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Improving the Innovative Climate by strengthening Leader-Teacher Relationships and Teacher's Self-  
Efficacy

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### Abstract

This thesis discusses the influence of both the formal and informal leader on someone's perception of the innovative climate (IC) to provide new insights in concepts that improve the school's IC. Leader-teacher relationships will be investigated by analyzing social networks at schools. A gap in literature was found concerning the influence of the informal leader. Hypothesized was a direct influence of both the formal and informal leader-teacher relationship on the IC, possibly mediated by the extent to which the teacher believes he is able to do his job, in other words 'teacher's self-efficacy' (SE). A total of 230 teammembers of 13 Dutch primary schools completed the questionnaire, with an overall response rate of 86%. Social network analyses and multiple statistical analyses were conducted to test the hypothesized model. Results show that a very strong informal leader-teacher relationship positively affects a teacher's perception of the innovative climate ( $p < .05$ ). No significant effect was found for the formal leader-teacher relationship on the IC. Results indicate a strong direct influence of informal leaders and of SE on the IC ( $p < .001$ ), mediation effects were not found (confidence intervals set at 95% all contained zero). At most schools the internal coach is the informal leader. Given these results, schools are recommended to analyze their social network, identify the informal leader and deliberately position him to influence the IC. Because of the strong influence of SE on the IC, SE should be more closely investigated in further research and addressed in practice.

*Keywords:* social network analysis, formal leader, informal leader, advice-networks, strength of relationships, teacher's self-efficacy, school's innovative climate.

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### Introduction

In this constantly changing world, change is the only constant (Thomas & Brown, 2011; Williamson, 1996). Now, more than ever, primary education should change and innovate adequately to prepare the students for their future (Fullan, 2002; Thomas & Brown, 2011). The extensive number of publications about innovation underlines the importance of investigating concepts to support innovation in organizations (e.g. Dunegan, Tierney, Duchon, 1992; Peck et al., 2009; Moolenaar et al., 2014; Van der Vegt, Van de Vliert, and Huang, 2005). Teachers have a strong influence on educational innovation (Peck, Gallucci, Sloan & Lippincott, 2007; Zimmerman, 2006). Research on educational change revealed that changing teachers' daily practice is very difficult and doing so successfully is dependent on teachers openness to change (Fullan, 2002; Zimmerman, 2006), i.e. their perception of the innovative climate (IC; Moolenaar & Slegers, 2010). It is imperative to get a better understanding in how this perception is influenced. This study focusses on the role of leaders and teacher's self-efficacy in this context.

The IC of the school is defined as the teammembers combined perceptions concerning the openness to change, new knowledge and practices (Van der Vegt, et al., 2005) and is influenced by a number of factors. The relationship between leadership and the IC is excessively investigated (e.g. Berson, Nemanich, Waldman, Galvin & Keller, 2006; Fullan, 2002; Moolenaar, 2010; Moolenaar, Daly, Slegers, 2010), but the specific influence of the *strength of relationships* with these leaders is not. Educational leadership tends to be distributed among the team (Hallinger & Heck, 2011; Spillane, Halverson, Diamond, 2001). Therefore, the strength of relationships with both the formal leader (i.e. the principal) and the informal leader (i.e. the teammember with the most influence and power) will be investigated. Research discussing the influence of the informal leader on the IC is limited. This study addresses these gaps in literature and is therefore a relevant addition to existing literature.

Besides leadership, IC depends on the relationships in the school, if relationships improve, the schools gets better in achieving organizational goals (Fullan, 2002). According to Frank, Zhao and Borman (2004) collaboration within teams results in communication, sharing ideas, and focusing on

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larger organizational goals. These results are necessary for being open to innovation, hence having a good IC. As shown by Moolenaar (2010), the social network is a good way to get an overall picture of the teammembers and their relationships. A social network plays a fundamental role in spreading information, ideas, innovation and influence among its members (Kempe, Kleinberg, Tardos, 2003). Therefore it is relevant to take collaboration into account. In this study, social network analysis is used to investigate the collaboration in a team.

I expect the leader-teacher relationship to affect the IC both direct and indirect via the confidence of an individual that he or she can perform certain tasks, i.e. self-efficacy (Pescosolido, 2001). More specifically this study focusses on teacher's self-efficacy (SE), i.e. the extent to which the teacher believes he can influence student outcomes and motivation (Tschannen-Moran, Hoy & Hoy, 1998; Tschannen-Moran & Hoy, 2000).

This leads to the following research questions:

1. How does the strength of the leader-teacher relationship affect a teacher's perception of the innovative climate?
2. To what extent does teacher's self-efficacy mediate this relationship?

To answer these research questions, first literature on the variables will be studied and briefly discussed, then social network analyses and multiple statistical analyses will be conducted and reported and finally conclusions, implications and limitations will be discussed.

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### **Theoretical framework**

#### **School's Innovative Climate**

The importance of innovation in education has been extensively investigated (e.g. Dunegan et al., 1992; Peck et al., 2009; Moolenaar et al., 2014; Van der Vegt et al., 2005). Innovation can be interpreted as introducing new ways of teaching, such as the use of digital tools in teaching (e.g. Brown, 2000; Howard, 2009). By looking at the IC of the school, openness to innovation and the possibilities of successfully implementing change can be determined (Moolenaar et al., 2014). In this research the school's IC as defined by Van der Vegt, et al. (2005, p. 1172) is used: "the shared perceptions of teammembers concerning the practices, procedures, and behaviors that promote the generation of new knowledge and practices". Thus, teachers' attitude towards change and innovations in education determine the innovative climate of the school. A teacher's perception of the IC is determined by whether he is innovative, willing to take risks and not scared to make mistakes (Moolenaar et al., 2014). The school's IC has been linked to student achievement (Zimmerman, 2006). Moolenaar (2010) has elaborated on the innovative climate and the importance for implementing change. Understanding the IC of a school can help explain why innovations succeed or fail. It is less context specific than looking at a single innovation (Moolenaar et al., 2014). Investigating the IC can be better to compare schools, because it can be generalized than opinions about one specific innovation.

Previous research describes a strong relationship between leadership and innovation (e.g. Berson, et al., 2006; Fullan, 2002; Moolenaar, 2010; Moolenaar, Daly, Slegers, 2010). I investigate whether and how leadership and self-efficacy influence the IC. The relationship between the IC and leadership will be further discussed in the next paragraph.

#### **Innovative climate and leadership**

Effective school leaders play an essential role in large-scale sustainable change in education (Fullan, 2002). Dunegan et al. (1992) show that work interactions and the quality of exchange between leader and subordinates significantly predict employee perceptions of the innovative climate.

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There are different ways to investigate leadership. Leadership has been investigated in terms of leadership personality traits (e.g. Judge, Bono, Ilies & Gerhardt, 2002) and leadership style (e.g. Davies & Davies, 2004; Hallinger, 2003; Pearce & Sims, 2002). A third way to investigate leadership is used in this research: a social network perspective that looks at power and influence. Leaders with strong relationships are believed to be more powerful (Balkundi & Kilduff, 2006).

