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The relationship between technology leadership strategies and effectiveness of school administration: An empirical study

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ABSTRACT

This research has four main themes: (1) the level of school technology leadership used by administrators in elementary schools; (2) the degree to which administrators are aware of the effectiveness of school administration; (3) the relationship between administrators' technology leadership strategies and the effectiveness of elementary school administration; and (4) whether administrators' technology leadership strategies can predict the effectiveness of elementary school administration. The participants were 323 administrators (comprising principals and directors of academic-affairs, student-affairs, general-affairs, and counseling divisions) from 82 elementary schools located all over Taiwan and its three offshore islands. Semi-structured interviews, expert validity surveys and a pilot-study were implemented to develop a "Technology Leadership Strategies and School Administrative Effectiveness Scale". The quantitative data gathered from the instrument was analyzed through the use of descriptive statistics, Pearson's product–moment correlation coefficient, and simple linear regression. The findings indicated that elementary school administrators were highly conscious of using technology leadership strategies, and that these administrators generally possessed a high level of effectiveness regarding school administration. The results also indicated that technology leadership strategies had a significantly positive impact on the effectiveness of school administration, and thus the former could significantly predict the latter. The findings revealed that technology leadership strategies should be seen as an essential part of school administrators' training programs, in order to improve the effectiveness of such administration.

1. Introduction

Since technology is increasingly being applied in all areas of our lives, technology leadership is a key issue with regard to school administration. The related educational technology management approaches usually embrace complex perspectives, including the relationships among the educational departments, enterprises, schools, and all stakeholders.

There is wide agreement that the use of technologies with readily accessible, flexible and interactive resources can help promote parental engagement and develop connections among schools, communities, and families (Flanagan & Jacobsen, 2003; Hohlfeld, Ritzhaupt, & Barron, 2010; Lewin, & Luckin, R., 2010). The United Nations Educational, Scientific and Cultural Organization also noted that every professional teacher must now be prepared and able to use technology to support student learning (UNESCO, 2008). The North Central Regional Educational Laboratory (2010) has also argued that appropriate technology use can not only be very beneficial in increasing educational productivity, such as students' learning achievement and motivation, but also improve teachers' satisfaction and school administrative effectiveness. The researchers also suggest that students should be immersed in a rich, technology-enhanced learning environment, where they can select appropriate technologies to meet their own personal learning needs (Conole, late, Dillon, & Darby, 2008; Tapp, Kumar, & Hansen, 2006).

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Technology in schools has too often been limited to the acquisition hardware and software. While an appropriate technology infrastructure or set of information and communication technology (ICT) resources are indispensable, technology planning and leadership are even more important for the effective utilization of technology in this context (Anderson & Dexter, 2005; Flanagan & Jacobsen, 2003). As a consequence, almost every K-12 leader must now become a technology director, coordinator, and supporter. Sugar (2005) stated that a technology coordinator must carry out a wide range of activities in their interactions with teachers, including instructing them on the particular set of skills needed to use a new technology, solving technical problems, providing access to existing technology resources, and collaborating with teaching staff to develop teaching materials. A school technology coordinator thus not only plays a crucial role in leading teachers to develop more effective K-12 school environments (Frazier & Bailey, 2004), but also serves as an instructional expert by providing advice, methods and strategies for appropriate curriculum-oriented technology use that maximizes students learning (Elsa & Kobus, 2003; Sugar & Holloman, 2009; Twomey, Shamburg, & Zieger, 2006). In sum, technology leadership is very important for the effective integration and use of technology in schools, and thus it is the focus of the current work.

The process of integrating technology into schools in a developing country, like Taiwan, should be managed at all levels, from the Ministry of Education down to individual teachers and other stakeholders. K-12 school leaders thus need to receive training in how to be technology coordinators and agents of change at the organizational level. In the United States a number of training programs have been developed, such as "The School Technology Leadership Initiative" (STLI), which offers innovative academic programs that include a graduate certificate for school technology leaders. Moreover, school administrators can now base their technology leadership learning and practice on the National Educational Technology Standards for Administrators (NETS-A), which involve the following factors: (1) leadership and vision; (2) learning and teaching; (3) productivity and professional practice; (4) support, management, and operations; (5) assessment and evaluation; and (6) social, legal, and ethical issues. The NETS-A could be an important framework that Taiwan could use to develop its own technology leadership strategies, and in the current work the diffusion of innovation, technology acceptance model, strategic leadership and transformational leadership are all considered, as explained in more detail below.

1.1. Diffusion of innovation

Pope, Hare, and Howard (2002) argued that successful integration of innovative technology tools into instruction normally challenges the prevailing practices of faculty members, and so this development is often met with opposition. A more open-minded culture would thus be helpful in triggering innovation. The diffusion of innovation theory argues that instrumentality and interpersonal contacts provide information and influence the opinions and judgments of the members of an organization with regard to specific technologies. Therefore, the nature of the networks within an organization or community, and the roles that opinion leaders play in them, determine the likelihood that the innovation will be adopted. Opinion leaders exert influence on the behaviors of others via their personal contact, but additional intermediaries, called change agents and gatekeepers, are also included in the process of diffusion (Rogers, 1995). Rogers (1995) also argued that the diffusion of innovation consists of four stages: invention, diffusion (or communication) through the social system, time and consequences.

Sichel (1997) argued that the low usage of installed systems is a major factor underlying the "productivity paradox" surrounding the disappointing returns from organizational investments in information technology. With the gradual increase in investment in educational technology over past decade in Taiwan, the current authors wondered whether school administrators have been able to achieve corresponding educational outcomes. If good results are to be obtained from such spending, then school principals and administrative directors need to play a leading role in promoting the appropriate use of technology in teaching and learning, and take the lead in shaping an innovative school culture or environment.

