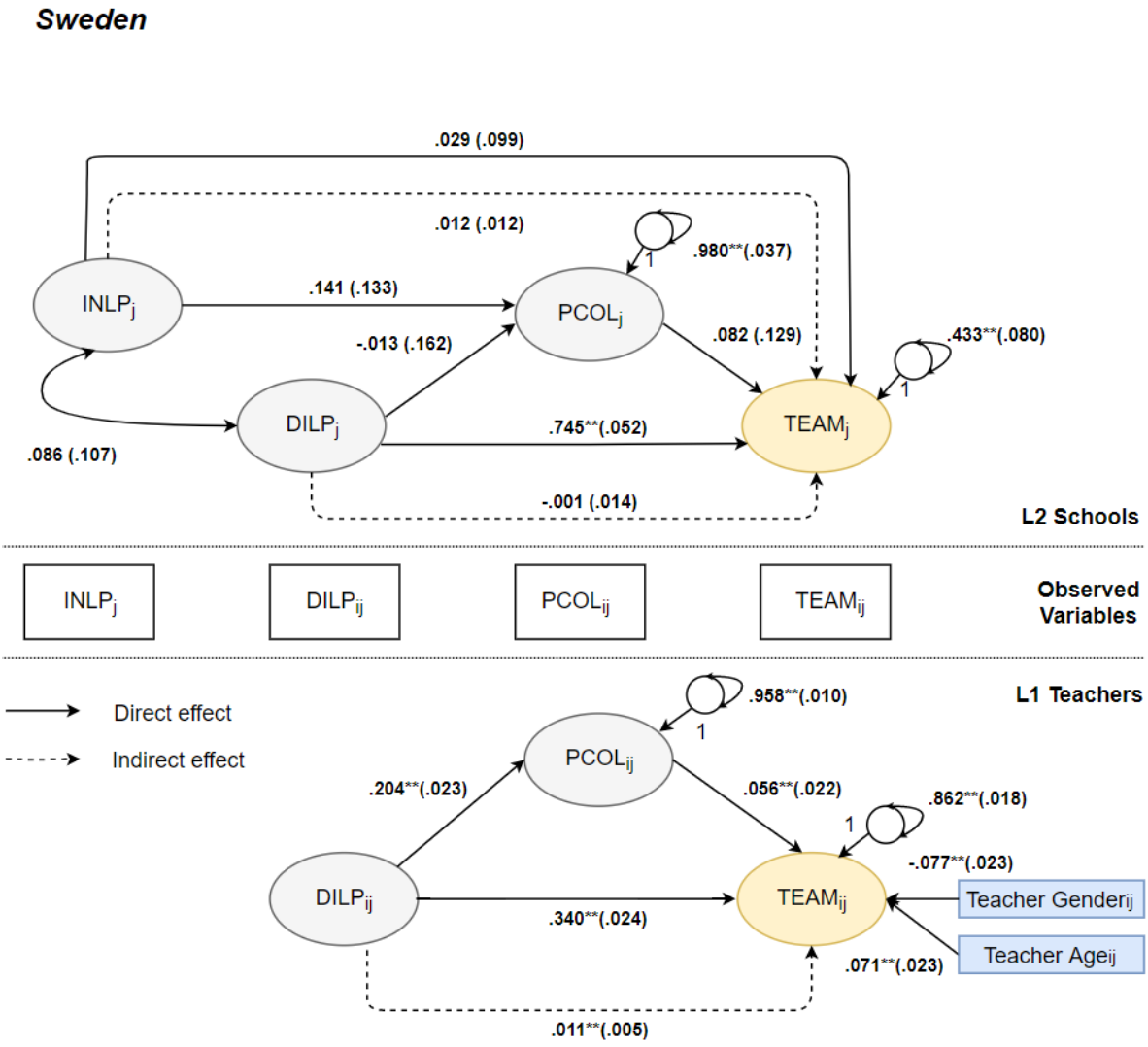
Multilevel structural equation model results representing the relations between distributed leadership, instructional leadership, professional collaboration and team innovativeness



Note. DILP = Distributed leadership, INLP = Instructional leadership, PCOL = Professional collaboration, TEAM = Team innovativeness. *i*= Teachers, *j* = Schools. * indicates $p < .05$. ** indicates $p < .01$, The standardized parameters were estimated.

Figure C5

Multilevel structural equation model results representing the relations between distributed leadership, instructional leadership, professional collaboration and team innovativeness



Note. DILP = Distributed leadership, INLP = Instructional leadership, PCOL = Professional collaboration, TEAM = Team innovativeness. *i* = Teachers, *j* = Schools. * indicates $p < .05$. ** indicates $p < .01$, The standardized parameters were estimated.

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