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Author(s)	Seng-Chee Tan and Ong Kian-Keong Aloysius
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Distributed leadership for integration of information and communication technology (ICT) in schools

Seng-Chee Tan, Ong Kian-Keong Aloysius

National Institute of Education,
Nanyang Technological University, Singapore

This study investigated the distributed leadership practices and system differentiation strategy in technology integration among three Singapore schools. These schools have achieved different levels of technology-related outcomes and are embarking on ICT integration of different scale and complexity. Luhmann's (1995) system theory was adopted to characterise the leadership distribution and differentiation strategies among the schools. Our findings showed that one school adopted a top-down leadership approach while the other two schools demonstrated leadership distribution. These two schools differed in their organisational differentiation strategy: one adopted segmentation differentiation while the other demonstrated functional differentiation. These variations in leadership practices seemed to be associated with the scale and complexity of ICT integration in the schools. We offered a preliminary explanation for the plausible relationship that exists between the level of complexity of ICT integration and the type of system differentiation.

Keywords: School technology leadership, distributed leadership, Luhmann's system theory

Introduction

The study of technology leadership has drawn considerable interest among educational researchers in recent years (Hadjithoma-Garstka, 2011). Research has found that technology leadership is an important factor for effective integration of technology in schools. Anderson and Dexter (2005), for example, found that technology leadership, compared to infrastructure and expenditure, was a stronger predictor of technology outcomes, including the level of technology use (Anderson & Dexter, 2005). Yuen, Law, and Wong (2003) suggested that technology leadership practices were associated with school characteristics, such as the stages of technology integration and the cultural characteristics of the schools. From a functional perspective, existing literature of technology leadership tended to focus on school principals as the central figure in leading technology change (Tan, 2010). Arguably, school principals are often not ICT experts and they do not necessarily assume the leadership role in technological implementation. A common practice among principals is to delegate key responsibilities to the head teachers and expert teachers (Dexter, 2008), which seems to be consistent with the concept of distributed leadership. Distributed leadership can be regarded as "a social distribution where the leadership function is stretched over the work of a number of individuals and the task is accomplished through the interaction of multiple leaders" (Spillane, Halverson, & Diamond, 2001, p. 20). Research that discussed technology leadership from a distributed leadership viewpoint has been less informed (Bennett, 2008).

Responding to the paucity of research in this focus area, we attempt to study how distributed leadership is enacted for technology implementation among three Singapore schools. Specifically, we aim to identify the variations of leadership distribution and investigate the differentiation mechanisms the schools adopt in technology integration. Guiding our study are the research questions:

1. In what ways are distributed leadership for integration of technology practised in three Singapore schools?
2. What types of system differentiation strategy, if any, do the schools adopt for technology integration?

The first question focuses on the identification of distributed leadership practices, if any, that were enacted in the participating schools. The second question addresses the differentiation strategies that the schools employed. Our selection of the three schools was informed by survey results revealed from a separate study on ICT implementation in Singapore schools. In August 2008, the Singapore Minister for Education launched the third MasterPlan for ICT in Education in the country. Working towards the vision “Harnessing ICT for Future Learning”, one specific goal of this Masterplan is that students will possess competencies for self-directed and collaborative learning through the effective use of ICT (Teo & Ting, 2010). We selected three schools that achieved different levels for this goal. Even though the participating schools in this study are either elementary or secondary schools, many of the leadership issues related to technology integration will resonate with leaders in institutes of higher education. This could serve as a springboard for further studies in different types of learning institutions.

