School Leadership for ICT and Teachers' Use of Digital Tools

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Abstract

International literature and Norwegian policy documents both identify school leadership as essential in order to implement ICT (Information and Communication Technologies) in teaching and learning practices in the classrooms. Data from an online survey in 2009 of 247 school leaders and 386 teachers from Norwegian primary and lower secondary schools are used to examine if conditions promoted by school leaders are associated with the use of ICT in classrooms by teachers. The research question posed in this paper is if *the attitudes and behaviours of school leaders with regard to ICT in their schools correlate with the attitudes and behaviours of teachers?* To answer the question, four construct variables are utilised as indicators of school leadership for ICT. These indicators are informative on school leaders' decisions and beliefs regarding their schools as ICT-using organizations. Results showed that the indicators were correlated with the time teachers spend on ICT in the classrooms and for administrative use, their use of common digital tools and with a construct measuring the teachers' attitudes towards innovative and student-centred pedagogy (life-long learning attitudes). The indicators of school leadership for ICT carry traits of perspectives from distributed, transformational and pedagogical leadership, but more research is needed in order to align the practice-based indicators with more overarching theoretical concepts.

Keywords: school leadership for ICT, teacher use of ICT, life-long learning, distributed leadership, transformational leadership

Introduction

School leadership is strongly associated with the pedagogical use of technology in schools. This paper focus specifically on the role of school leaders for the use of Information and Communication Technologies (ICT) in schools, for teaching and learning, hereby referred to by the term "School leadership for ICT".

School leadership for ICT is found to be highly important in order to make teachers both implement and be innovative with ICT in their practice (Kirkland & Sutch, 2009; Kozma, 2003). School leadership for ICT is also crucial in order to foster digitally competent pupils, by facilitating necessary infrastructure and a good working environment, together with explicit plans and visions on pedagogical use of ICT (Dexter 2008).

This paper aims to examine if conditions promoted by school leaders are associated with the use of ICT in classrooms by teachers. The paper draws on data from a Norwegian survey in 2009 (Berge, Hatlevik, Kløvstad, Ottestad, & Skaug, 2009) of 512 initial sampled primary and lower secondary schools where 247 school leaders from separate schools and 386 teachers answered online questionnaires.

The use of ICT for pedagogical purposes in Norwegian schools is legislatively founded through the national curriculum, where digital competence is defined as a basic skill with the same importance as reading, writing, numeracy and oral presentation (NDET, 2008). The curriculum thus equips school leaders with a mandate to promote the inclusion of ICT into actual teaching practice. This mandate is by no means very clearly stated as the schools are given a large degree of autonomy in their implementation and translation of the national curriculum. Evaluations of the implementation of the curriculum show that teachers and school leaders often decode the term "digital competence" more narrowly than the intentions of the policymakers (Hodgson, Rønning, Skogvold, & Tomlinson, 2010). It is of interest to try to investigate if school leaders are following through the intentions in the Norwegian curriculum by taking leadership measures to integrate ICT in pedagogical practice at their schools, and to see if these measures are correlating with practices in the classroom.

Thus, the main research question in this paper is:

> *Do the attitudes and behaviour of school leaders with regard to ICT in their schools correlate with the attitudes and behaviour of teachers?*

The research question will be operationalized through a set of hypotheses that specifies assumed relationships between chosen variables. Selected variables from the school leader questionnaire are summarized into four construct variables that serve as indicators of important dimensions for school leadership that promotes the use of ICT. Similarly, selected variables from the teacher questionnaire are summarized into two construct variables, one that measures teacher use of ICT and one that measures the responding teachers' pedagogical orientation towards life-long learning attitudes. These constructs are explained and placed in context in the theoretical and analytical framework.

Theoretical and analytical framework

A general trend in educational policies worldwide is to foster self-directed learners capable of life-long learning (R. E. Anderson & Plomp, 2009). This requires schools to change from institutions

that transfer knowledge into learning organizations (Coppieters, 2005). Studies of school improvement point to the importance of principals' leadership in such efforts (Kenneth Leithwood, Harris, & Hopkins, 2008). A distinction of three theoretical perspectives on general school leadership – *distributed* (K. Leithwood & Mascall, 2008; Møller, 2006; Møller et al., 2005; Robinson, Hohepa, & Lloyd, 2009; Spillane, 2005), *pedagogical* (K. Leithwood & Mascall, 2008; Møller, 2006; Møller et al., 2005; Robinson et al., 2009) and *transformational / managerial leadership* (K. Leithwood & Jantzi, 1999); (Møller, 2006) – can be used to build an analytical framework for contextualizing the study data.