### **Leadership from the perspective of power and influence**

Regarding this perspective on leadership, two kinds of leaders are distinguished: the formal and the informal leader. Sun, Frank, Penuel and Kim (2013) define formal leaders as being designated by their roles in the organization of the schools, this is for example the principal or the middle management. The informal leader is the most central team member without a formal management function.

Moolenaar (2010) argues about the importance of formal leaders to improve the innovative climate. Moolenaar, et al. (2010) concluded that the more closely connected leaders are to their teachers, the more willing teachers are to invest in creating and adopting new knowledge and practices (i.e. innovation).

In a social network perspective, the influence of central team members (i.e. the informal leader) should not be overlooked. Educational leadership is not limited to the actions of the formal management because it tends to be distributed among the team (Hallinger & Heck, 2011; Spillane, et al., 2001). Besides the formal leader, every school has central team members with power to influence others. Harris (2004) underlines the importance of more empirical studies to better understand the relationship between distributed leadership and school improvement. Therefore this research will investigate both the influence of the formal leader and the informal leader. Similar to the influence of the formal leader, it can be argued that the influence of the informal leader on the perception of others depends on the number of close relationships. This will be further discussed in the next section.

### **Position of the leader in a social network**

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Effective leadership requires the management of social relationships (Balkundi & Kilduff, 2006). Power and centrality in the organization's social network are closely related (Hanneman & Riddle, 2005). Central teammembers are more autonomous and have more power to make decisions because they have more access to resources and knowledge of the other teammembers than non-central teammembers (Hanneman & Riddle, 2005). Degree centrality is conceptualized as the total number of direct relationships of a teammember within a social network, a high number of direct relationships indicates high centrality for that person. The large number of relationships give central actors easy access to information, knowledge and advice, which can be used for influencing others with personal (Battistoni, Colladon & Mercorelli, 2013).

In previous network research, scholars used an *advice network question* to map the social network (e.g. Moolenaar, et al., 2010; Nebus, 2006). This question is used since effective leadership is related to creating and sharing knowledge. Information becomes knowledge through a social process, such as the process of asking advice (Fullan, 2002). Additionally, the process of giving and asking advice provides the advisor with more knowledge about the other and the situation and the ability to influence the advice seeker's perceptions (Moolenaar et al., 2010).

To identify the most powerful teammember apart from the formal leader(s), a measurement of degree centrality was used, more specifically *indegree centrality*. It measures by how many people and how often someone is asked for advice. The person with the highest indegree centrality score, apart from the formal leader, is identified as the informal leader of the team.

### **The strength of the (in-)formal leader-teacher relationship**

Moolenaar (2010) concluded that strong relationships in a social network lead to innovation. Because there is more interaction between all teammembers, knowledge is more frequently transferred through the network. This may lead to the creation of new knowledge, resulting a more innovative climate (Nonaka, 1994). On the other hand, some scholars conclude that weak ties are better for stimulating innovation than strong ties, since a network with weaker ties is more open to other, external influences (other networks with new or other knowledge). Because these actors could act as

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bridges and bring new outside knowledge into the social network which may lead to innovation (Blumstein & Kollock, 1988; Granovetter, 1973). However, the same author argues ten years later that the majority of actors with weak ties do not act as bridges and are less influential than actors with strong ties (Granovetter, 1983). In this paper, it is assumed that strong relationships lead to a stronger IC. The strength of the relationship is measured as networkdistance (how many networksteps to the leader) and contactfrequency (how often do you ask the leader for advice).

It can be argued that people with a lot of relationships and communication with teammembers (i.e. the (in-)formal leaders) have the strongest influence on the perception of others. Thereby, they are expected to have to biggest influence on others' perception of the IC, especially when relationships are strong, this leads to the following hypotheses:

- *The strength of formal leader-teacher relationship (measured as networkdistance and contactfrequency) positively affects the teacher's perception of the innovative climate (H1a).*
- *The strength of informal leader-teacher relationship (measured as networkdistance and contactfrequency) positively affects the teacher's perception of the innovative climate (H1b).*

### **Possible mediating role of teacher's self-efficacy**

The strength of the leader-teacher relationship may directly influence the perception of the innovative climate, however it can be argued that this relationship is mediated by teacher's self-efficacy.

Self-efficacy is defined by Pescosolido (2001) as the confidence of an individual that he can perform certain tasks. Efficacy beliefs have an impact on how people behave, feel, think and motivate themselves (Bandura, 1993). There are different efficacy beliefs: self-efficacy and the collective or team efficacy. In this research, an individual score of self-efficacy, specifically for teachers, is used since this research focusses on the effect of a teacher's relationship with the leader on his self-efficacy and thereby his/her perception of the IC. Previous research confirmed that teachers self-efficacy beliefs are related to their professional learning and enhancement of student achievement (e.g. Dembo & Gibson, 1985; Geijsel, Slegers, Stoel and Kruger, 2009; Ghaith & Yaghi, 1997).



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Bandura (as described by Pescolido, 2001) describes four ways to develop self-efficacy: previous successes or failure, experiences of related others, verbal persuasion and psychological and emotional arousal. Self-efficacy is influenced by intrinsic and extrinsic factors (Lee, Dedrick & Smith, 1991). Intrinsic factors can not directly be influenced by others, extrinsic factors can. Extrinsic factors can be for instance the relationship with the (in-) formal leaders of the school.

### **Teacher's self-efficacy and leadership**

Social models are linked to strengthening SE, seeing other's succeed or fail leads to belief in own capacities (Bandura, 1998). Leaders can influence teacher's self-efficacy (Fullan, 2002; Geijssel et al., 2009), by example with role modelling, social persuasion and physiological arousal (Gist and Mitchell, 1992; Pillai & Williams, 2004). It can be expected that there has to be frequent and direct contact between leader and teacher to achieve this influence. However, there is a gap in literature concerning the influence of this leader-teacher relationship on SE. In this research will be investigated whether (in-) formal leader-teacher relationship effects the IC via SE.

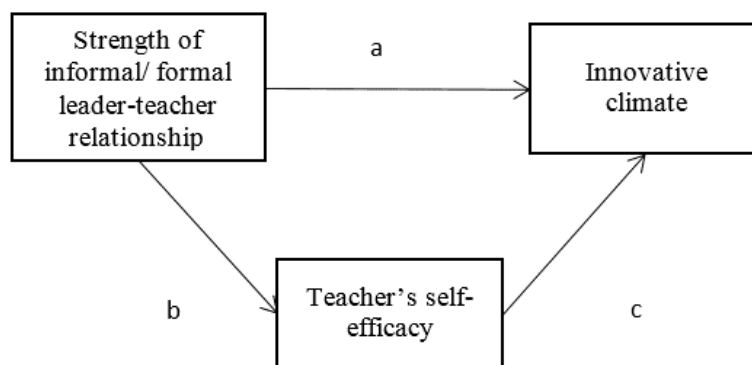
### **Teacher's self-efficacy and the innovative climate**

Teacher's self-efficacy (SE) has been related to organizational improvement (e.g. Gist and Mitchell, 1992; Goddard & Goddard, 2001; Pillai & Williams, 2004; Tschannen-Moran & Hoy, 2001). Geijssel et al. (2009) state that people with higher self-efficacy are more likely to take risks and are more creative in their learning, thinking and work. Zimmerman (2006) describes that teachers with high self-efficacy are more likely to try new strategies and embrace new ideas; traits required for innovation. For that organizational improvement, openness to change and a good IC are key. All these authors argue that higher self-efficacy is beneficial for the IC. It can be expected that:

- *The strength of formal leader-teacher relationship positively affects teacher's self-efficacy, which in turn positively affects the school's innovative climate (H2a).*
- *The strength of informal leader-teacher relationship positively affects teacher's self-efficacy, which in turn positively affects the school's innovative climate (H2b).*

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This theoretical framework leads to the following hypothesized model (see Figure 1).