Literature review

This study on ICT leadership is shaped by two theories: distributed leadership and Luhmann’s (1995) system theory. In recent years, scholars and researchers from various countries began to employ a distributed perspective to frame studies of school leadership (Spillane, Hunt, & Healey, 2009; Timperley, 2005). One reason was attributed to the potential of this theory to “generate new knowledge about school leadership and management” (Spillane & Healey, 2010, p. 253). Leadership literature has traditionally focused on principals and their roles and functions in reforming schools successfully (Heng & Marsh, 2009). This “heroic” model of leadership is deemed problematic as school principals often do not single-handedly lead schools to success (Spillane, 2005); this issue becomes more prominent in the face of ICT integration in schools where the ability of a school leader to take the sole responsibility and authority in implementing technology initiatives is called into question (Harris, 2003). Gurr (2004), for instance, argued that leadership models founded on a leader-centric, heroic and individualistic view are no longer appropriate in the context of leading technology change, but a shared or distributed view of leadership is better reflected in the practices of schools. Indeed, principals are unlikely to be the sole agent in leading technology-related changes because schools often have a multi-level leadership structure for technology integration (Dexter, 2008; Pulley & Sessa, 2001). There is often an array of individuals such as the heads of departments (HoDs) and teachers involved in leading the change process. Hence, taking a distributive perspective is one feasible way to explore and understand how various members of a school, apart from the principals, are involved in the leadership practices for ICT implementation.

Among the pioneering works, Spillane, Halverson and Diamond (2001) developed a distributed leadership concept to explain leadership for organisational learning. Building on Hutchins’ (1995) notion of distributed cognition, Spillane, Halverson and Diamond (2001, p. 20) defined distributed leadership as “a social distribution where the leadership function is stretched over the work of a number of individuals and the task is accomplished through the interaction of multiple leaders.” Distributed leadership recognises that leadership practices in schools involve multiple individuals from all levels (Leithwood, et al., 2007). Besides the top management, members of the teaching staff may take responsibility for leadership work as well, with or without formal designations. Distributed leadership is thus concerned about the practices among leaders rather than attributes or characteristics of individual leaders (Spillane, 2005). Leadership practice, as Spillane (2005) explained, is seen as an outcome of the interactions among the leaders to achieve their joint goals and visions, taking into account the context of the schools. Hence, a distributed leadership viewpoint seeks to understand the interactions between the leaders and their followers.

Several forms and patterns of distributed leadership practices have been proposed. For example, Gronn’s (2002) conceptualised two distinct forms of distributed leadership, namely, the additive and holistic forms. The additive form of distribution describes an uncoordinated pattern of distributed leadership in which various leaders act independently with little coordination with other leaders within the organization (Leithwood, et al., 2007). On

the other hand, the holistic distributed leadership depicts a “consciously managed and synergistic leadership among the sources of leadership in the organization” (Leithwood, et al., 2007, p. 39). Thompson (2003) suggested three types of interdependencies among the relationship between leaders and their followers: pooled, sequential and reciprocal interdependency. Pooled interdependency occurred when the joint productivity is the result of a combination of individual’s work, but each individual’s output is not dependent on the output of the others. Sequential interdependency describes a relay of outputs where individual build on the output of another, so the individual cannot start until he received the output of the other. Reciprocal interdependency happens when the output is produced via a collaboration of all individuals and individuals work together in order to produce the optimal output.

While the above patterns and forms could be detected in organisations where distributed leadership is well established, it could be challenging to identify and study these practices in its inchoate state. In this study, we adapted Luhmann’s (1995) system differentiation as an analytical framework to examine the leadership distribution. In essence, Luhmann’s system theory claims that a social system undergoes internal differentiation in order to deal with changes in its environment. According to his theory, when the environment becomes more complex with the increase in components and the possible relations between them, the system must develop mechanisms or structures to reduce the overall complexity. System differentiation thus leads to a division into subsystems with each focusing on different dimensions of the environment and the complexity of the subsystems. In this process, the overall complexity in a given system is thereby increased and hence, the paradox that “only complexity can reduce complexity” (Luhmann, 1995, p. 26). Luhmann proposed three main forms of differentiation: segmentation, stratification and functional differentiation. Segmentation differentiates a system into similar units on the basis of the need to fulfil identical functions continually. These subunits are functionally identical and do not provide new or alternative ways to meet the environment challenges. Stratification is a vertical differentiation of subsystems according to power and prestige which gives rise to a hierarchy. More complex relations with the environment occur as each subsystem works on a particular and distinct function in the system. However, subunits tend to operate independently in stratified systems and the effectiveness of subsystems is limited by its place in the hierarchy. Functional differentiation is the most complex form of differentiation as the system is divided into unequal subsystems specialising in different functions within a system. Although functionally differentiated, subunits rely on each other and form a complex network of which interdependence and communication are essential for its success.