Distributed leadership emphasizes leadership as activity and interaction between school leaders and teachers (Spillane, 2005). Leadership of a school is a collaborative team effort, and teachers are also perceived as leaders in the classroom. Both stretched boundaries and co-enactment between leaders and teachers are seen as central (Bennet, 2008). Research on exemplary school leadership in Norway has documented that cooperation between all actors and team-based efforts are used systematically to put the learner and the learning process in focus. In turn, this yields strong communities of practice between teachers and leaders (Møller, 2006; Møller et al., 2005). Within the more specific domain of leadership for ICT in schools, an Israeli case study demonstrated that the principal had a crucial role in initiating innovations in schools that had integrated ICT school-wide, as opposed to schools characterized by an "island of innovations" where innovative usage of ICT was confined within a smaller group (Forkosh-Baruch, Nachmias, Mioduser, & Tubin, 2005, 2006). Dexter (2008) suggested that a broad team should influence and effectuate leadership decisions in this field. Such a team might consist of the principal, ICT-coordinators, teacher leaders and competent teachers. In schools, examples are plentiful of teachers who use their competence on ICT to innovate in their own pedagogical practice, train peers and challenge the traditional role of the teacher (Hadjithoma & Karagiorgi, 2009; Hatlevik, Tømte, Skaug, & Ottestad, 2011). Such teachers take on the role of knowledge activists at their schools (Nonaka, von Krogh, & Voelpel, 2006). From a distributed leadership perspective, knowledge activist teachers might be very useful for school leaders who seek a school-wide implementation of innovative use of ICT. *Pedagogical leadership* points to the need for school leaders to be involved in the teachers' pedagogical practice by observation, counselling and implementation of professional development efforts when needed (Jackson & Marriott, 2012; Robinson et al., 2009). Pedagogical leadership for ICT should, according to Dexter (2008), be applied to setting a direction for pedagogical practices and assessment with ICT. These directions must be tuned to reasonable expectations in the faculty on which direction to take, and what speed to adapt. Such tuning to staff needs and capabilities should also inform the decisions made when leaders identify and assign tracks for teachers' professional development in pedagogical use of ICT (Dexter, 2008). The school leader's charismatic authority and the use of formal role descriptions for the support of leadership actions (Møller, 2006; Robinson et al., 2009) distinguish *transformational* leadership in the sense used in this paper. In order to succeed in building a supportive environment for teachers, Dexter (2008) points out that it is crucial for leaders to instil team learning, build a shared vision and employ systems thinking. This points back to the visionary and inspirational features of transformational leadership, and places the school leader in a prominent and charismatic position. However, this position should not be seen as being in opposition to the leadership role that distributes control and initiative to knowledge activists or that closely mentors the staff on pedagogical matters with ICT (Robinson et al., 2009).

These three perspectives may be seen as complementary, i.e. school leadership is inherently a mixture of features from all perspectives. School leadership, seen from the principals' role, could then be characterized by clear distribution of formal roles and legitimacy, a functional distribution of

leadership responsibilities to teams and individuals, and close monitoring and counselling of teachers' needs and pedagogical practice. It is, however, necessary to stress that pedagogical leadership in school should be understood as the "interaction of principal and teacher influence" (Jackson & Marriott, 2012, p. 235). The role of the school leader is put under additional demand when ICT is present in the everyday pedagogical practice, as they need to undertake ICT-related professional development activities to support their new roles as technology leaders (Stuart, Mills, & Remus, 2009).

In a previous iteration of the study (Arnseth, Hatlevik, Kløvstad, Kristiansen, & Ottestad, 2007), four constructs indicating school leadership for ICTs were identified (Ottestad 2008). The indicators were based on the principals' perceptions of their schools as organisations more or less inclined to utilise ICT in pedagogical practice. The findings emphasize that school leadership based on flexibility and digital maturity and promotion of shared practice and assessments with ICT are features shared by schools that adapted ICT in their pedagogical practice (Ottestad 2008). The questions were repeated in the 2009 cycle, allowing for new use of the constructs as indicators of school leadership for ICT. A full presentation of the items and their psychometric properties is included in the appendix. A short interpretation of the meaning of each indicator is listed in Table 1, together with a conceptual mapping of the indicators against the three dimensions of school leadership for ICT – distributed, pedagogical and transformational leadership.