*Figure 1.* Hypothesized influence of the strength of (in-)formal leader-teacher relationship on the innovative climate, mediated by teacher's self-efficacy.

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### Method

#### Sample

This research was conducted at 13 primary schools in the Netherlands, 267 teammembers were questioned, this lead to 230 respondents (with ages  $M = 42,61$   $SD = 12,33$ ,  $Min = 20$ ;  $Max = 65$ , see table 1), of which 185 primary school teachers (164 female), and 16 formal school leaders (11 female), 15 internal coaches and 14 with other functions. A high response rate (>80%) within the teams is required to map the social network. The overall response rate was 86% ( $Min = 83\%$ ,  $Max = 100\%$  per schoolteam) which is sufficient for social network analysis. Teams differed in size,  $Max = 45$   $Min = 8$  ( $M = 17.69$ ).

Preferably, the schools in this research are participating in the program 'School aan Zet' (SaZ). This program is initiated by the Dutch Government in order to stimulate innovation at schools (PO-raad, VO-raad & the Dutch Government, 2013). These schools are focused on innovation and therefore interesting for this study. During collecting data I decided to enlarge my sample by contacting primary schools outside the project SaZ, by convenience sampling. Finally, the sample consisted of five SaZ schools with a total of 86 teammembers and nine non-SaZ schools with a total of 144 teammembers. The schools are located in various cities throughout The Netherlands: Bergen op Zoom, Bussum, Halsteren, Hoogeveen, Klazienaveen, Ried, 's Hertogenbosch, Schiebroek, Utrecht, and Zevenaar.

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Table 1

*Sample Characteristics of Schools, Teachers and Formal leaders*

	<i>N</i>	Min.	Max.	<i>M</i>	<i>SD</i>				
Teachers	185								
Age	184	21	65	41.44	12.48				
Experience (in years)	168	0	43	16.42	12.35				
Formal leaders	16								
Age	16	31	59	48.63	8.92				
Experience (in years)	14	9	39	23.00	9.11				
Internal coaches	15								
Age	15	33	58	44.53	9.37				
Experience (in years)	14	8	38	18.43	8.57				
Others	14								
Age	14	20	63	49.00	13.22				
Experience (in years)	13	5	41	23.08	14.32				
School	13								
Age (in years)	13	20	65	62.61	12.33				
Gender ratio (%)	13	76.19	100	86.96	8.46				
Team size	13	8	45	17.69	10.85				
Response rate (%)	13	83	100	86	8.01				
		Teachers		Formal leaders		Internal coaches		Others	
		<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
Gender									
Male	21	11.35	5	31.25	0	0	4	28.57	
Female	164	88.65	11	68.75	15	100	10	71.43	

*Note.* Gender ratio is calculated as the percentage female respondents compared to the percentage male respondents. Experience is experience in education.

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### **Pilot**

Previous to the research, a pilotstudy was conducted on one primary school with 25 teammembers to make sure the questions in the questionnaire were appropriate and the translation of the different items was adequate<sup>1</sup>. In the pilotstudy, the scales were found to be reliable and measure one factor (IC or SE) and therefore the use of this questionnaire is justified. This outcome justifies using the pilotdata in the overall data sample.

### **Procedure**

Previous to the data collection the research was introduced with a short powerpoint presentation. Clear agreements were made about deadlines, informing the schools about what was required and what could be expected in return. All teammembers were asked to fill out the questionnaire, using either a paper or a digital version. The respondents were free to answer the questionnaire at any convenient moment before the deadline set at two weeks. All respondents were informed about the possible risks and that participating is voluntary.

### **Instruments**

#### **Social network analyses**

To map the school's social network, an advice network-question was asked to all members of the team. As stated earlier, advice relationships are connected to innovation as well as leader's influence and power (e.g. Moolenaar, et al., 2010; Nebus, 2006). Therefore teachers were asked to answer the following network-question: "Who do you turn to for work related advice, and how often?". In this section, all relevant social network measurements are clarified.

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<sup>1</sup> This pilotstudy showed that both scales were reliable (IC:  $\alpha = .77$ ; SE:  $\alpha = .96$ ). A principle component analysis (PCA) was conducted on both scales without rotation. The factor of the IC-scale explains 47% of the variance and has an eigenvalue  $> 1$ , which is sufficient according to the Kaiser's criterion. The factor of the SE-scale explains 70% of the variance and has an eigenvalue  $> 1$ , which is sufficient according to the Kaiser's criterion. Both screeplots showed obvious points of inflexion after the first factor and all items have a factor loading wide above .30. Except from the SE-item 12: "How much can you assist families in helping their children do well in school?" With a factor loading of .29. It's the only item concerning the cooperation with the children's parents, and it doesn't influence the reliability of the scale at all. Based on these arguments I decided to preserve this item.

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**Contactfrequency.** The variable contactfrequency (multiple times a day, daily, weekly, monthly, never) was used to point out the *strength of the leader-teacher relationship*. In regression and mediationanalyses all variables should be continuous. The variable contactfrequency is not continuous (i.e. because the difference between weekly and monthly is bigger than the difference between daily and weekly). Therefore this variable was transformed into dummy variables, making groups for the different contactfrequency-scores (see table 2).

Table 2

*Dummy coding contactfrequency*

	D1-Monthly	D2-Weekly	D3-Daily	D4-Multiple times a day
Never	0	0	0	0
Monthly	1	0	0	0
Weekly	0	1	0	0
Daily	0	0	1	0
Multiple times a day	0	0	0	1

*Note.* The control condition (D0) is never contact.

**Networkdistance.** The variable 'networkdistance' was measured in network steps (e.g. when two people are in direct contact with each other this is considered one networkstep) but this variable had almost zero variance  $s^2 = .04$ ,  $M = 1.05$ ,  $Max. = 2$ ,  $Min = 1$  networksteps to the formal leader; and  $s^2 = .07$ ,  $M = 1.07$ ,  $Max. = 2$ ,  $Min = 1$  networksteps to the informal leader. This variance was considered insufficient and therefore this variable was not further included in this research.