While literature on distributed leadership is emerging, there are only a few empirical studies that examine school leadership in technology integration from this perspective. One exception is the study by Yuen, Law, and Wong (2003), who found that schools with strong cultural characteristics associated with technology integration adopted a multiple leadership strategy (akin to distributed leadership) and the teachers had autonomy in implementing ICT initiatives. A recent study has also revealed the potential of the systems theory to explain ICT implementation in schools. Employing systems theory, Tubin (2007) found that the ICT initiatives in schools could be characterised by systems differentiation. For example, schools that created a new level of computer trustees among the students were identified as adopting stratification strategy while schools that developed a specialized independent learning unit such as an excellence centre were regarded as using functional differentiation strategy. The study also attempted to associate leadership styles with each form of differentiation. There was, however, little elaboration on this aspect of her work. As our study involved looking at division of leadership roles for ICT implementation, system differentiation could serve as a practical analytical lens to characterise possible variations. We aim to identify the variations of leadership distribution in technology integration and investigate the different mechanisms that the schools adopt in technology integration. This study responds to the dearth of empirical study in distributed leadership for technology integration. At theoretical level, it aims to enrich explanation for distributed leadership from the perspective of system theory.

Methods

We adopted a case study approach because this methodology is highly appropriate when a holistic and in-depth investigation is required (Feagin, Orum, & Sjoberg, 1991). This study is part of a nationwide 5-year longitudinal study that involves survey of 110 schools and tracking of development of 12 schools. The study was commissioned in 2009 by the Ministry of Education to investigate into the implementation of the third ICT Masterplan in Singapore schools. This paper uses data from the second-year study conducted in 2010.

Among the 12 schools, three government-funded schools were chosen as contrasting cases in terms of their scale and complexity in ICT integration. School A is an elementary co-ed school located in the west of Singapore,

which represents a typical Singapore school in terms of ICT integration. School B is a secondary co-ed school located in the north of Singapore. This school is awarded the LEADICT@schools status awarded by the Ministry of Education, and was provided additional funding to conduct experiments on specific ICT integration projects. School C is a Secondary Girls' school located in the south of Singapore. This school is one of the six schools that have achieved the FutureSchools@Singapore status at the time of the data collection. The FutureSchools are recognized for their school-wide ICT implementation and are supported with more generous funding than LEADICT@schools. Both School B and C could be considered as ICT-enhanced schools. The school management committees in all the three schools basically comprise the principal, the vice-principals and a team of Head of Departments (HoDs) in various subject areas and one head teacher placed in charge of the ICT matters (HoD ICT).

The data collection methods include quantitative survey of students, as well as interview with the principals and focus group discussion with teachers. The survey was administered to 7390 students in 2010, and included the following two sections: (a) 7 items on the use of ICT for self-directed learning (Cronbach $\alpha=.843$); and (b) 5 items on the use of ICT for collaborative learning (Cronbach $\alpha=.878$). For example, an item that assesses the use of ICT for self-directed learning is: "I find out more information on the Internet to help me understand my lessons better." An item that assesses the use of ICT for collaborative learning is: "When I work in a group, I use the computer to work with my group members to complete a project." The students were asked to respond to these items in terms of their frequency of engaging in these activities, on a Likert scale of 1 to 6 (1 for "Not at all" and 6 for "All the time"). This instrument has been validated (see Teo et al., 2010).

The interview and focus-group sessions were guided by open-structured questions to invite the participants to comment on the school ICT implementation. In each school, a team of two researchers conducted one face-to-face interview with the principal, one face-to-face interview with the HoD ICT and a focus group discussion with six to eight teachers. The data collection was conducted from July to September 2010. Each session was audio-recorded and transcribed. We first analysed and coded the transcripts for sources of leadership distribution and functions. We then identified possible differences among the three cases and examined these differentiation based on our analytical framework. Results reported in this paper were based on the variations found in the structural differentiation (leadership hierarchy) in ICT implementation.