Table 1. The four indicators of school leadership for ICT

Name	Short interpretation	Leadership dimensions covered
Digital practice	Teachers' practices are comprehended as decisive for the schools' adaptation of ICT	Distributed
ICT maturity	The school's general preparedness and ability to realise the use of ICT	Transformational and pedagogical
Assessment and roles with ICT	ICT brings change in roles between students and teachers, and the changes are tied together with the need for new assessment practices	Pedagogical and distributed
Leadership for collaboration	Signifies the school leaders' influences on how much teachers collaborate, discuss and learn from each other in order to develop pedagogical usage of ICT.	Transformational

The four indicators will not be analysed individually in this paper. An exhaustive discussion of the initial interpretations of items and their explanatory potential is given in Ottestad (2008). A few comments on the indicators and their relation to the given leadership dimensions follows: the items that comprise the indicator "digital practice" suggest that teachers' practices are comprehended by school leaders as being decisive for the schools' adaptation of ICT. Features of distributed leadership are present in four out of five items in the indicator. ICT maturity "(…) provides a picture of the school's general preparedness and ability to realise the use of ICT in areas other than those that are purely administrative and skills related" (Ottestad, 2008, p. 153). ICT maturity can also refer to a maturity modelling of a school's adaptation to usage of ICT (Davis, 2008; Forkosh-Baruch et al., 2005). Three items can be classified as pointing towards transformational leadership and two items

to pedagogical leadership. Hence the indicator carries traits from both perspectives, with emphasis on transformational leadership. The third indicator is termed "assessment and roles with ICT". The items in this indicator point towards the fact that changes in roles between students and teachers are taking place, and that the changes are tied together with the need for new assessment practices. Items denoting pedagogical leadership and transformational leadership comprise the indicator. The indicator "Leadership for collaboration" signifies school leaders' influences on how much teachers collaborate, discuss and learn from each other in order to develop pedagogical usage of ICT. Another important dimension is the school leaders' active dialogue with the faculty on the use of ICT. Although the indicator as a whole from this might be understood as indicating distributed leadership, the single items in the indicator are arguably tied to the perspective of transformational leadership, by indicating that the principal exerts authority by planning, funding and engaging in dialogue with the staff.

Although the indicators from the 2007 study were an interesting contribution to the body of school leadership literature, the analyses did not span a connection from school leader data to data on teachers' attitudes and actions. Vanderlinde & van Braak (2010) recognize the need to empirically explore such relationships between school level conditions and the teachers' actual use of ICT in the classrooms (Vanderlinde & van Braak, 2010).

Numerous studies have placed the main influence on many performance indicators for students on the teacher (Bransford & National Research Council Committee on developments in the Science of learning, 2000; John Hattie, 2009). For pedagogical use of ICT in particular, studies show that teachers' actions and values are crucial in order to implement the use of ICT in pedagogical practice in schools (Somekh, 2008; Wong & Li, 2008). Vanderlinde & van Braak (2010) see teachers' use of ICT both as a function of schools' e-capacities and as an independent factor that affects curriculum implementation and instructional change.

It is believed that most ICT-related benefits to teaching and learning are acquired when an innovative and student-centred pedagogy is adopted (Ronald E. Anderson, 2008; Dede, 2008). In order to provide a measure for such pedagogies, "life-long learning practices with ICT" was distinguished as an indicator in the IEA[1] SITES[2] 2006 study (Law & Chow, 2008; Law & Pelgrum, 2008; Law, Pelgrum, Monseur, et al., 2008). The construct was used to analyse whether school system level factors influenced teachers' innovative use of ICT in their pedagogical practice. The construct was conceptually placed within the loose paradigms of 21st century pedagogy or "innovative" pedagogical practices, and is biased towards the understanding of knowledge as co-created between pupils and teachers. The study found teachers' attitudes towards student-centred and life-long learning practices to be associated with higher levels of ICT use (Law, Pelgrum, & Plomp, 2008).

From the present study, five items in the teacher instrument were chosen for a construct that is inspired by the construct in the SITES 2006 study. The measure of life-long learning orientation comprises items that describe if the teacher applies pupil-centred pedagogy, if pupils use ICT for project work and if ICT is used in feedback and feed-forward cycles for supporting the pupils' learning processes in written assignments. See Table 2 for a description of the applied construct.

Additional variables from the teachers' dataset that have previously been documented to be of importance for pedagogical use of ICT are included. *Teachers' time spent on computers* is separated into two variables: time spent on computers for teaching activities and time spent on computers for

planning, preparation and administrative work. Norwegian teachers' time spent on computers at school in both fashions has been documented as increasing over the last decade (Berge et al., 2009; Egeberg et al., 2012). However, administrative usage, counted by hours, still dominates compared with use for teaching activities, and huge differences between schools exist. *Teachers' use of a selection of digital tools used for teaching activities* (e-mail, learning management systems, presentation software) combines information on the amount of usage and didactic processes, like giving computer-based presentations and giving pupils digital assignments (Egeberg et al., 2012; Kennisnet, 2011). These four items have been combined into a construct that gives an overall measure of the amount of ICT usage among teachers (Table 2).