**Indegree centrality.** To measure influence and power of each teammember, a measurement of indegree centrality was used, counting all direct ties of the teammember with other teammembers. Someone's indegree centrality depends on how many teammembers have indicated to ask that person for work-related advice. The informal leader was conceptualized as the person with the highest

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indegree centrality score at that school, without taking the formal leader into account. Each school has at least one formal and one informal leader. In case a school had more than one (in-)formal leader, out of the contactfrequency scores with all leaders, the highest score was used. Mean-scores could not be used as dummyvariables since these scores would be continuous.

**Measurement of *the perception of the innovative climate (IC)*.** The perception of the IC is measured by using the validated scale of Moolenaar (2010, table 3). Moolenaar's research focused on the same target group and context, therefore it was appropriate to use this scale in this study. In the original scale, a four-point Likert agreement scale was used (1= disagree and 4= agree). The questions were slightly adjusted to better fit this context. Also a neutral and fifth answer option was added, so that the data could be considered continuous.

A principal component analysis (PCA) was conducted on six variables of the IC-scale without rotation. The Kaiser-Meyer-Olkin measure verified that the sampling adequacy for the analysis was sufficient ( $KMO = .75$ ). Bartlett's test of sphericity indicated that correlations between items were sufficiently large for PCA;  $X^2(15) = 313.86, p < .05$ . For the initial analysis one fixed factor was used because of the expectations from the pilot and the theory. The factor explained 45% of the variance. Table 3 shows the factor loadings of the six items of this adequately reliable scale ( $\alpha = .76$ ). Mean-scores of these items were used for measuring IC.

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Table 3.

*Items of the scale used to measure the Perception of Innovative Climate and Summary of PCA for the SPSS IC-scale (N=230)*

Perception of the innovative climate	Factor loadings
1. I am continuously learning and developing new ideas	.77
2. I am generally willing to try new ideas	.70
3. I am constantly trying to improve their teaching	.64
4. I have a positive 'can-do' attitude	.61
5. I am willing to take risks to make this school better	.70
6. I am encouraged to go as far as I can	.64
Eigenvalue	2.75
% of variance	45
$\alpha$	.76

*Note.* Based on the scale for measuring a school's innovative climate, developed by Moolenaar (2010).

**Measurement of Teacher's Self-Efficacy.** According to Bandura (1997), self-efficacy scales need to be tailored to the object of interest. In the educational context it concerns teacher's self-efficacy (SE). The 'Ohio State Teacher Self-Efficacy Scale' (OSTES) designed by Tschannen-Moran and Hoy (2001) was especially suited for the context of this research since it was designed to measure SE. Klassen et al. (2009) provided evidence which suggested that SE is a valid construct across culturally diverse settings. Furthermore, it has been argued that this scale is superior to previous measures of the same construct (Klassen et al., 2009). There is a long and a short version of the OSTES, the validated short version consists of twelve questions (Tschannen-Moran & Hoy, 2001) and was used in this study. The original OSTES-scale measures three factors: efficacy for instructional strategies, for classroom management and for student engagement (see table 4). The overall score was



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used as an overall self-efficacy score. The OSTES was translated by the researcher to better fit the Dutch context.

Table 4

*Items of the scale used to measure teacher's self-efficacy, summary of the PCA (N = 189)*

Teacher's self-efficacy	Factor loadings
<u>Efficacy for instructional strategies</u>	
1. To what extent can you use a variety of assessment strategies?	.45
2. To what extent can you provide an alternative explanation or example when students are confused?	.55
3. To what extent can you craft good questions for your students?	.64
4. How well can you implement alternative strategies in your classroom?	.64
<u>Efficacy for classroom management</u>	
5. How much can you do to control disruptive behavior in the classroom?	.76
6. How much can you do to get children to follow classroom rules?	.72
7. How much can you do to calm a student who is disruptive or noisy?	.69
8. How well can you establish a classroom management system with each group of students?	.63
<u>Efficacy for student engagement</u>	
9. How much can you do to get students to believe they can do well in schoolwork?	.70
10. How much can you do to help your students value learning?	.69
11. How much can you do to motivate students who show low interest in schoolwork?	.59
12. How much can you assist families in helping their children do well in school?	.49
Eigenvalue	4.83
% of variance	40
$\alpha$	.85

*Note.* These questions were answered by teaching personnel only, i.e. all teachers and some of the group 'others'.

A PCA was conducted on twelve variables of the SE-scale, no rotation was used (see table 4).

The Kaiser-Meyer-Olkin measure verified the sampling adequacy for the analysis (KMO = .87), which

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is sufficient. Bartlett's test of sphericity  $X^2(66) = 785.93, p < .05$ , indicated that correlations between items were sufficiently large for PCA. For the initial analysis one fixed factor was used because of the expectations from the pilot and the theory. The factor explains 40% of the variance and has an eigenvalue of 4.83, which is sufficient according to the Kaiser's criterion. Table 4 shows the factor loadings of the twelve items of this scale. All items load above .35. The IC-scale had a good reliability of  $\alpha = .85$ . In sum, the OSTES was used in order to measure teacher's self-efficacy, calculating the mean of all items to assign all teachers their personal SE-score.

To make sure the translation of both scales were in order, back-translation was used (see appendix 1).

### **Analyses**

After collecting the data, descriptive statistics were calculated. An independent t-test was used to compare the SaZ schools to the non-SaZ schools. UCI-Net software was used to analyze the social network, the indegree centrality of the actors and the strength of the relationship with the (in-)formal leader (contactfrequency). For measuring the possible relationship between the strength of leader-teacher relationship and the IC, first a Pearson's correlational analysis was conducted. Secondly multiple regression analyses were executed in SPSS v.22. According to Zao, Lynch and Chen (2010) a significant effect of X on Y can be mediated by another variable even when there is no direct effect of X on Y. The possible mediating role of SE was taken into account by using the PROCESS script in mediating analyses, using the bootstrap test of the indirect effect described by Zhao et al. (2010), using the instructions described by Hayes and Preacher (2014)<sup>2</sup>.

Prior to the different statistical analyses several assumptions were evaluated, as described by Field (2009) and Allen and Bennet (2012). First, histograms with a normal curve and a score of kurtosis and skewness were used to investigate the assumption of normality. The kurtosis and

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<sup>2</sup> Opened and ran the Preacher-Hayes PROCESS script in SPSS, identified IC as dependent variable, independent is contactfrequency (one of the dummy variables) and the mediating variable SE. Bootstrap samples were set on 5000 and confidence level at 95%.

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skewness scores tend to be significant in large samples ( $N > 200$ ), and therefore the distribution should be visually examined and the significance test should not be used (Field, 2009). According to the output, these variables are within the acceptable range of a normal distribution. This meant parametric tests such as an independent t-test could be used to compare the means of SaZ-schools and not- SaZ-schools. Second, all variables in mediation and multiple regression analyses should be continuous. The variables IC and SE were measured at a five point Likert scale, this can be considered interval measurement level and thereby continuous.