1.2. Technology acceptance model

Significant progress has been made over the last two decades in explaining and predicting user acceptance of information technology at work (Davis, 1989). Numerous empirical studies have found that the technology acceptance model (TAM) consistently explains a substantial proportion of the variance in usage intentions and behavior, and that it compares favorably with alternative models, such as the Theory of Reasoned Action (TRA) and the Theory of Planned Behavior (TPB). In addition, in the many empirical tests of TAM that have been reported in the literature, perceived usefulness was consistently confirmed to be a strong determinant of usage intentions. Furthermore, Venkatesh and Davis (2000) developed and tested a theoretical extension of TAM that explains perceived usefulness and usage intentions in terms of social influence and cognitive instrumental processes (see Fig. 1). They found that both social influence processes (subjective norm, voluntariness, and image) and cognitive instrumental processes (job relevance, output quality, result demonstrability, and perceived ease of use) significantly influenced user acceptance.

Gabriella (2011) also found that principals' support for ICT integration behaviors depend on both contextual- and individual-level variables. Contextual variables include the amount of ICT equipment available for teachers in their school, teachers' competence and frequency of use and teachers' attitudes towards the ICT usage. Individual-level variables include the principals' attitudes towards ICT integration into school teaching, their exposure to ICT training courses and their own perceptions of their competence in using ICT. Accordingly, in order to promote their school technology leadership, school administrators, especially principals, must choose and adopt appropriate strategies, which can then be expected to improve all school members' willingness to adopt key technologies, as well as their abilities to use them.

1.3. Strategic leadership and transformational leadership

The integration of technology into strategic leadership has been emphasized by researchers in many non-educational fields, as it can increase the probability of achieving superior long-term performance (Hinterhuber & Friedrich, 2002; Hitt, Ireland, Camp, & Sexton, 2001). Since schools are places for developing competitive manpower, they should also adopt strategic plans to use technology well, and to support

such ICT innovations (Hagenson & Castle, 2003). In this context, Booth (2011) stated that support from school administrators, a clear and articulated vision and collaboration among administrators and faculty, are also critical for success in applying ICT.

Strategic leadership is as an essential capability that school leaders require to anticipate, envision, maintain flexibility, think strategically, and work with others in initiating changes that will create a viable future for the organization. There are three critical approaches to achieving better strategic leadership: (1) formulating a strategic vision based on facts, informed assumptions, and the best-possible what-if thinking; (2) implementing and communicating the vision throughout the organization to clarify and align the role of every strategically critical player and process; (3) monitoring, reviewing, and updating the vision to ensure its continued strength, agility, and relevance. As Freedman and Tregoe (2004) urged senior executives to force themselves to take the longer term perspective that strategic leadership demands, we believe that strategic leadership can provide a foundation for integrating technology into educational contexts.

Over the past two decades, school leaders have been required to become instructional leaders and focus on students' learning by emphasizing effective leadership strategies, use of data for decision making, vision sharing, and parental involvement in administrative matters. In fact, leadership is an important factor in developing effective, innovative schools and in facilitating quality teaching and learning (Dinham, 2005). Transformational leadership can also benefit school leaders by increasing the successful use of technology in schools (Mojgan, Kamariah, Wong, Bahaman, & Foo, 2009). Transformational leadership theory provides practical guidance for technology leadership researchers to follow. Generally speaking, transformational leaders make decisions based on a broad perspective, organizational vision and mission, group goals, and network development. Some of the behaviors of transformational leaders—applicable in both educational and business settings—may include the following: (1) identifying and articulating an organizational vision; (2) fostering acceptance of group goals; (3) having high performance expectations; (4) providing appropriate models; (5) providing intellectual stimulation; and (6) developing a strong organizational culture (Lashway, Mazzarella, & Grundy, 1995). Technology leadership strategies have thus been developed on the basis of various transformational leadership behavioral characteristics to achieve various educational goals.

1.4. Leadership and technology planning in school

The differences between technology leadership and technology management are not easy to distinguish. One commonly made distinction is that management emphasizes maintenance and coordination functions, while leadership involves working with others to prepare for the future and respond to change. Regarding the practical integration of technology into schools, the concepts of both leading and managing have been combined to form the technology leadership strategies considered in this study. Leadership affects both the performance and culture in schools, and there are five key roles and responsibilities: (1) leader of learning; (2) leader of student entitlement; (3) leader of capacity building; (4) leader of community; and (5) leader of resource management (Flanagan & Jacobsen, 2003). The key role of the principal in effectively leading the integration of ICT has been recognized by the ISTE National Educational Technology Standards (NETS) and Performance Indicators for Administrators in the United States. These standards identify the need for high levels of understanding and competence on the behalf of principals with regard to the major dimensions of leadership and vision; learning and teaching; productivity and professional practice; support, management and operations; assessment and evaluation; and social, legal and ethical issues as they relate to ICT in schools.

At the same time, technology planning or ICT policy planning are commonly referred to as the process of developing, revising and implementing a school technology plan that guides teachers and the school organization in the integration of technology for teaching and learning (Baylor & Ritchie, 2002), or seen as the product of joint interactions among school leaders, technology coordinators, teachers and specific aspects of their situation, such as tools, routines and structures (Dexter, 2011). Recently, a technology planning in schools (TPS) model that integrates the research results of several studies of technology planning in primary schools was proposed by Vanderlinde and Braak (2013), to help teachers to investigate technology planning and inspire school leaders to design initiatives that support schools in this