Table 2. Selected variables at teacher level. Dispersion in percentages (chosen categories)

	Variable	Hypothesis #	Dispersion
a.	Time in hours per week spent on PC for teaching activities	1.	31.4% (4 hours or more/week) N = 386
b.	Time in hours per week spent on PC for planning preparation and administrative activities	1.	83.5% (4 hours or more/week) N = 386
c.	E-mail for teaching purposes	2.	62.8% (Once a week or more often) N = 362
d.	Publishing assignments for the students on our Learning Management System	2.	43.9% (Once a week or more often) N = 342
e.	Making students upload assignments on our Learning Management System	2.	24.8% (Once a week or more often) N = 334
f.	Making a presentation in PowerPoint or similar	2.	16.1% (Once a week or more often) N = 369
g.	Teacher usage of ICT (construct of items c., d., e. and f.)	2.	CA = .734 on 4 items, factor analysis (ML method, KMO = .699, Bartlett's test of sphericity $p < .001$, one-factor solution with 48.7% explained variance, saved by regression method).
h.	Life-long learning (LLL)[3]	3.	CA = .792 on 5 items, factor analysis (ML method, KMO = .761, Bartlett's test of sphericity $p < .01$, one-factor solution with 49.3% explained variance, saved by regression method).

Methods

The survey on ICT in Norwegian schools from 2009 was designed to be representative for each category of respondents; pupils, teachers and school leaders from primary schools, lower secondary schools and upper secondary schools. Upper secondary schools are excluded from the analyses in this paper due to a different ownership structure and thus very different investment regimes towards ICT infrastructure.

512 primary and lower secondary schools were initially sampled. 247 school leaders from separate schools and 386 teachers answered online questionnaires. Response rates for school leaders were

66% and for teachers 51%. All instruments were administered online. Three strata were predefined before the selection of schools, region, school type and numbers of students enrolled.

Reliability analyses with Cronbach's alpha and factor analyses were applied to find and create school-level indicators and indicators of teacher practice. Measures of bivariate correlations were used to test the strength of relationships between variables. Linear regression (stepwise) was used to test whether all indicators of school leadership for ICT together can explain a reportable size of the variance in the dependent teacher-level variables.

All processing of data was conducted in PASW SPSS 18 (IBM Corporation, NY 10589, USA).

The sampling procedure was designed for analyses within each respondent category only (i.e. teachers and school leaders separately), and only one to three teachers were sampled from each school. This violates sample conditions for multilevel analysis (Hox, 2010), which recommends at a minimum 30 groups (schools) with at least 10 participants (teachers) each. As a consequence, standard linear regression will be used in order to explore the relationship of the variables.

Research hypotheses

In order to specify the research question, three hypothesised relationships between the defined variables are formulated:

1. Higher scores on the four indicators of school leadership for ICT predict more use of ICT by teachers, measured in hours per week for teaching and administrative purposes.

2. Higher scores on the four indicators of school leadership for ICT predict high frequency of teachers' use of different digital tools for teaching purposes

3. Higher scores on the four indicators of school leadership for ICT predict higher scores by teachers on a construct measuring central dimensions of the concept of life-long learning (as distinguished in the IEA SITES 2006 study (Law, Pelgrum, & Plomp, 2008)).

The selection of variables from the teachers' dataset used to test hypotheses 1 to 3 is accounted for in Table 2.

Results

This section will be structured according to the three hypotheses to first investigate correlations between the indicators of school leadership for ICT and each teacher-level variable. To test the predictive strength of the indicators on each teacher-level variable, regression models will be presented.

Hypothesis 1: Time spent on computers

Hypothesis 1 stated an expected relationship between the four indicators and two variables measuring teachers' time spent on computers at school, which may function as a crude measure of a school's level of ICT activity. In the context of this article, the interesting point is to see if leadership perceptions expressed in the indicators of school leadership for ICT are correlated with the time

spent by teachers. Table 3 shows the correlations between the four indicators of school leadership for ICT and teachers' reported time spent on computers for teaching, planning and administration.

Table 3. Correlations (Pearson's R) for Hypothesis 1

	Digital practice	ICT maturity	Assessment and roles using ICT	Leadership for collaboration
Time in hours spent on PC for teaching activities	.195**	.159**	.143**	.180**
Time in hours spent on PC for planning preparation and administrative activities	.199**	.085	.084**	.226**
** Correlation is significant at the 0.01 level (2-tailed).				