Third, after visually assessing the scatterplot, the absence of any clear patterns in the spread of points indicated that the assumptions of normality, linearity and homoscedasticity of residuals have been met. The regression plot of standardized residuals suggests that the residuals are normally distributed. All collinearity scores had tolerances  $> .1$  and VIF scores  $< 10$ , therefore these scores were deemed not too high, i.e. not multicollinear. The risk of multicollinearity between the variables contact frequency with the formal and with the informal leader was taken into account by running every analysis twice, once for the formal leader and once for the informal leader. Multivariate outliers were of no concern (Mahalanobis Distance  $9.87 < \chi^2(5) = 11.07$ ,  $\alpha = .05$ ). Furthermore, no individual case had an unusual high impact on the predictive efficacy of the model (Cook's distance  $< 1$ ). Independence of data could not be completely guaranteed because the questions were answered by whole teams. To encounter this possible risk, multiple teams were questioned ( $N=13$ ).

Zhao et al (2010) and Field (2009) both referred to the website of Hayes (2015) to download the PROCESS script and run it in SPSS for analyzing a possible mediating effect. In this case multiple mediation analyses with multiple categorical interdependent variables (dummies) were used. Following the steps of Hayes and Preacher's later work (2014), the hypothesized model was adapted, see figure 2. Indicator coding was used to code the dummy variables equally. According to Hypotheses H1a and H2a, the biggest difference was expected for D4 (very high contact frequency) compared to the control condition (no contact), and the smallest difference between D1 (very low contact frequency) and the control condition. A limitation of the PROCESS script is that only a single

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independent variable can be specified<sup>3</sup>. This problem was encountered by indicating the other dummyvariables as covariates.

In conclusion, the strength of leader-teacher relationships was tested by the different contactfrequency scores compared to no contact (i.e. strength of the relationship). The direct effect (Figure 2;  $c^1, c^2, c^3, c^4$ ) of the contactfrequency and the mediating effect of teacher's self-efficacy (Figure 2;  $a^1, a^2, a^3, a^4$  &  $b$ ) on the IC were analyzed.

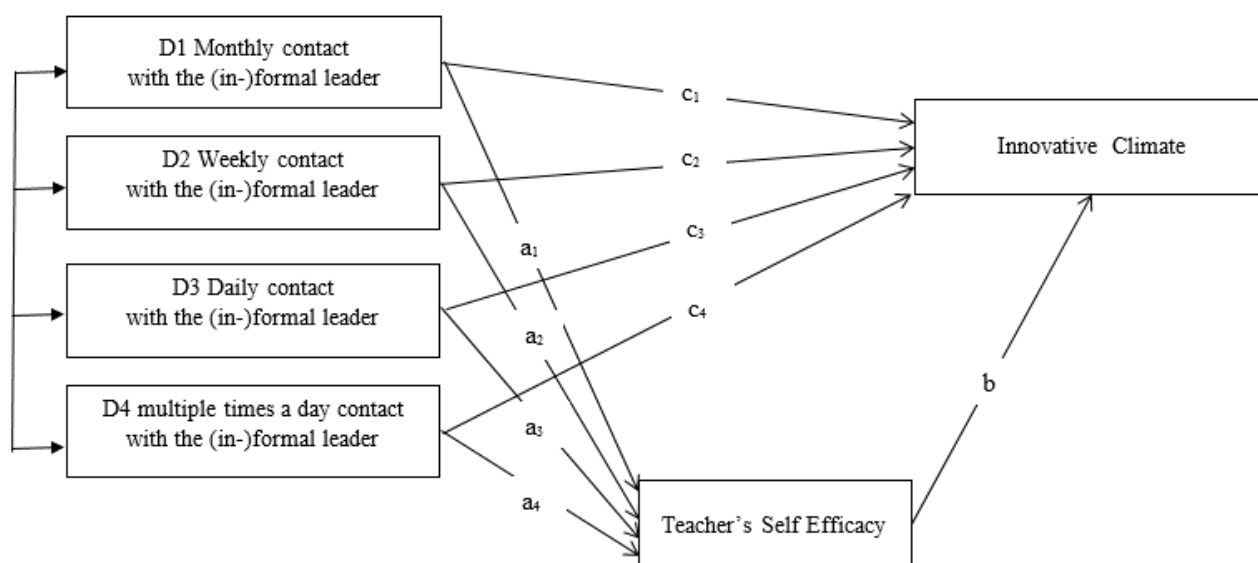


Figure 2. Renewed hypothesized model for this research

<sup>3</sup> According to Hayes and Preacher (2014) the PROCESS script can estimate a model like in figure 2 with the strategic use of covariates and manual construction of the indicator codes prior to execution and multiple executions of the macro to account for the different dummy variables and their interdependence. The percentile bootstrap IC-method was used. Although the bias-corrected method is more powerful, it has a slightly higher risk of a Type I error when one of the two paths is zero (Hayes & Preacher, 2014).

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### Results

There was no significant difference found in means for the variable IC between schools participating in the project SaZ (IC;  $M = 4.21$ ) and schools that are not participating in the project SaZ (IC;  $M = 4.19$ )  $t(227) = -.233, p > .05$ . The means for SE for SaZ-schools ( $M = 4.30$ ) and not-SaZ schools ( $M = 4.16$ ) analyzed as groups were slightly different. However, the difference in means for individual scores was not significant  $t(218) = -2.53, p > .05$ . Because the individual scores were more relevant for this study I can conclude that SaZ-schools can be analyzed the same as non-SaZ schools and this can be considered as one overall sample of Dutch Primary Schools.

### Descriptive analyses

The calculated descriptive statistics for IC, strength of teacher-leader relationship (informal and formal leadership) and SE are displayed in table 5.

Table 5

*Descriptive statistics for Innovative Climate (IC), Teacher Self Efficacy (SE), strength of relationship with the formal and the informal leader (measured as contactfrequency)*

	<i>N</i>	Min	Max	<i>M</i>	<i>SD</i>
IC	229	2	5	4.20	.51
SE	220	3	5	4.21	.41
Strength of relationship with the formal leader	219	0	4	1.72	.89
Strength of relationship with the informal leader	220	0	4	1.76	.98

*Note.* All decimals were rounded to two decimals

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### **Social Network Analyses**

Social network analyses of all schoolteams resulted in indegree centrality scores for all respondents. These scores were used to identify the informal leaders and showed a higher centrality score for the informal leader than the formal leader for 7 of the 13 schools in this research, for two schools the centrality score was equal for the formal and the informal leader and for the remaining four schools, the formal leader had the highest centrality score. At most schools (9/13) the 'internal coach' (in Dutch: 'intern begeleider') was found to be the informal leader.

To visualize the biggest differences in centrality scores, two social networks are shown in figure 3 and 4. These schools were chosen as examples because they can best illustrate the variety in centrality scores and strength of relationships. At the school of figure 3, leadership is highly distributed over the team and the informal leader is slightly more central than the formal leader, all teammembers have a high indegree centrality, this means they all ask each other for advice regularly. Teammember 5 is an exception, she is studying to be a teacher and was not included in the questionnaire. At the school in figure 4 the formal leader has a central position and power and influence is less distributed over the team.