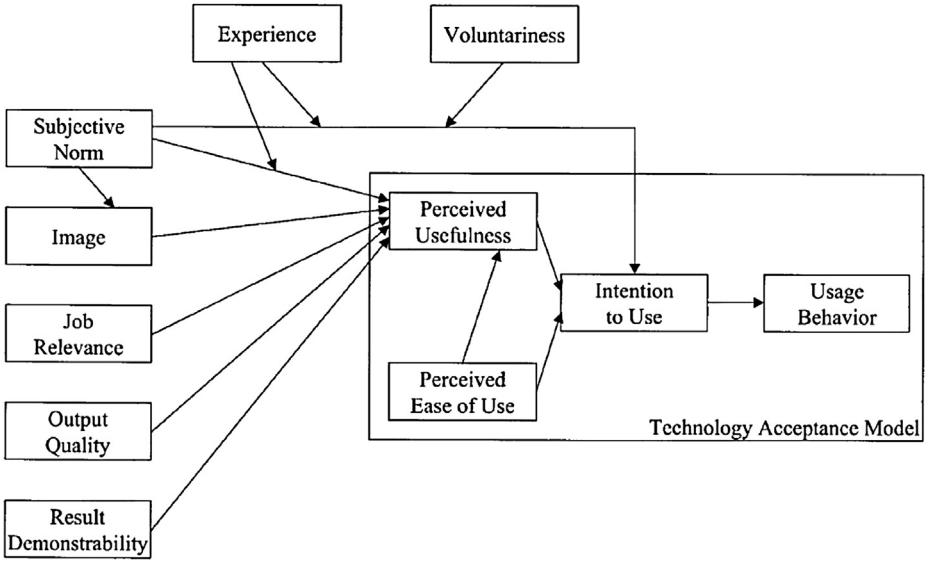

Fig. 1. Proposed TAM2-extension of the technology acceptance model.

process. In the TPS model, a major distinction is made between "technology planning" (a verb) and "technology plan" (a noun). The TPS model thus contains both a product and process perspective.

Vanderlinde, van Braak, and Dexter (2012) argued that a school's ICT policy is as much about developing shared meanings among stakeholders for ICT, and coordinating their relations and interactions with the school's culture, as it is about content related decisions. Flexible and appropriate strategies of technology leadership are able to provide practical coverage of the intelligence necessary to manage technology in schools for current K-12 educational leaders, as well as school administrators.

ICT strategies are not only adopted to make policy decisions, but also benefit all school members with regard to developing innovative pedagogical approaches to enhance students' learning. Administrators thus need to develop their professional skills in this area as much as the actual teaching staff (National School Boards Association, 2009; Stuart, Mills, & Remus, 2009). Furthermore, the regular use of ICT by school leaders will encourage other staff to use it, and can help the school leader be a more effective champion of ICT (Baylor & Ritchie, 2002). Administrators can also provide teaching staff with appropriate visions of technology change, which include empowering teachers and students in new ways, and then learning how to effectively manage them. School leaders need the ability to articulate a captivating vision, to inspire and encourage higher-order efforts on the part of followers, and to instill respect, faith, loyalty, and trust in the leader. Due to a falling birthrate, K-12 schools in Taiwan now have fewer pupils (see Fig. 2), and thus face a more competitive environment. To avoid being merged or closed, thus schools must become more effective, and one way to achieve this is the successful implementation of new technology.

1.5. Effectiveness of school administration

Research indicates that appropriate technology use can be very beneficial in increasing educational productivity (Bingham & Byrom, 2001; Clements & Sarama, 2003 North Central Regional Educational Laboratory, 2009). The seemingly diverse examples of successful implementations of ICT in the educational literature have five key elements in common: (1) student engagement; (2) shared vision; (3) equity of access; (4) professional development; and (5) ubiquitous networks. Crippen (2012) revealed that recent feedback from over 400 Canadian teachers suggests that effective schools establish a balanced leadership–followership dynamic that provides opportunities for all members of the school community, regardless of role, to participate. All school members can be easily connected with each other using technologies such as e-mail and video conferences, and thus collectively participate in school activities as well as policy-making.

Bassett (2007) stated that in the future schools must be more open and flexible, and we also believe that a greater dependence on new forms of communication and computing technologies will be required. ICT thus presents both opportunities and challenges for those involved in its implementation and application in teaching and learning (Tearle, 2003). In more developed countries, such as the United States and United Kingdom, there is an agreement that technologies with readily accessible, flexible and interactive resources can help develop parental engagement and benefit connecting schools, communities, and families (Hohlfeld et al., 2010; Lewin, & Luckin, 2010). Specific web tools, such as blogs, have also added a new dimension to teaching effectiveness by enabling teachers to do things that were not possible before, such as communicating with parents anytime and anywhere, without cost (Churchill, 2009).

The Southwest Educational Development Laboratory (SEDL, 2009) states that most high-performing schools and school districts have good, strong leadership. These leaders are able to inspire a shared vision, motivate others to action, provide encouragement, and serve as role models. There should be less time spent in piecemeal routines, as well as more time invested in educational content and working with students. Furthermore, school members can engage in communicating with one another and maintain tighter feedback relations. For instance, email literacy, which can enable teachers to develop confidence (Toh, 2002), helped Singapore elementary school teachers to communicate more effectively with colleagues, students, and parents (Hu, Wong, Cheah, & Wong, 2009).

1.6. School technology leadership and effective administration

The history of computer technology in educational administration began in the 1950s, when a limited number of large school districts, colleges, and universities invested in data-processing machines to perform such routine tasks as accounting, payroll, and financial reporting (Bozeman & Spuck, 1994). Kose (2009) revealed that a computer-aided educational environment can be more effective than a conventional

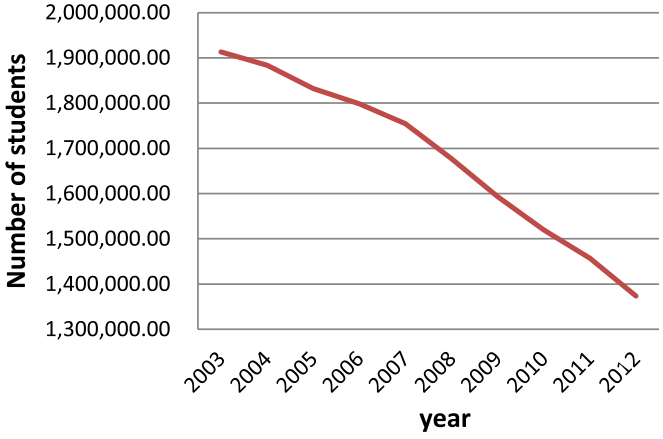

Fig. 2. Number of students in Taiwanese K-12 schools from 2003 to 2012.