Findings and discussions

To answer the two research questions, we first present the survey outcomes on the use of ICT for self-directed learning and for collaborative learning. Next, we examine how each school structured their leadership for technology integration and their differentiation strategy, if any, in the process of technology integration. We then make a comparison across the three schools.

Survey outcomes of the three schools

The survey results provide evidence about how successful each school was with regard to the Masterplan goal on student's learning outcome. Table 1 summarises the survey outcomes of the three schools.

Table 1. A comparison of the survey outcomes of the three schools

School (number or respondents)	Types of school	Use of ICT for self-directed learning	Use of ICT for collaborative learning
		mean scores (std dev)	mean scores (std dev)
School A (62)	Elementary, mixed gender	3.34 (1.17)	3.93 (1.29)
School B (68)	Secondary, mixed gender	3.64 (1.00)	4.10 (1.09)
School C (77)	Secondary, Girls	3.91 (1.13)	4.55 (1.08)

The survey findings showed that similar trend existed among the three schools for the students' use of ICT for self-directed learning and for collaborative learning. School C showed the highest mean scores, followed by School B and School A. On the use of ICT for self-directed learning, analysis of variance at $\alpha=.05$ level showed that there was significant difference among the three schools, $F(2,204)=4.550$, $p=.012$. Post hoc analysis using Tukey HSD showed that the significant difference existed between School C and School A ($p=.008$). Similarly,

on the use of ICT for collaborative learning, analysis of variance at $\alpha=.05$ level showed that there was significant difference among the three schools, $F(2,204)=5.468$, $p=.005$. Post hoc analysis using Tukey HSD showed that the significant difference existed between School C and School A ($p=.005$). In short, School C seemed to be the most successful in achieving the student-related goals specified in the ICT Masterplan whereas School A was the least successful. Next, we turn to the qualitative analysis to gain an insight into the leadership practices among the three schools.

School A: Top-down leadership

An interview with the HoD ICT in School A revealed that she was the key driver to communicate ICT goals and initiatives to the teaching staff. She made decisions about the foci for technology integration, revolving around the types of technology tools to be used.

Basically this year was for them to use interactive whiteboard and then after that it's the Microsoft Excel. And... a refresher of the LMS... these three that I've focused on. Also because I didn't want to focus on too many things. Because no point training on too many things and nothing is being transferred... they don't use it.

She introduced several new ICT tools to the teachers, arranged for training for the tools and let the teachers decide which tools they would like to employ for their teaching practices.

I shared with them Webspiration collaboration mindmapping tool online... then I told them... let's integrate this into our curriculum... and they started and it blends in well... I see that happening, it's like spreading, it's taking roots now.

She shared that she had trained a team of teachers who would provide coaching to the other teaching staff. The selected teachers would learn the ICT tools and try it in their own classes before they trained the other teachers. The HoD ICT would then supervise these teachers and they were given opportunities to share their practices during staff meetings.

I started up this small team of teachers who do training for the rest of the teachers... for example like... the new system... they call it the... iConnect... each of us take a section. And then we ourselves will train our own staff. So right now it's what we're going to do for the new WES portal, the Vshare portal... we'll learn it, we'll do it in our own class and then we'll share it and train the teachers individually.

Thus, in School A, the principal and department head teachers of various subject domains were positioned in the ICT leadership structure. In terms of hierarchy, the HoD ICT operated at the same level as HoDs of various subject domains. However, the development and management of ICT programmes and applications were mostly directed and implemented by the HoD ICT. Thus, the HoD ICT acted as the key personnel to provide directions and create conditions for ICT implementation and her instructions were often cascaded down to the teaching staff through the various department heads. The school adopts a "heroic" model of leadership (Spillane, 2005) where there is a concentration of power and responsibility on the HoD ICT. This HoD was the key person directing and planning the ICT integration in the school. We could not detect significant differentiation strategy employed by School A. We conclude that School A was practicing top-down leadership approach for ICT leadership, as show in Figure 1. Note that this hierarchical structure represents the most common structure in mainstream Singapore schools.