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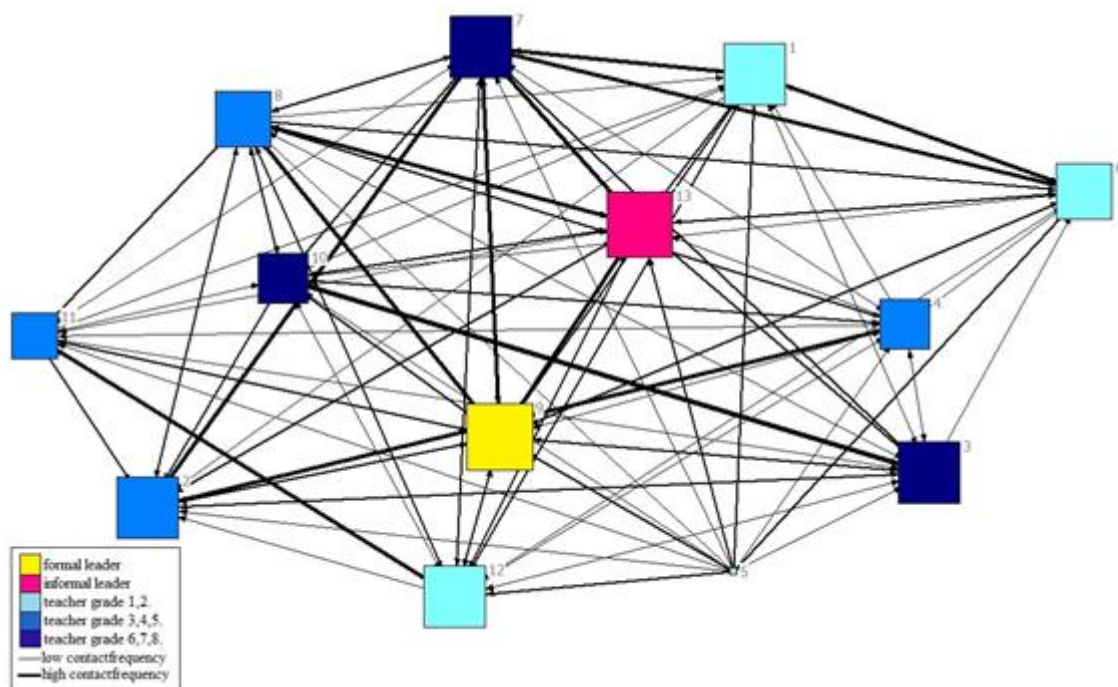


Figure 3. Example of a school's social network with highly distributed leadership ( $N = 13$ ).

The size of the symbols referred to the indegree centrality. The color of the symbols referred to the different functions at the school. The thicker the lines, the stronger the relationship.

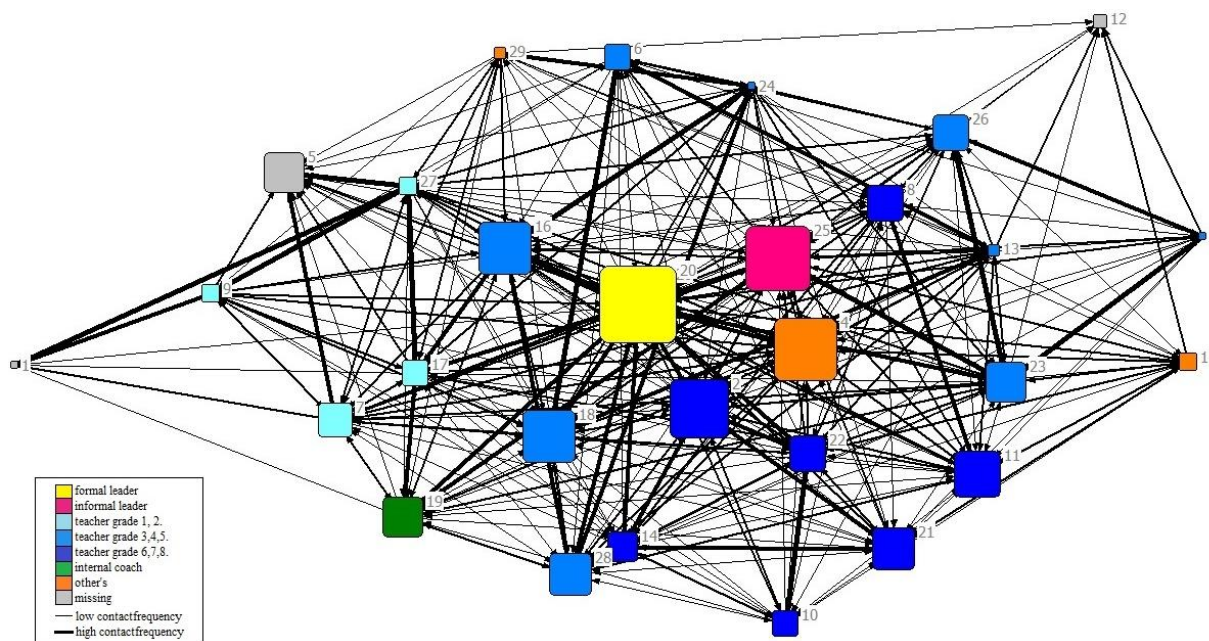


Figure 4. Example of a school's social network with a more central formal leader ( $N = 26$ ). The size of the symbols referred to the indegree centrality, the bigger the symbol, the higher is the indegree centrality score. The color of the symbols referred to the different functions at the school. The thicker the lines, the stronger the relationship.

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### Correlational Analyses

To assess possible linear relationships between strength of leader-teacher relationships, SE and IC, correlational analyses were conducted, see table 6 for the results of the bivariate Pearson's correlation coefficient ( $r$ ).

Remarkably, a weak relationship with the formal leader (FLD1) and the IC are negative and significantly correlated  $r(227) = -.16, p < .05$ . The other strengths of relationship with the formal leader are non-significantly positively correlated to the IC. This is remarkable because it was expected that a strong relation would have a greater and significant influence on the IC. These results suggest otherwise.

Table 6.

*Correlations and internal consistencies of all contactfrequency dummy-variables for the formal leader and the informal leader, IC and SE*

Formal leaders (N= 229)	IC	SE	FLD1	FLD2	FLD3	FLD4
IC (N= 230)	1	.34**	-.16*	.06	.02	.10
SE (N= 220)		1	-.05	.07	.03	-.01
FLD1 - Monthly			1	-.58**	-.32**	-.14*
FLD2 - Weekly				1	-.30**	-.13*
FLD3 - Daily					1	-.07
FLD4 – Multiple times a day						1
Informal leaders (N= 230)			ILD1	ILD2	ILD3	ILD4
IC			-.06	.02	-.00	.19**
SE			-.01	-.01	.01	.05
ILD1 - Monthly			1	-.51**	-.28	-.15
ILD2 - Weekly				1	-.32**	-.17**
ILD3- Daily					1	-.09
ILD4 – Multiple times a day						1

Note. FL= formal leader IL= informal leader. All decimals were rounded to two decimals. \*\*  $p < .01$ ,

\* $p < .05$ .