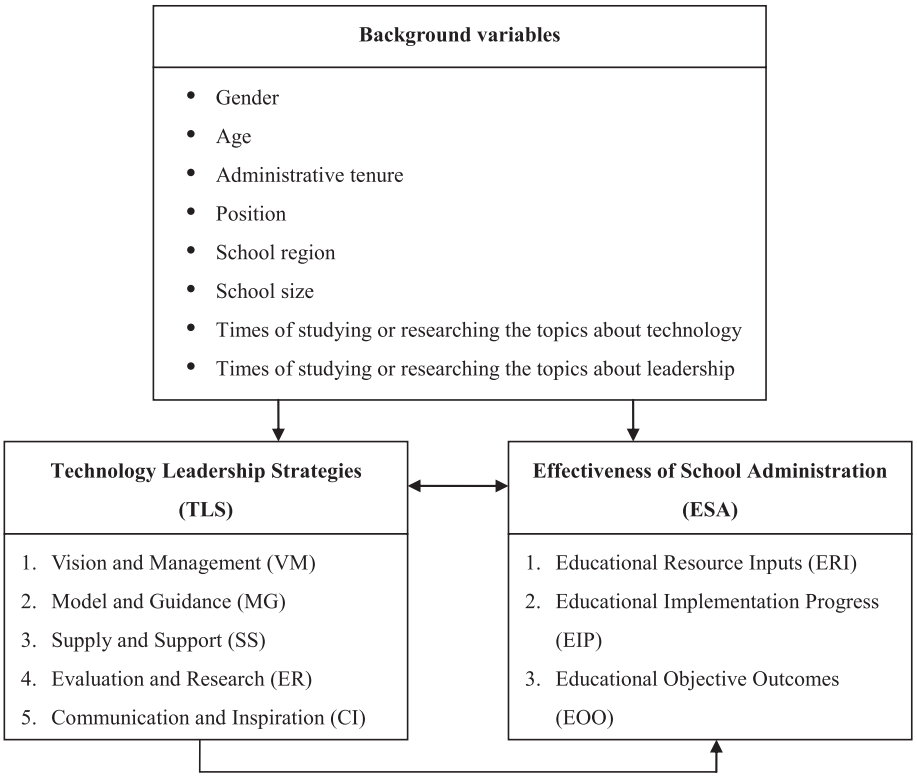

Fig. 3. Research model.

one in terms of learning at the elementary school level. However, school leaders need to find more effective ways to support, motivate, equip, and facilitate teachers with the skills and abilities needed to effectively use technology in education (Keengwe, Kidd, & Blankson, 2009). It is thus essential for school leaders to develop technology competencies that can effectively benefit their leadership, administration, and educational outcomes (Baek, Jung, & Kim, 2008; Flanagan & Jacobsen, 2003; Gosmire & Grady, 2007; Schiller, 2003; Slowinski, 2003; Stuart et al., 2009; Thite, 2000).

However, Sun and Yu (2009) argued that research on educational accountability systems in Taiwan is still at as early phrase, although implementing and promoting such systems are essential in the near future. To evaluate the effectiveness of elementary school administration, we developed the "Effectiveness of School Administration scale" (ESA), based on the CIPP evaluation model proposed by Stufflebeam and Shinkfield (1985). Corresponding to the letters in the acronym CIPP, this earlier model's main concepts are context, input, process, and product evaluation (Stufflebeam, Madam, & Kellaghan, 2000). Therein contrast, there are three dimensions in the ESA scale: Educational Resource Input (comprising indicators for assessing alternative approaches or circumstance to meet school members' needs including positive climate, fair resource distribution, and so on.); Educational Implementation Progress (comprising indicators for assessing the implementation of plans to guide activities and later to help explain outcomes, includes policy making, administrative facilitation, and so on.); and Educational Objective Outcomes (comprising indicators for identifying intended and unintended outcomes both to help keep the process on track and determine effectiveness, includes all members' performance, satisfaction, relation with community, and so on).

In response to the computerization of school-management information systems, school administrators have inevitably evolved into technology leaders who are responsible for seeking potential technology resources that improve the effectiveness of administration (Telem, 2001). There have been many examples of technology companies supporting schools by providing hardware, software, training opportunities, or even substantial funds. For example, Microsoft Corp signed "Partners in Learning", which encompasses three aspects: Innovative Schools, Innovative Teachers, and Innovative Students, with the Taiwanese Ministry of Education in May 2003, and provided software investments, skills training, tailored curriculum development, technical support, and research funds and resources to both students and teachers (Microsoft Corporation, 2009). Today's teachers must be prepared to use technology and must know that it can support student learning (UNESCO, 2008). Simultaneously, a school-technology coordinator not only plays a crucial role in leading teachers and developing more effective K-12 school environments (Frazier & Bailey, 2004), but also serves as an instructional expert by providing advice, methods and strategies for appropriate curriculum-oriented technology use that maximizes students learning (Sugar & Holloman, 2009; Twomey et al., 2006).