Table 3 shows that the indicator "digital practice" correlates significantly positively with the time teachers spend on their computers at school both for teaching and administrative purposes. Digital practice indicates that a principal recognises the teachers' use of ICT for sharing and creating lesson plans, assessment and pupil-centred computer use. The correlation between digital practice and the teachers' reported time spent on computers could be understood to reflect the principals' rightful perception of conditions at their schools. It is also interesting to see that time spent on both administrative and pedagogical use of ICT is equally strongly correlated. Norwegian teachers have historically reported more use of ICT for administrative and planning purposes than in pedagogical practice (Arnseth et al., 2007; Berge et al., 2009; Erstad, Søby, Kløvstad, & Kristiansen, 2005; Kløvstad & Kristiansen, 2004). The relatively equal correlation sizes in this case might point back to the notion that high performing schools have both the leadership features and the motivated teachers that benefit from the utilization of ICT as a professional tool (Ottestad, 2008).

ICT maturity correlates quite strongly with use of computers for teaching activities, but to a much lesser extent with use for administration and planning (Table 3). The lack of equality in correlation strength for the indicator of these two variables might be explained by the fact that the indicator is less specific than digital practice in describing teachers' use of ICT outside of classroom practice. The emphasis in ICT maturity lies in a description of routines, purposes and leadership demands for use of ICT. The correlation between ICT maturity and teachers' use of ICT in the classrooms thus expresses that a thorough anchoring of ICT use by the school leader is associated with increased levels of hours spent on computers in teaching practice. This, in turn, supports the idea that school leaders who actively express their views on routines, purposes and demands regarding the use of ICT are also influencing their teachers to increase use of ICT in their pedagogical practice.

Table 3 shows that the indicator "assessment and roles using ICT" also correlates more strongly with the time teachers spend on computers for teaching practices than for planning and administration. This is not surprising, as the indicators describe the effects ICT usage has on subject learning and the relationship between the teacher and pupils, and the efforts the school is undertaking in order to rewrite the assessment systems to cater for ICT use. Traditionally, teacher–pupil relationships are hierarchic, and come together with summative assessment. Formative assessment and co-creation of knowledge breaks with this paradigm of objectified knowledge and

the notion of pupils as passive receptors of knowledge. The indicator "assessment and roles using ICT" might point to processes that challenge the traditional structures inherent in the school system.

"Leadership for collaboration" is the indicator most strongly attached to the time teachers spend on computers for administrative and planning purposes. It also strongly correlates with teachers' use of ICT in their teaching practice (Table 3). This indicator is the one that in a most direct way describes leadership actions and choices. It stresses dialogue, funding for targeted internal professional development between teachers and organisation of time, all for the promotion of pedagogical ICT use. The three other indicators are more attached to what the principals are observing in their schools, while leadership for collaboration describes an active leader who takes measure to build features necessary to evolve the school as a learning organisation.

Combined, the correlations of the four indicators of teachers' time spent on computers might point to the notion that leadership towards use of ICT can influence the work patterns of the teachers. On a basic level, instalment of ICT equipment for teachers might raise the number of hours the teachers use ICT in their work time. On a more advanced level, there are examples of schools where the leaders are making dedicated efforts to motivate teachers to digitalise their work (Fredriksson, Gajek, & Jedeskog, 2009), and as a consequence are pushing teachers to adopt ICT as a primary work tool. Two regression models are presented in Table 4, one for each of the dependent teacher-level variables: teachers' time with computers for teaching practices and teachers' time with computers for planning and administration.

Table 4. Linear regression models for the four indicators of school leadership for ICT on teachers' time with computers for teaching practices, and teachers' time with computers for planning and administration

	Dependent variable: Time in hours per week spent on PC for teaching activities				Dependent variable: Time in hours per week spent on PC for planning, preparation and administrative activities			
	B	SE	t	Sig.	B	SE	t	Sig.
(Constant)	3.056	.032	95.398	.000	4.889	.040	121.490	.000
Digital practice	.228	.041	5.515	.000	.319	.051	6.255	.000
ICT maturity	.162	.039	4.200	.000	.110	.048	2.316	.021
Assessment and roles using ICT	.010	.039	.269	.788	-.018	.050	-.370	.712
Leadership for collaboration	.152	.043	3.544	.000	.426	.053	7.976	.000
Notes	$R^2 = .051, p < .001$				$R^2 = .100, p < .001$			

The regression analyses reveal that the four indicators of school leadership for ICT explain about 5% of the variance in the time teachers spend on computers for teaching practices and 10% of the time they spend on computers for planning and administration. Regression weights are significant for all independent variables, except "assessment and roles using ICT". "Digital practice" has the strongest impact on the time teachers spend on computers for teaching practices, with "ICT maturity" and "leadership for collaboration" as almost equal two and three. Leadership for collaboration has the strongest impact on teachers' use of computers for administration and

planning, with digital practice counting as number two. ICT maturity is a weak predictor in this model.