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A very strong relationship with the informal leader (IL D4) is positively and significantly correlated to IC:  $r(227) = .19, p < .001$ . The results show high correlations between SE and IC,  $r(118) = .34, p < .001$ . To test whether these variables can be used to predict the IC, in other words to test hypotheses H1a and H1b, multiple regression analyses will be conducted.

### Results of the multiple regression analysis

Results of the correlational analyses showed only a significant and negative correlation between a very low contact frequency (monthly contact) with the formal leader and the IC. In combination, all contact frequency scores for contact with the formal leader and SE accounted for a significant 14.8 % of variance of the outcome variable IC,  $R^2 = .15$ , adjusted  $R^2 = .13$ ,  $F(5, 214) = 7.46, p < .0001$ . Which means this model significantly predicts the IC. In combination, all contact frequency scores for contact with the informal leader and SE accounted for a significant 15.3 % of variance of the outcome variable IC,  $R^2 = .15$ , adjusted  $R^2 = .13$ ,  $F(5, 214) = 7.71, p < .0001$ . Unstandardised ( $B$ ) and standardised ( $\beta$ ) Regression Coefficients, and squared semi-partial correlations ( $sr^2$ ) for each predictor in the regression model are reported in Table 7.

Variables SE and a very strong relationship with the informal leader are the only significant predictors of the IC. The strength of the relationship with the formal leader did not significantly predict the IC, only the very high contact frequency with the formal leader had a small positive effect ( $p < .1$ ). Contact frequency monthly, weekly and daily (FLD1, FLD2, FLD3) had a small not significant negative effect compared to the control condition: no contact at all. All dummy variables did not significantly differ from the control condition: no contact. Therefore it cannot be concluded that the strength of the formal leader-teacher relationship is related to the team members' IC and the hypothesis H1a is not supported therefore I reject H1a: the strength of relationship with the formal leader positively affects the IC.

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Table 7.

*Unstandardised (B) and standardised ( $\beta$ ) Regression Coefficients, and squared semi-partial correlations ( $sr^2$ ) for each dummy variable for strength of relationship with the formal and the informal leader and teacher's efficacy (SE) in a Regression Model Predicting the Perception of the Innovative Climate.*

Relationship with the formal leader (N = 214)	B [95% CI]	SE B	$\beta$	$sr^2$
Constant	2.53 [1.85- 3.21]	0.35		
SE	0.43 [.27, .58]	0.08	.34***	.12
FLD1 - Monthly	-0.21 [-.46, .30]	0.12	-.11	.02
FLD2 - Weekly	-0.11 [-.35, .14]	0.13	-.06	.00
FLD3 - Daily	-0.06 [-.34, .22]	0.14	-.03	.00
FLD4 – Multiple times a day	0.25 [-.22, .72]	0.24	.07*	.01
Relationship with the informal leader (N = 230)				
Constant	2.34 [1.66, 3.02]	0.34		
SE	0.42 [.26, .57]	0.08	.33***	.33
ILD1 - Monthly	0.08 [.26, .57]	0.11	.07	.05
ILD2 - Weekly	0.11 [-.13, .28]	0.10	.11	.07
ILD3 - Daily	0.05 [-.09, .32]	0.13	.04	.03
ILD4 – Multiple times a day	0.49 [-.19, .30]	0.17	.21**	.19

*Note.* All decimals were rounded to two decimals. FL= formal leader IL= informal leader. FL:  $R^2 = .15$ . IL:  $R^2 = .39$ . CI = confidence interval 95%. \* $p < .1$ , \*\* $p < .05$ , \*\*\* $p < .001$

Results showed a significant positive influence of a teammember's very strong relationship with the informal leader (IL D4) on his/her perception of the IC, these results support H1b stating that the strength of relationship with the informal leader positively affects the IC. Contactfrequency monthly, weekly and daily (D1, D2, D3) with the informal leader had a small positive effect compared to the control condition: no contact at all. Given these results, I can conclude that a very strong relationship with the informal leader has a positive and more substantial influence on the IC than the strength of relationship with the formal leader. This justifies the acceptance of hypothesis H1b: *The*

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*strength of informal leader-teacher relationship (measured as contactfrequency) positively affects the teacher's perception of the innovative climate.*

Zao et al. (2010) argued that there does not have to be a significant effect of X on Y to establish mediation, they introduce the indirect-only mediation. Therefore mediation analyses were conducted to test if SE mediates these influences of the informal and formal leader. Mediation analyses were conducted using the Hayes and Preacher PROCESS-script (2014).

### **Results for the multiple mediator analyses**

No direct effect was found for all different contactfrequency scores indicating the strength of formal leader- teacher relationship does not significantly predict IC. The output of the mediating analyses showed that all dummy variables did not significantly predict the variable SE, thus, there is no effect at all.

A strong relationship with the informal leader (e.g. a very high contactfrequency) positively predicts the IC, thus, there is a direct effect. Results for the mediation analyses showed no significant effect of the strength of relationship with the informal leader on SE. All the confidence intervals (set at 95%) included zero, meaning there is not enough evidence to assume there is any effect. So relationships  $a^1$ ,  $a^2$ ,  $a^3$  and  $a^4$  as shown in figure 2 were all not significant for the relationship with the formal and the informal leader.

Concluding, no notable indirect mediating effect of teacher's self-efficacy was found for the contact with the formal leader (H2a) and with the informal leader (H2b). Therefore both hypotheses that stated that the *Strength of formal and informal leader-teacher relationship positively affect teacher's self-efficacy, which leads to an improvement of the school's innovative climate* were rejected. The proposed mediating variable SE, however, did predict the outcome variable IC significantly ( $p < .001$ ) and accounts for 12% of the variance, meaning that this is a good predictor of the IC.

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### Discussion

This thesis aims to investigate the possible influence of relationships with formal and informal leaders on someone's perception of the innovative climate (someone's openness to change), possibly influenced by teacher's self-efficacy. The research was conducted on primary schools in the Netherlands and shows the importance of leader's centrality in the social network to influence others. After carefully analysing the results, the research questions related can be answered.

The answers to these research questions are discussed below, as are the practical implications, possible limitations and suggestions for further research.

1. How does the strength of the leader-teacher relationship affect a teacher's perception of the innovative climate?
2. To what extent does teacher's self-efficacy mediate this relationship?

### **Informal leader has a greater influence on the IC than the formal leader**

This research shows that a strong relationship with the informal leader has more influence on someone's perception of the IC than the formal leader. Although this is only true for very strong relationships, it indicates a powerful role of informal leaders.

The practical implication of this conclusion is that schools should strategically position their informal leader to improve the school's IC. The formal leader should adequately organize distributed leadership (Hopkins & Jackson, 2002). When implementing desired change, formal leaders can assign a central role to the most central teammembers, i.e. informal leaders. Thereby making these informal leaders 'change sponsors' who can communicate about change and motivate other teammembers using their central position in the social network. Schools should analyze their social network in order to identify the informal leader and obtain more knowledge of the networkposition of teammembers. Furthermore the formal leader can invest in maintaining and nurturing strong and close relationships with all teammembers and thereby increase his own influence on their perceptions of the IC.