Despite the huge investments that schools have made in technology, there is still some doubt at the whether this has actually enhance outcomes. Gulbahar (2007) suggested that technology planning can overcome the problems that arise with implementing ICT, and thus administrators should develop their competence with regard to this. They should better know their own behaviors, traits, and skills, cognitively balancing these according to the situations that they face (Strang, 2007). In sum, an effective technology leader should be able to assess their circumstances, consciously select skills to apply in the related educational situation, and act out beneficial project leadership behaviors such as directing, monitoring, facilitating, mentoring, communicating, and encouraging others.

Although technology infrastructure is important, technology leadership is even more important for effective utilization of technology in schools (Anderson & Dexter, 2005). However, few districts in the United States sufficiently train practicing administrators to facilitate the effective use of technology in schools or to use technology meaningfully to improve the efficiency and effectiveness of their own administrative work (Hughes, 2005). The School Technology Leadership Initiative (STLI) is an innovative academic program that includes a graduate certificate for school technology leaders. The administrators of schools now can anchor technology leadership learning and practice in the National Educational Technology Standards for Administrators (NETS-A), which involve leadership and vision; learning and teaching; productivity and professional practice; support, management, and operations; assessment and evaluation; and social, legal, and ethical issues.

After giving consideration to the theoretical foundations and specific educational context of Taiwan, we constructed the five main categories of technology-leadership strategies pertaining to school leaders, such as principals, deputy principals, and assistant/associate principals, as follows: (1) vision and management, (2) model and guidance, (3) supply and support, (4) evaluation and research, and (5) communication and inspiration. The study will examine how schools reached the position of championing innovations, as well as the technology leadership strategies they have adopted, identifying features that may have been influential in achieving more effective school administration. Based on the TPS model, which contains a product and process perspective, we propose that effective administration has the following three dimensions: (1) educational resource inputs, (2) educational implementation progress, and (3) educational objective outcomes. Additionally, this study aimed to uncover any particular school characteristics that may have been supportive in the process of achieving technology leadership. More specifically, this study empirically investigates the following research questions:

RQ1: How do administrators implement technology leadership strategies in Taiwan?
RQ2: How do administrators become aware of the effectiveness of their school administration?
RQ3: What kind of relationship is there between the technology leadership strategies of administrators and the effectiveness of elementary school administration?
RQ4: Can the technology leadership strategies of administrators predict the effectiveness of elementary school administration?

Drawing on the previous discussion of diffusion of innovation, technology acceptance model, transformational leadership, technology planning in school, and the effectiveness of school administration, a research model and hypotheses are developed to help investigate the research questions that underpin this study (see Fig. 3). Hence, this study suggests that the effective school administration is positively related to the school administrators' perceived usefulness of using technology leadership strategies, and vice versa. This study also suggests that using technology leadership strategies is linked to achieve effective school administration.

Hypothesis 1. The technology leadership strategies of administrators are related to the effectiveness of elementary school administration.

Hypothesis 2. The technology leadership strategies of administrators can significantly predict the effectiveness of elementary school administration.

2. Method

2.1. Development of instrument

The "Technology Leadership Strategies and School Administrative Effectiveness Scale" (see Table 1) was developed to investigate our research questions. To ensure the instrument's effectiveness, a four-phase research procedure was implemented, as follows. **Phase I**: Synthesizing and establishing a preliminary framework of the scale and outlines for the interviews from a thorough review of the literature. **Phase II**: Conducting interviews with the school administrators and then analyzing the key items in the conversations to evaluate and refine the preliminary scale. **Phase III**: Validating and finalizing the refined scale according to expert validity surveys and the pilot test. **Phase IV**: Implementing the final (or formal) test using our revised scale to gather raw data, and then analyzing this using various statistical instruments.

In Phase I, we reviewed the literature that discusses the relevant theories and research on the school administrative technology leadership. To increase our understanding of technology leadership strategies, 15 school administrators and ICT specific-field teachers/staff were invited to take part in semi-structured interviews by purposive sampling. Questions were asked based on the following five domains: (1) vision and management, (2) model and guidance, (3) supply and support, (4) evaluation and research, and (5) communication and inspiration. The interviews were recorded, and transcripts of these then underwent qualitative data analysis. A number of keywords were obtained after a close reading of the text and overlapping coding. We then established a preliminary scale and an outline by synthesizing the important themes collected from the literature review, as well as the concepts that were obtained from the semi-structured interviews. The major references used in this process were as follows: (1) Essential conditions: Necessary conditions to effectively leverage technology for learning (ISTE, 2009a); (2) National Educational Technology Standards for Administrators (NETS-A) (ISTE, 2009b); (3) Assessing the Dimensions of Principals' Effective Technology Leadership: An Application of Structural Equation Modeling (Chang, 2003); and (4) The Construction of Performance Criteria for Technology Leadership of Elementary and Secondary School Principals (Chang & Hsu, 2009).

Next, in Phase II, we validated and refined the scale through expert validity surveys, and finalized our evaluation criteria based on the views of a panel of scholars in the fields of school technology leadership and administrative effectiveness. As a result, 73 items relevant to the five constructs of the proposed research model were adopted from the existing literature, and refined based on the specific focus of this study.

Finally, in Phases III and IV, we adjusted the scale according to both the experts' suggestions and the results of the pilot test. These items were pilot-tested with 211 administrators, comprising principals and directors of academic-affairs divisions, student-affairs divisions,

Table 1
List of "Technology Leadership Strategies and School Administrative Effectiveness Scale" items by construct.