Hypothesis 2: Digital tools and related activities

Hypothesis 2 stated an expected relationship between the four indicators and variables measuring teachers' use of different digital tools and related activities in their pedagogical practice. This expectancy builds on the notion that school leaders who score highly in the indicators of school leadership for ICT are promoting pedagogical use of ICT, and that this, in turn, yields higher reported use of core digital tools. In the questionnaire, the teachers were asked to report on how often they used different digital tools and related activities in their pedagogical practice. The initial question read: "How often do you use a computer at school for the following activities?" with answer categories: "Several times a day", "Once a day", "Several times a week, "Once a week", "Several times each month" and "Never". The use of software for e-mail, presentation and Learning Management Systems (abbr. LMS) were listed as alternatives. Table 5 provides the bivariate correlations between the teacher usage of ICT variables and the four indicators of school leadership for ICTs.

Table 5. Correlations for Hypothesis 2. Indicators of school leadership for ICT with use of different digital tools and activities (percentage reporting use weekly or more often)

Activity	Digital practice	ICT maturity	Assessment and roles using ICT	Leadership for collaboration
E-mail for teaching purposes (63%)	.152**	.065**	.132**	.285**
Publishing assignments for students on our Learning Management System (44%)	.157**	.061*	.211**	.203**
Making students upload assignments on our Learning Management System (25%)	.237**	.102**	.283**	.137**
Making a presentation in PowerPoint or similar (16%)	.238**	.122**	.119**	.137**
** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).				

Table 5 reveals that the indicators of school leadership for ICT significantly correlate positively with all of the digital tools and activities that were measured. It is of particular interest that tools and activities with the overall highest correlations to the indicators are making the students upload assignments on the LMS and publishing assignments on the LMS. Using the LMS both to publish assignments and as a channel for receiving student work can be understood as a relatively advanced use of this technology, and might point to practices that support the pedagogical feature of feedback-

feed forward cycles (J. Hattie & Timperley, 2007). Earlier studies in Norway found that teachers' most common use of LMS was for publishing lesson plans and registering absenteeism (Arnseth et al., 2007). Perhaps this is about to change, as a huge majority of teachers in the present study reported at least some use of LMS for dissemination and collection of assignments. The positive correlation between the indicators of school leadership for ICTs and the two specific uses of LMS may point to the fact that sustained and systematic efforts of the school leaders may have an influence on teachers' practice. It is interesting that "assessment and roles using ICT" clearly correlates more with the two LMS-related items, which describe collaborative practices, than to the more individualistic practices of e-mail and presentations. "Assessment and roles using ICT" describes traits that on a school level might be labelled as "progressive" in their emphasis on role change and formative assessment practices (Østerud, 2004). This again might support a growing notion that use of LMS in Norway is coming to be associated with 21st century pedagogical practices (Dede, 2008), and not with traditional pedagogy as much of the early critique in Norway was concerned with (Utdanningsdirektoratet, 2006). "Digital practice" most strongly correlates with the items with the fewest frequent users, whereas "leadership for collaboration" most strongly correlates with the two items with the highest number of frequent users. This might point back to the discriminating strength of the indicators. "Leadership for collaboration" consists of items that many principals might feel inclined to answer positively, while items more easily answered neutrally entail "digital practice". Of the four indicators, "ICT maturity" correlates least with the use of digital tools and activities. The items that entail ICT maturity do not mention specifically any use of ICT by teachers, and perhaps measure conditions and dimensions that have an indirect influence on teachers' pedagogical practices with ICT. ICT maturity is perhaps also the indicator that carries the most diverse dimensions, and as a consequence, is the one that discriminates the least between schools.

In summary, the correlation analyses support the statements in Hypothesis 2. Schools with higher scores in the indicators of school leadership for ICT tend to have teachers who report more frequent use of e-mail, LMS and presentation software for teaching purposes. A regression model is presented in Table 6 for the four indicators of school leadership for ICT on a constructed variable "teacher usage of ICT".

Table 6. Linear regression models for the four indicators of school leadership for ICT on teacher usage of ICT (construct)

	Dependent Variable: Teacher usage of ICT (construct)			
	B	SE	t	Sig.
(Constant)	.067	.026	2.599	.009
Digital practice	.180	.032	5.556	.000
ICT maturity	.083	.030	2.726	.006
Assessment and roles using ICT	.253	.031	8.051	.000
Leadership for collaboration	.204	.034	6.035	.000
Notes	$R^2 = .135, p < .001$			

The regression analyses reveal that the four indicators of school leadership for ICT explain about 13% of the variance in the variable "teacher usage of ICT". In this case, regression weights are

significant for all the four independent variables. In this model, "assessment and roles using ICT" has the strongest impact on teachers' usage of four different types of ICT, followed by "leadership for collaboration" and "digital practice". "ICT maturity" is a weaker predictor, and may be neglected. The implications of these findings will be discussed in the next main section.