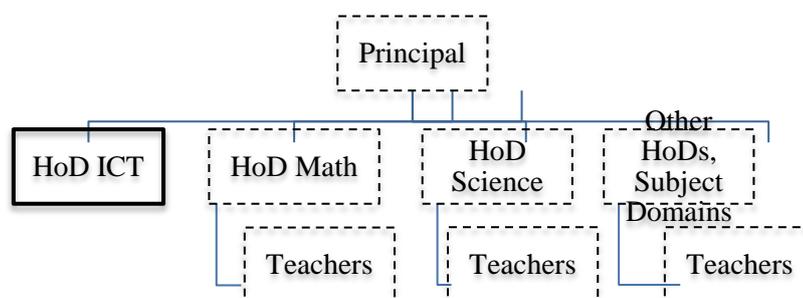


Figure 1. Top-down ICT leadership in School A

School B: Segmentation distribution

School B adopted a segmentation differentiation approach for ICT leadership where there was a division of the leadership structure into identical units that operated in a similar ways from which it emerged. Unlike the structure for School A where the HoD ICT directed and implemented ICT programmes and applications, the findings from School B showed that the department heads for various subject domains were the key personnel involved in setting the directions for technology integration. The principal and the HoD ICT assisted in supervising and facilitating their work. In the words of the HoD ICT, they helped to “make sure that... when every department design programs, design things, project work... they have a set of guidelines... linking it to our school vision as well.”

The HoD ICT shared that School B is encouraging department-based ICT experimentation. As the school was participating in a nationwide initiative called “TLLM (Teach-Less Learn-More) Ignite”, teachers from various departments were tasked to initiate action research projects. He described two existing projects implemented by the Mathematics department and the Science department respectively.

The Maths department is involved in this... project. So they are exploring using tablet PCs for learning of graphs. So last year we’ve already had action research project on... that is one strand. The other strand is... the AR [Action Research] by the Science department. They are looking into the use of blogs for developing inquisitiveness in the students... that’s another research we’re doing.

One teacher from the science department provided an elaboration on one of the science projects. In brief, the science teachers collaboratively investigated the effects of blogs as a reflective tool on students’ learning.

For the science department, we are actually embarking on the science research project on reflections... so we are using ICT and reflection on the board... Students after every lesson... everyday will reflect... we split them into different groups, one group will reflect and post it up on notice board what they have learnt today, what are some of the things they have thought about, what do they feel about the lesson, is there any questions they want to ask about the lesson that was taught. Another group will do it on the blog. They will just post up their reflections on the blog... and the third group will do the reflective journal with no audience, that means they will just write inside their ‘My Reflective Journal’ book, and then they will just submit to the teacher. So we are testing for any effects... (Teacher, School B)

There was a distribution of leadership branching out from the individual departments where teachers were tasked to lead ICT programmes or initiatives. Figure 2 depicts this structure.

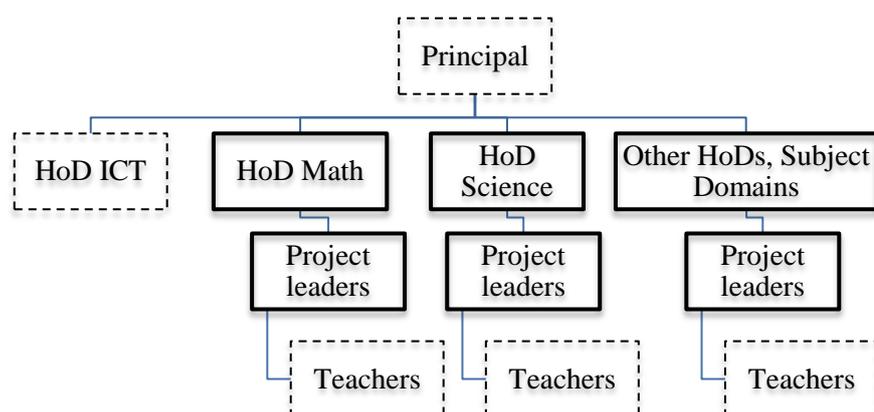


Figure 2. Segmentation differentiation strategy in School B

Noteworthy is that the projects conducted by various departments seemed to be independent of one another and were conducted in a similar fashion as action research projects. In other words, each department would start a project and assign experienced (senior) teachers to take charge of it; each project did not rely on one another for its planning and implementation. This division of structure is a characteristic of a segmentation distribution as new independent subunits continue to branch out from each department, forming identical units with similar functions.