Item	Question
Part I: Technology Leadership Strategies (TLS)	
Vision and Management (VM)	
VM1	I always communicate with my colleagues about how to better apply technology.
VM2	I endeavor to share my vision of applying technology in the school environment.
VM3	I always consider the ability of all team members before making any technological strategic decisions.
VM4	I always consider the specific position of the school before making technological strategic decisions.
VM5	I can establish specific norms to prevent the misuse of technological resources.
VM6	I can sensibly allocate technological resources to promote effectiveness of school administration.
Model and Guidance (MG)	
MG1	I realize that faculties with better technology can communicate more effectively.
MG2	I always encourage my colleagues to actively research new developments of technology.
MG3	I know that it is essential to build a friendly interface for the administrative management system.
MG4	I can use digital technology personally to facilitate teachers enriching their pedagogies.
MG5	I always lead by example through being enthusiastic about the application and understanding of new technology.
MG6	I always allot reasonable time and resources for faculties to receive training and development in regards to technology usage.
Supply and Support (SS)	
SS1	I always use legal software to demonstrate the value of intellectual property.
SS2	I advocate establishing a campus with wireless or optical fiber internet.
SS3	I endeavor to seek subvention or financing for new technology/project that would benefit the school.
SS4	I always offer my colleagues the chance to integrate technology with their professional work.
SS5	I always provide opportunities for my colleagues to receive training or acquire new technological resources as equally as possible.
SS6	For faculties who infrequently use technology in the workplace, I provide peer-support and motivation for them to integrate technology into their work.
Evaluation and Research (ER)	
ER1	The effectiveness of integrating technology in work is part of my criteria when judging the quality of colleagues' work.
ER2	I have introduced evaluation programs to monitor and observe the effect of technology resources on the school.
ER3	I have cited the research from other schools in order to improve the capability of teachers within my school.
ER4	I encourage my colleagues to publish the results of their applications of technology.
ER5	I can evaluate the effectiveness of integrating technology in terms of cost benefit analysis.
ER6	I can share and popularize the results of integrating technology in our school.
Communication and Inspiration (CI)	
CI1	I always actively observe and understand the technology needs of my colleagues.
CI2	I have created forums with school members to discuss technology issues.
CI3	I can make positive contacts with people of organizations outside school and get an effective cooperation on technology issues.
CI4	I actively seek opportunities through government or non-government means for funds or manpower to implement innovative technological resources.
CI5	I encourage students and faculties to join the technology community or the ICT Contest.
CI6	I endeavor to create a strategic alliance with other schools, public and private organizations that have embraced the integration of technology into my school.
Part II: Effectiveness of School Administration (ESA)	
Educational Resource Input (ERI)	
ERI1	Members of my school can enjoy the use of facilities in a welcoming environment.
ERI2	The condition of the school has been well maintained due to good management.
ERI3	The distribution and application of resources in my school have been fair and effective.
ERI4	The faculty and staff of my school have demonstrated a stronger competency in the use and application of technology than before.
ERI5	I believe that the buildings/constructions within my school can unobtrusively influence people.
ERI6	I believe that the atmosphere in my school is open and creative.
Educational Implement Progress (EIP)	
EIP1	In my school, the administrator' s deeds are supported by all colleagues.
EIP2	The administrators embrace stronger interactions between colleagues to create a more intimate workplace.
EIP3	The teachers are encouraged to contribute in the creation and amendment of school policy.
EIP4	The administrators always encourage teachers to innovate teaching.
EIP5	In my school, members of different departments support one another to achieve personal and professional outcomes.
EIP6	The faculties have consensus to cooperate and help one another.
EIP7	I believe that the overall planning of campus and facilities can meet teachers' needs of teaching.
EIP8	Faculties usually approach and overcome team challenges in a joyful atmosphere.
EIP9	Over time,the administrative effectiveness has gradually improved within the school.
EIP10	The administration is well structured and procedures are clear and defined.
Educational objective outcome (EOO)	
EOO1	The results show that students have progressed in their studies.
EOO2	The students have showed improvements in their behavior.
EOO3	The teachers have devoted themselves to professional development and have better performance.
EOO4	The learning environment of the school is quite good.
EOO5	The faculties and students are able to enjoy themselves in a safe and free campus.
EOO6	The equipment of the school has been well maintained due to good management.
EOO7	The relationship between the student and teachers is harmonious.
EOO8	Parents and teachers experience positive interactions and better communication.
EOO9	I believe that the entire pedagogic effectiveness of teachers is quite good.
EOO10	At school, teachers adopt various resources and media to improve their teaching.
EOO11	Members of the local community appreciate and support our teaching habits and administration.
EOO12	I believe that faculties are able to use resources within the community efficiently and effectively.
EOO13	I believe that parents are satisfied with the overall performance of the school.

Table 2
Cronbach's alpha coefficient of the constructs investigated.

Construct	Cronbach's alpha	Number of item[a]	Connection with theoretical frameworks and related references
Vision and Management	0.89	6	•Transformational leadership
Model and Guidance	0.88	6	•Diffusion of innovation
Supply and Support	0.89	6	•Technology acceptance model (TAM)
Evaluation and Research	0.90	6	•National Educational Technology Standards for
Communication and Inspiration	0.92	6	Administrators (NETS-A)
TLS total	0.97		•Technology planning in schools (TPS)
Educational resources input	0.88	6	•Assessing the Dimensions of Principals' Effective Technology
Educational implement progress	0.96	10	Leadership: An Application of Structural Equation Modeling (Chang, 2003)
Educational objective outcome	0.95	13	•The Construction of Performance Criteria for Technology Leadership
ESA Total	0.96		of Elementary and Secondary School Principals (Chang & Hsu, 2009)

[a] Totally 59 items.

general-affairs divisions, and counseling divisions, that were sampled from 52 public elementary schools all over Taiwan and its three offshore islands. The goal was to examine internal consistency and reliability of these items using Cronbach's alpha coefficient analysis.