Hypothesis 3: Life-long learning

Correlations between the LLL construct and the indicators of school leadership for ICT are presented in Table 7.

Table 7. Correlations (Pearson's R) for Hypothesis 3

	Digital practice	**ICT maturity**	**Assessment and roles using ICT**	**Leadership for collaboration**
LLL construct	.264[**]	.222**	.207**	.128**
** Correlation is significant at the 0.01 level (2-tailed).				

Positive scores in life-long learning attitudes among the teachers are clearly associated with positive scores on the indicators of school leadership for ICTs. The three indicators "digital practice", "ICT maturity" and "assessment and roles with ICT", which most directly describe traits among teachers and relationships between school leaders and teachers, more strongly correlate with the LLL construct than the school leader-centric indicator "leadership for collaboration". A regression model is presented in Table 8, for the four indicators of school leadership for ICT on the constructed variable of "teachers' life-long learning attitudes".

Table 8. Linear regression models for the four indicators of school leadership for ICT on LLL construct

	Dependent variable: LLL construct			
	B	SE	t	Sig.
(Constant)	.048	.024	2.031	.042
Digital practice	.238	.030	7.890	.000
ICT maturity	.214	.029	7.435	.000
Assessment and roles using ICT	.161	.029	5.616	.000
Leadership for collaboration	.063	.031	2.010	.045
Notes	$R^2 = .127$, $p < .001$			

The regression analysis reveals that the four indicators of school leadership for ICT explain about 12% of the variance in the variable LLL construct. Regression weights are significant for all the four independent variables. "Digital practice" and "ICT maturity" are the two stronger predictors in the model, while "leadership for collaboration" may be neglected in this context.

Discussion

The research question in this paper asked if the attitudes and behaviour of school leaders with regard to ICT in their schools correlate with the attitudes and behaviour of teachers. Based on the analyses, the answer is a tentative yes. Three indicators seem to be significant but weak predictors of teachers' time spent on computers for teaching and administrative purposes (Table 4). All four indicators are predictors of teacher usage of different ICT-tools (Table 6) and for teachers' life-long learning attitudes (Table 8). However, the implications of these predictions are not straightforward. In the context of this paper and the cross-sectional data underpinning it, it is conceptually problematic to try to establish a causal relationship between the dimensions that have been investigated. A more fruitful approach is to understand the relationship between teachers' attitudes and practices and school leaders' attitudes and practices as mutually interdependent. The correlations provided in Table 7 are possible evidence of what can be described as good cycles of practice and attitudes within schools. From a leadership perspective, this is a school culture where the school leader promotes ICT for planning, developing and sharing teaching practice, where student-centred pedagogy prevails and leadership actions are taken systematically to foster digital competence among the staff. From a teacher's perspective we can see evidence of similar attitudes and practices both with and without ICT, which is in accordance with the leaders' efforts and a shared set of values, expectations and goals.

Some main conclusions can be drawn from the findings and discussions in this paper. First, the indicators of school leadership for ICT by themselves carry traits relevant to what is recognised in the literature as school leadership for implementing ICT, with emphasis on innovative pedagogies and sound professional development. Policymakers in Norway have also put these dimensions forward in various policy documents and programmes (Helland, 2008; Ottestad, 2010). The indicators of school leadership for ICT are thus a possible tool for an analysis of schools' readiness for the application of ICT in accordance with national policy and research. Second, the indicators of school leadership for ICT also seem to be associated with higher levels of teachers' use of computers for teaching, planning and administration. Additionally the indicators of school leadership for ICT and teachers' use of e-mail, presentation and LMS software also positively correlate. Evidence in the present study points to the direction of advanced use of LMS associated with the indicator that is strongest on "innovative" or modern pedagogy, namely "assessment and roles with ICT". Last, the indicators correlate with teachers' attitudes concerning innovative and student-centred pedagogy. School leaders' higher scores on the indicators associate with teachers' higher scores on the construct for life-long learning pedagogy with ICT.

On a more conceptual level, the indicators and the associations with other variables presented in this paper can possibly be used to identify preferred patterns of school leadership for ICT. Tables 3 and 4 show that if teachers' use of ICT in teaching practice is to be increased, the indicators "digital practice" and "ICT maturity" might be informative. The conceptual mapping of the indicators towards the three perspectives on school leadership then suggest that a school leader should give dimensions of distributed leadership priority, but not forget entirely dimensions of pedagogical or transformational leadership. From Table 3 and the model in Table 4, it might be suggested that particularly transformational and distributed leadership considerations are important dimensions if teachers' use of ICT for administration and planning are to be prioritized, even if the transformational considerations carried by "leadership for collaboration" should not be forgotten. Table 6 points to associating teachers' use of digital tools with leadership perspectives within the pedagogical and transformational perspective, while Table 8 associates teachers' life-long learning