School C: Functional differentiation distribution

Unlike School B where the principal and the HoD ICT play a facilitative role, the HoD ICT of School C reported that the principal and vice-principals, Heads of Department, senior teachers and IT directors were all involved in the planning of school ICT goals and initiatives. According to him, the principal and vice-principals examined the key MOE initiatives or directions and they did the envisioning exercise. The ICT department played a distinct role. Teachers, appointed as IT directors, worked with the HoD ICT in setting the directions for technology integration. These IT directors took charge of the sub-divisions within the ICT department. There are four sub-divisions within the ICT department: staff development, student development, infrastructure and special projects. The ICT plans from these sub-divisions were incorporated into the overall school plan.

For ICT plans... it's a combination of... IT plans from... all the different departments... at the same time... I will have all the four different IT directors overseeing things like staff development, student development, infrastructure as well as special projects. Again they would have their own ICT plans, which I will incorporate inside my entire plan. (HoD ICT, School C)

The Heads of Department in charge of the various subject disciplines also provided individual department plans for ICT integration. Expert teachers such as senior teachers were also involved in the planning of key ICT programmes. For instance, a senior teacher, in collaboration with the HoD ICT and Pastoral Care and Career Guidance (PCCG) department, planned the school cyberwellness programme.

A senior teacher... he's being supported by two key departments, the PCCG department and the IT department... we work very closely, the three of us, and in terms of so-called the cyber wellness plan that we've put in place for the school, it's at different levels. For example for the technology side, IT department, we have integrated into our lower secondary computer education programme alright so in Sec 1 and Sec 2, students will be going through computer education programme and a lot of projects it ties in with this cyber wellness. (HoD ICT, School C)

In the area of teaching and learning, School C involved teachers in the discussion on ICT implementation. The principal shared that they engaged all teachers in designing ICT lessons during an annual staff seminar.

Every half a year, we have our staff seminar and... we have discussions about how are you using IT, introduce to them new IT tools and we also ask them to share, discuss, plan a lesson together and it is that constant communication, discussion of concerns, bouncing ideas off one another that is making it more ingrained in them, making them realise more possibilities... (P, School C)

The HoD ICT also reported that the leadership practice for integrating ICT into teaching and learning was a "bottom up" approach "where our teachers ranging from our e-coaches to the... staff... they will be the ones who's coming up with ideas. From there we actually embrace it." Teachers, therefore, had the autonomy to design and implement their own ICT pedagogical practices. This point is emphasised in the quote below.

The teachers need to be able to articulate what it means... to think through what is it that they are doing in the classroom and... be able to articulate what does a good self-directed learning environment look like and how they are going to create the environment, how are they going to create and design the lesson in various different subject areas, which are very unique and very different. So we give them that space and that time to do that... (HoD ICT, School C)

We could conclude that School C adopts a functional differentiation strategy, where division of the leadership structure forms unequal subunits that operate with different and specialised functions for the ICT implementation. The principal and vice-principals take on a visionary role while the department head teachers and HoD ICT collaborate to implement ICT programmes and initiatives. In addition, there is a further division of the leadership structure into subunits that oversee specialised functional areas of the school ICT integration. For instance, under the HoD ICT, the leadership structure branches out to four subunits with specialised areas. Figure 3 depicts this structure. Note that in School C, leadership permeates several hierarchical levels, even at the level of classroom teachers.