Drawing on the results and feedback from the pilot test, we further refined the instrument. The final survey included demographic information and a six-point Likert-type scale (59 items) with eight constructs. The former five constructs are part of the Technology Leadership Strategies (TLS) for investigating the first research variable: Vision and Management (VM, six formative items), Model and Guidance (MG, six formative items), Supply and Support (SS, six formative items), Evaluation and Research (ER, 6 formative items), and Communication and Inspiration (CI, 6 formative items). Moreover, the latter three constructs are from the Effectiveness of School Administration (ESA) for investigating the second research variable: Educational Resource Input (ERI, six formative items), Educational Implementation Progress (EIP, 10 formative items), and Educational Objective Outcome (EOO, 13 formative items). The Likert scald ranged from 6 to 1, as follows: "strongly agree", "mostly agree", "slightly agree", "slightly disagree", "mostly disagree", and "strongly disagree". Accordingly, a higher score on the scale indicates a greater awareness of how to use the technology leadership strategy well and how to strengthen the effectiveness of school administration. The total number of items included in the final revised survey was considered highly reliable, because the individual Cronbach's alpha coefficients of the eight constructs were all greater than 0.80 (see Table 2).

2.2. Participants

Participating in the pilot test (Phase III) were 211 administrators (including principals and directors of academic-affairs divisions, student-affairs divisions, general-affairs divisions, counseling divisions, and academic/student affairs divisions particularly in small schools) sampled from 52 elementary schools all over Taiwan. The subjects were selected from public elementary schools in Taiwan, and thus came from the north (17 schools, 31% of all), middle region (13 schools, 27% of all), south (13 schools, 29% of all), and east (9 schools, 13% of all). There were around three to five administrators per school, depending on its size.

Table 3
Demographic information of the survey respondents and their schools.

		Frequency	Percentage (%)
Gender	(1) Male	210	65
	(2) Female	113	35
Age	(1) 30–39 years	61	19
	(2) 40–49 years	183	57
	(3) 50 or more years	79	24
Administrative tenure	(1) Less than 3 years	70	22
	(2) 3–6 years	84	26
	(3) 7–10 years	67	21
	(4) More than 10 years	102	31
Position	(1) Principal	76	23
	(2) The director of academic-affairs division	63	20
	(3) The director of students-affairs division	60	19
	(4) The director of general-affairs division	68	21
	(5) The director of counseling division	50	15
	(6) Directors of academic & student affairs division (in small schools)	6	2
School region	(1) North	102	32
	(2) Middle	74	23
	(3) South	104	32
	(4) East and off-shore island	43	13
School size	(1) Less than 12 classes	33	10
	(2) 13–24 classes	72	22
	(3) 25–36 classes	73	23
	(4) More than 37 classes	145	45
Times of studying or researching the topics about technology	(1) More than once	258	80
	(2) Never	65	20
Times of studying or researching the topics about leadership	(1) More than once	189	59
	(2) Never	133	41

Table 4
Research questions and responding data analysis ways.

Research questions	Dependent variables	Independent variables	Statistical methods/selecting reason
RQ1: How do administrators implement technology leadership strategies in Taiwan?	Technology Leadership Strategies (TLS)	background variables: gender, age, administrative tenure, position, region, school size, times of studying or researching the topics about technology,	*t*-test, one-way ANOVA/descriptive statistics
RQ2: How do administrators become aware of the effectiveness of their school administration?	Effectiveness of School Administration (ESA)	times of studying or researching the topics about leadership	
RQ3: What kind of relationship is there between the technology-leadership strategies of administrators and the effectiveness of elementary school administration?	Technology Leadership Strategies (TLS), Effectiveness of School Administration (ESA)	NA	Pearson's product–moment correlation coefficient
RQ4: Can the technology leadership strategies of administrators predict the effectiveness of elementary school administration?	Effectiveness of School Administration (ESA)	Technology Leadership Strategies (TLS)	simple linear regression

In the final, formal test, 382 surveys were distributed to administrators from 82 elementary schools all over Taiwan (26 schools in the north, 20 schools in the middle region, 26 schools in the south), and 334 were mailed back, thus achieving an overall response rate of 87%. Of the 334 surveys returned, 323 were completed and thus used in our analysis. In terms of educational attainment, 66% of the respondents had a postgraduate diploma or Masters' Degree ($n = 212$), while 33% of respondents had a Bachelors' Degree ($n = 108$). Demographic information of the final survey respondents and their schools are shown in Table 3.

2.3. Data analysis

We examined the survey data using SPSS 16.0. RQ1 and RQ2 were analyzed by using descriptive statistics, namely a *t*-test and one-way ANOVA, while RQ3 were analyzed by using Pearson's product–moment correlation coefficient. Finally, we used simple linear regression to examine RQ4. All research questions, variables and corresponding methods of data analysis are shown in Table 4. LISREL 8.5 was also used to carry out confirmatory factor analysis (CFA) and test whether the measures of the Technology Leadership Strategies and School Administrative Effectiveness Scale were consistent with our understanding of the nature of the individual constructs.

3. Analysis, results, and discussion

3.1. Confirmatory factor analysis

The results and model fit statistics of confirmatory factor analysis of the scale are presented in Tables 5and 6. In addition, a diagram of this model is shown as Fig. 4.

The CFA results revealed several findings. First, all the unstandardized estimates reached the.05 level of statistical significance, without negative error variance. Secondly, the factor loadings ranged from 0.85 to 0.94 ideally, and none were below 0.50 or above 0.95. Thirdly, all the standard errors of the unstandardized estimates ranged from.03 to 0.04 without any large values being found. Besides, considering chi-square is severely influenced by sample size, this model was evaluated and specified by examining the measure of fit – Root Mean Square Error of Approximation (RMSEA). RMSEA takes into account the error of approximation. A value of less than 0.06 indicates a good fit (Hu & Bentler, 1999). A value that ranges from 0.06 to 0.08 indicates an acceptable fit (MacCallum, Browne, & Sugawara, 1996). Other goodness-of-fit statistics of relative fit index (RFI), and comparative fit index (CFI) were also examined. RFI provides a measure of model fit versus the degrees of freedom needed to achieve that fit. CFI compares the existing model fit with a null model, which assumes that the latent variables in the model are uncorrelated. Values RFI and CFI close to 0.9 or above for these indexes suggest acceptable fit (Bentler, 1992). Above all, our observational data fitted the CFA model of our scale quite well.