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A possible limitation for the results is that the strength of relationships was measured only in a quantitative way (by contact frequency) and not in a qualitative way, i.e. the content of the interactions. The strength of relationships can be further investigated by using multiple questions or a qualitative research method, e.g. an interview to investigate the content of these interactions and their effect on the IC.

### **Informal leader more central than formal leader**

At more than half of the researched schools (7/13) the informal leader had a more central position in the school's social network compared to the formal leader. From a social network perspective this explains the stronger influence of informal leaders on the IC. Their centrality implicates that the informal leaders were more frequently asked for advice than the formal leader, which allows them to influence the perception of more teammembers. In other words, leaders should have strong relationships with their teammembers if they want to implement change.

Unlike what some formal leaders might expect, they are not always the most influential and central person in the team. If they want to bring change, they should increase their centrality (hence, their influence) by strengthening the relationship. Research shows that successful leaders are those who invest in relationships (Harris, 2004). They can strengthen their relationships by for example making sure they maintain close and regular contact with all teammembers. According to Bush and Glover (2003) a transformational, interpersonal or participative leadership style is suiting for improving relationships in the social network and enhancing the IC. Further research can investigate how different leadership styles influence leaders' centrality, that discussion is beyond the scope of this thesis.

### **Most informal leaders are internal coaches (IB'er)**

At most schools (9/13) the internal coach, responsible for (special) care for all students and advice on these matters to teachers, is more frequently asked for advice than other teammembers. Given their position and function in the team this was to be expected. The informal leader was conceptualized as the most central teammember(s) without a formal management function. The function internal coach is not a specific management position, but he can act as a bridge between the

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formal leader and the other teammembers. It cannot be ruled out that part of their centrality is attributed to his/her function and the fact that teachers must stay in regular contact with this person. This was not relevant in this study. I advise other scholars to be aware of this special role when investigating (Dutch) schools' social networks. Further research could focus on typical personal traits, or roles of informal leaders making it easier to strategically place the right person at the right place.

### **Importance of teacher's self-efficacy (SE)**

Results show that teacher's self-efficacy does not mediate the influence of leader-teacher relationships on the IC. However, a very strong direct effect was found for SE on the IC, underlining the importance of SE. This conclusion supports the findings of Geijsel et al. (2009) and Zimmerman (2006) stating that a higher self-efficacy is beneficial for an innovative attitude, thereby enhancing the IC. Thus, when SE is sufficient, teachers are more likely to cooperate in implementing change desired by the schoolleaders.

This means that, to improve the school's IC, there has to be attention for strengthening teacher's self-efficacy. According to the results of this study, SE is not influenced by strong or weak relationships with leaders. Bandura (1998) argued that there are other ways for leaders to influence SE. Leaders can persuade teachers that they have what it takes to succeed and being or indicating a good role model with whom they can identify in order to strengthen SE-beliefs through vicarious experiences. They should do more than praise teachers; they should organize situations to avoid failure and to bring success (Bandura, 1998). Apart from improving the IC, SE will enhance student performance (Dembo & Gibson, 1985; Geijsel, et al., 2009; Ghaith & Yaghi, 1997) and job motivation (Bandura, 1993). Given the important influence of SE on schools, SE should be further investigated and addressed in practice.

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**Appendix 1**

(back) translation of the complete questionnaire

Translation in Dutch	Back-translation in English	Possible correction
Aan wie vraagt u werkgerelateerd advies en hoe vaak?	Whom do you ask for work related advice and how often? "who do you turn to for work related advise?"	
Ik ben continu bezig met leren en het ontwikkelen van nieuwe ideeën	I am continuously learning and developing new ideas	
Over het algemeen wil ik best nieuwe ideeën uitproberen	In general, I am willing to try new ideas (concepts)	
Ik verbeter mijn lessen continu	I improve my lessons continuously	Ik probeer constant mijn manier van lesgeven te verbeteren.
Ik heb een positieve houding ("ik kan het!")	I have a positive attitude (I can do it)	
Ik wil risico's nemen om deze school te verbeteren	I am willing to take risks to enhance quality at school (of: to improve)	
Ik voel me gestimuleerd om zo ver te gaan als ik kan	I feel encouraged (stimulated) to get the best out of myself	
In hoeverre kun je gebruik maken van verschillende toetsstrategieën	To which extent can you use (apply) different test strategies	In hoeverre ben je in staat om verschillende toetsstrategieën te gebruiken?
In hoeverre kun je leerlingen een alternatieve uitleg geven als zij het de eerste keer niet begrijpen?	To which extent can you give students a different explanation when then do not understand your first explanation/answer	In hoeverre kun je leerlingen een alternatieve uitleg geven wanneer ze iets niet begrijpen?
In hoeverre kun je goede vragen bedenken voor je leerlingen?	To which extent can you come up / create appropriate questions for your students	
Hoe goed ben je in het implementeren van alternatieve strategieën in je klas?	How good are you in using alternative / new strategies in your class(room)	
Hoeverre kun jij storend gedrag in je klas onder controle krijgen?	To which extent can you get control over annoying/difficult behaviour?	
In hoeverre kun jij ervoor zorgen dat leerlingen de regels volgen?	What can you do to make students follow the rules?	

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In hoeverre kun jij storende leerlingen rustig krijgen?	To which extent can you get annoying/loud/.. students quiet?	
Hoe goed ben jij in het inrichten van een goed klassenmanagement voor alle leerlingen?	How well can you implement good class management for all students?	Hoe goed ben jij in het inrichten van een goed klassenmanagement voor diverse groepen leerlingen?
The original SE scale has a 9 point Likertscale. In this study, a 5 point Likertscale was used because the answers 2,4,6,8 are not specified	A 5-point scale was used for each item, with anchors at 1=nothing, 3=very little, 5=some influence, 7=quite a bit, and 9=a great deal.	1 = geen invloed 2 = een kleine invloed 3 = een beetje invloed 4 = vrij veel invloed 5 = veel invloed
In hoeverre kun jij bijdragen aan het zelfvertrouwen van de leerling?	To which extent can you contribute to the student's self confidence / esteem?	In hoeverre kun jij bijdragen aan het vertrouwen van de leerling dat hij/zij het schoolwerk goed kan maken?
In hoeverre heb jij invloed op of de leerlingen waarde hechten aan leren?	To which extent can you influence how students value learning?	In hoeverre zorg jij ervoor dat leerlingen het leren waarderen
In hoeverre kun jij leerlingen motiveren die weinig interesse tonen in hun schoolwerk?	To which extent can you motivate students who show little interest in their schoolwork?	
In hoeverre kun jij families ondersteunen om de leerling te helpen bij het schoolwerk?	To which extent can you support/assist families to let them help the student with schoolwork?	In hoeverre heb jij invloed op de ondersteuning die families hun kinderen bieden op het gebied van schoolprestaties.

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