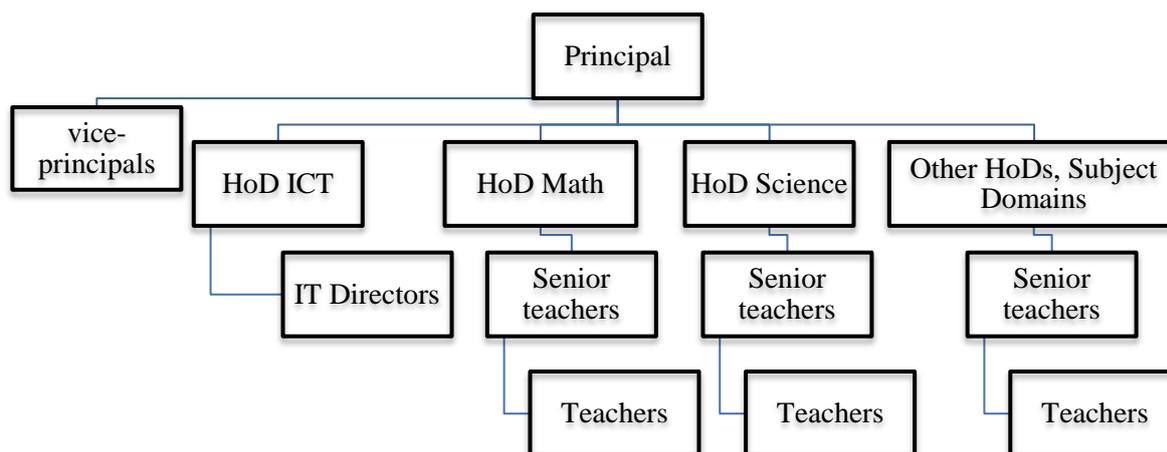


Figure 3. Functional differentiation strategy in School C

We have reported the findings for each school in terms of their leadership practices in ICT integration, in particular, the leadership structure and the differentiation strategy. A comparison of the three schools could help to uncover the plausible factors influencing the practices in these schools. Table 2 summarises the comparison.

Table 2. A comparison of the ICT leadership practices in the three schools

	Scale and Complexity of ICT integration	Differentiation Strategy	Distributed leadership
School A	<ul style="list-style-type: none"> • A typical Singapore school in terms of ICT integration • Least successful in achieving technology-related outcomes 	<ul style="list-style-type: none"> • Standard leadership configuration 	<ul style="list-style-type: none"> • Non-distributed • Leadership resides mainly in one person (HoD ICT)
School B	<ul style="list-style-type: none"> • LeadICT@School • Recognition for specific ICT projects 	<ul style="list-style-type: none"> • Segmentation differentiation, forming identical and independent subunits with similar functions 	<ul style="list-style-type: none"> • Distributed at two levels • Mainly Heads of Department of various subject domains and Project leaders
School C	<ul style="list-style-type: none"> • FutureSchool@Singapore • Recognition for school-wide integration of ICT • Most successful in achieving technology-related outcomes 	<ul style="list-style-type: none"> • Functional differentiation, forming unequal subunits that operate with different and specialised functions 	<ul style="list-style-type: none"> • Distributed at more than three levels • Whole-school approach

In this study, the three cases revealed structural differentiation in their leadership hierarchy for ICT implementation which could provide an indication of their distributed leadership practices. School A reflected a top-down leadership structure while School B and School C showed a distributed form of leadership structure. School B showed a limited degree of distribution in leadership and employed a segmentation strategy. On the other hand, School C demonstrated high level of distribution in leadership and a functional differentiation approach. These variations in leadership practices seem to be associated with the scale and complexity of the schools' ICT integration effort. School A was a non-ICT enhanced school; School B was under the LeadICT@School, recognised for its specific ICT project; and School C achieved the pinnacle FutureSchool@Singapore status for its school-wide integration of ICT. To suggest an explanation for such relationship, we first consulted two reported studies for ideas.