attitudes and practices with distributed and transformational leadership dimensions. In summary, these considerations give a fragmented view on which a pedagogical perspective might promote teachers' use of ICT, mainly due to the exploratory nature of the indicators of school leadership for ICT. The overall findings in this paper corroborate with Law (2008), who concludes from the SITES 2006 study that school principals' leadership and vision for pedagogical use of ICT is largely realized through the influence these principals have on support (pedagogical and technical) and technology infrastructure, and that these factors are crucial for fostering teachers' pedagogical practices with ICT within a lifelong learning perspective. In order to advise both practicing school leaders and policymakers in leadership for ICT in schools, further research on the alignment of indicators of school leadership for ICT with established dimensions of school leadership seems to be necessary.

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Appendix

The indicators are presented in Table A1, where each item is also mapped to the three different perspectives of school leadership for ICT presented in this section – distributed, pedagogical and transformational leadership.

The indicators were made by an explorative factor analysis of 20 items (ML-method, Varimax rotation, KMO = .886, Bartlett's test p <.001) provided four factors (42% variance explained), saved as variables (regression method). All items were responses to the main question which read: *"To what extent does the following statement describe your present organization?" ("Not at all", "A slight extent", "Some extent", "A great extent" and "Not applicable").* See Table A1 for complete item description and factor loadings.

Table A1. Indicators on digitally competent schools. Items and Rotated Factor Matrix. Conceptual mapping to three perspectives on school leadership

Indicator	Items	Rotated factor loadings				Map
		1	2	3	4	
Digital practice CA=.669	The teachers in our school share their digital lesson plans	**.652**	.288	.101	.219	**D**
	Assessment with the use of ICT is utilized to improve the pupils' performance.*	**.626**	.177	.285	.194	**P**
	Teachers develop their own digital teaching material.	**.518**	.246	.221	.280	**D**
	The pupils are engaged in deciding when and how ICT is to be used*	**.442**	.163	.264	.085	**D**
	The teachers are organized in subject teams	**.401**	-.181	.113	.244	**D**
ICT Maturity CA=.660	In our school ICT is integrated in the daily routine, and has its natural place within the local teaching plans, strategy plans and other plans.*	.391	**.673**	-.019	.188	**T**
	ICT is accessible and adapted to groups with special needs.	.005	**.665**	.137	.012	**T**
	The school leaders support and put forward clear demands upon the teachers' use of ICT.*	.214	**.582**	.160	.372	**T**
	We take measures to prevent illegal and unethical use of ICT.	.196	**.425**	.133	.148	**P**
	The teachers use a variety of teaching methods (e.g. problem-based teaching, project work).	.310	**.329**	-.019	.173	**P**
	Our school has access to adequate ICT resources.	.010	**.321**	.144	.049	**O**

Assessment and roles using ICT CA=.730	Applying ICT to subject learning has given pupils more responsibility for their own learning.	.205	.139	**.676**	.049	**D**
	The teacher-pupil relationship has changed as a result of introducing ICT in the teaching.	.019	.168	**.579**	.071	**O**
	As a result of introducing ICT in teaching, the school places greater emphasis on formative assessment.	.445	.100	**.542**	.221	**P**
	After the school started to use ICT, the tools used for assessment of pupils are not good enough anymore. *	.120	.012	**.413**	.260	**P**
	We have introduced digital tests and exams at our school.	.388	.134	**.390**	.111	**P**
	Teachers and pupils work together to define guidelines for use of ICT at the school.*	.333	.137	**.369**	.232	**D**
Leadership for collaboration CA=.719	The schedule is organized in a way that allows for teachers to develop digital lesson plans	.285	.185	.150	**.675**	**T**
	As a principal, I am facilitating and allocating funds to let ICT-capable teachers spend time coaching their colleagues*	.168	.212	.171	**.598**	**T**
	The school leader and teachers have a continuous dialogue about pedagogical use of ICT*	.454	.249	.036	**.582**	**T**
	Extraction Method: Maximum Likelihood. Rotation Method: Varimax with Kaiser Normalization. Rotation converged in 7 iterations. * Denotes new items in 2009 Map legend: D=Distributed leadership, P=Pedagogical leadership, T=Transformational leadership, O=Organizational features or other observations					

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2 Second Information Technology in Education Studies

3 Items: "The pupils are involved in choosing how to work in subject teaching". "How often do you use ICT for group work, project work and similar?" "I use a PC to comment on the pupils' draft assignments before their deadline". "I use a PC to comment on the pupils' final assignments". "When I?m using a PC to comment on pupils' assignments, I give advice on how to improve their work".