Yuen, Law, and Wong (2003) found that schools in the beginning stage of ICT implementation reflected a top-down management from principals while the leadership in schools in the advanced stage of ICT implementation involved multiple leaders. They suggested that schools in the beginning stage of ICT implementation tend to focus on developing students' ICT competencies and enhancing teaching effectiveness; a top-down management from principals could help both teachers and students to achieve the minimal level of ICT competencies. Schools in the advanced stage, however, engaged teachers and students in the use of ICT to implement new ideas for teaching and learning and hence the leadership involved multiple leaders. Thus, the principal was not necessarily the leader in initiatives related to ICT. In short, Yuen, Law, and Wong (2003) suggested that the leadership practices were influenced by the key concerns and stage of ICT implementation in the schools. On the other hand, Tubin (2007) used Luhmann's system theory (1995) to characterise schools by the types of system differentiation. She provided a cursory comment on the association between leadership style and each form of differentiation. Our study differs from the above two studies in two ways. First, since 1997, Singapore schools have experienced two ICT Masterplan in Education and are currently in the third phase of ICT Masterplan. Evaluation of the first ICT Masterplan found that both students and teachers possessed the basic ICT skills (Koh & Lee, 2009). Thus, it is likely that even School A has progressed beyond the stage of developing students' ICT competencies and enhancing teaching effectiveness. Second, Tubin (2007) focused on explaining the relationship between school's communication and the differentiation strategy. Though there was a brief attempt to associate leadership style and the type of differentiation, however, the leadership style seems to be focusing on the characteristics of a leader rather than distributed leadership. Nevertheless, these two studies provided ideas for us to explain distributed leadership practices using Luhmann's theory.

From our findings, we propose an explanation for the emerging relationship: A school that has successful school-wide ICT integration and adopts a functional differentiation approach could demonstrate a deeper level of distributed leadership. This explanation is consistent with Luhmann's explanation that "only complexity can reduce complexity" (Luhmann, 1995, p. 26). A school that engages in holistic and school-wide ICT integration is likely to encounter complex changes. This high complexity of change necessitates reaction mechanisms that are systemic in nature. It calls for new units that are more focused in their functions and there is a need to coordinate these functional units, resulting in stronger inter-dependency among the units. In addition, the complexity prevents a leader from providing direction and supervising at the level of functionally different sub-units; a higher degree of empowerment at each level is called for, and therefore, a deeper level of distribution of leadership. In short, the complexity of change influences the types of system differentiation and the degree of distribution of leadership. Incidentally, the survey findings indicated that School C was the most successful in achieving the technology-related goal among the students. Although the case study method prevents us from drawing a causal relationship, we could see this as a positive indicator of the practices enacted in School A. Acknowledging the limitations of a case study approach in generalising the findings, our explanation should be subjected to further verification.

Conclusion

This study set out to identify the variations of leadership distribution and investigate the differentiation mechanisms of the schools in technology integration among three Singapore schools. Using case-study approach, three schools with different scale of ICT integration effort were selected as contrasting cases to study the distributed practices.

Our findings revealed that School A, which represented a typical Singapore school in terms of ICT integration, displayed a top-down leadership approach. There was no apparent differentiation strategy. Within the standard leadership configuration of a Singapore school, the HoD ICT assumed the key leadership role in ICT integration. School B, which was recognized for its specific ICT projects, adopted a segmentation differentiation strategy where sub-units of similar functions were formed. In the case of School B, Heads of department for various subjects and project leaders took the leadership roles in implementing action research projects while the principal and the HoD ICT played facilitative roles. School C, which was recognised for its school-wide implement, adopted a functional differentiation strategy where new units of specialised functions were formed. In School C, four new positions of IT Director were created with unique functions: staff development, student development, infrastructure and special projects. Distributed leadership related to ICT integration permeated through various hierarchies within the school, including the teacher level. School C was also found to be the most successful in terms of the use of ICT for self-directed learning and collaborative learning among the students. By using the lens of Luhmann's system theory (1995) to study school leadership, we present a new

perspective for explaining distributed leadership in ICT integration. We suggest that a relationship exists between the level of complexity of ICT integration and the type of system differentiation, which could influence the degree of distribution of leadership.

Research on how distributed leadership is practised among school personnel in leading technology change is at its infancy stage. This study represents an initial effort to contribute to this field of study. Extending from this study, we aim to verify our preliminary explanation for the observed relationship, to study the interdependencies among the sub-units, as well as to explore the relationship between distributed leadership and various outcomes of ICT integration, including students' and teachers' pedagogical use of ICT tools in teaching and learning.

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Author contact details:

Seng-Chee Tan sengchee.tan@nie.edu.sg

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