Table 5
Abstract of the result of Confirmatory factor analysis of TLS and ESA ($N = 323$).

Variables	Unstandardized			Standardized
	Estimate	S.E.	C.R.	Regression weights
TLS				
At01 VM	0.82	0.03	23.88***	0.86
At02 MG	0.88	0.03	26.17***	0.89
At03 SS	0.83	0.03	26.41***	0.89
At04 ER	1.04	0.04	28.04***	0.91
At05 CI	1.00	–	–	0.93
ESA				
Bt01ERI	1.01	0.04	22.97***	0.85
Bt02 EIP	0.99	0.04	24.55***	0.88
Bt03 EOO	1.00	–	–	0.94

***$p < .001$.

Table 6
Abstract of the model fit statistics in CFA.

Degrees of Freedom = 19
Minimum Fit Function Chi-Square = 148.02 (p = .0)
Comparative Fit Index (CFI) = 0.97
Relative Fit Index (RFI) = 0.95
Root Mean Square Error of Approximation (RMSEA) = 0.15

3.2. Technology leadership strategies

To answer RQ1, the descriptive statistics include a t-test or a one-way ANOVA, depending on the type of variable examined. Table 7 reports the means and standard deviations of the five dimensions for technology leadership strategy. These show that the elementary school administrators were highly conscious of the Technology Leadership Strategies (TLS) (M = 4.56, while the full score is 6.00), and that they generally possessed a high level of strategy-related self-efficacy when using Supply and Support (SS) (M = 4.78), Model and Guidance (MG) (M = 4.70), Vision and Management (VM) (M = 4.52), Communication and Inspiration (CI) (M = 4.50), and Evaluation and Research (ER) (M = 4.30) in sequence. Worth noting is that within the entire set of technology leadership strategies, Evaluation and Research (ER) was the one with the lowest score. Elementary school administrators thus need to pay more attention to how to effectively improve their competencies in this area.

After performing the t-test and the one-way ANOVA, we found significant differences between different ages (F = 4.72, p = .00) and different positions (F = 7.85, p = .00, η^2 = .101). The results of the Scheffé post hoc multiple-comparison test indicated the following: (1) As Tables 8and 9 show, elementary school administrators who were at least 50 years old performed better than those aged 30–39 years old in all items related to the technology leadership strategy. Concurrently, there was no apparent difference found among administrative tenures in this study. This pattern perhaps reflects the elder administrators' gradual accumulation of comprehensive experience and wisdom in integrating applicable technology into administration. The young administrators were probably too mentally inexperienced to develop interpersonal skills and well-rounded leadership strategies, even they were likely to be more familiar with new technology than the elder ones. (2) As Tables 10 and 11 show, significant differences in use of the technology leadership strategy were found in different administrative positions. Regarding different administrative positions, principals performed significantly better in Technology Leadership Strategies (TLS) than those in other positions for all constructs. Additionally, the directors of the academic-affairs divisions performed better than the directors of the counseling divisions in the constructs of Vision and Management (VM), Evaluation and Research (ER), and Communication and Inspiration (CI). (3) As Table 12 shows, elementary school administrators who had studied or researched technology-related topics, or who had attended any technology-related conferences, obtained significantly higher scores in the constructs of Vision and Management (VM) and Model and Guidance (MG) than those who had never done so. However, there was no significant difference found between the genders, or among school regions, and school sizes. Furthermore, whether the survey responders had studied leadership topics or not did not affect their performance of the technology leadership strategies.

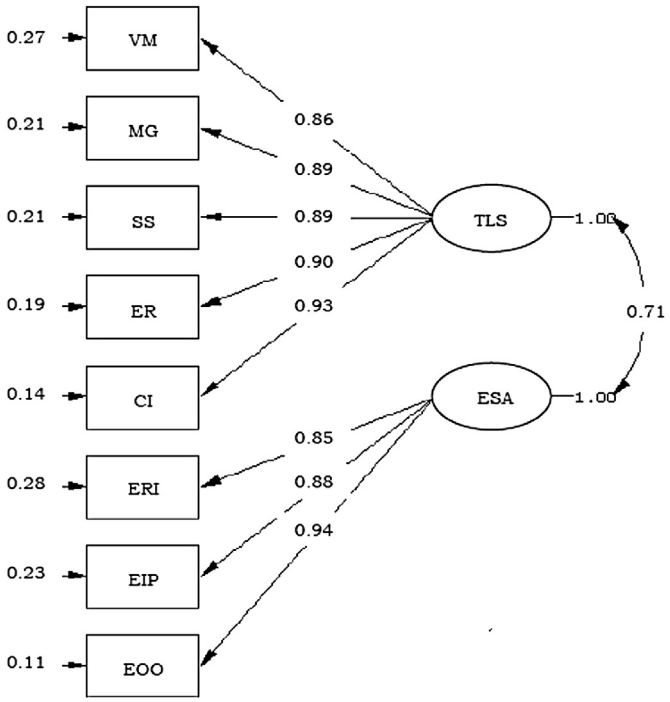

Fig. 4. Confirmatory factor analysis model.

Table 7
Descriptive statistics – technology leadership strategies.

Factors	*M*	*SD*	1.	2.	3.	4.	5.	6.
1. Vision and management	4.52	0.78	1					
2. Model and guidance	4.70	0.79	0.82**	1				
3. Supply and support	4.78	0.73	0.75**	0.79**	1			
4. Evaluation and research	4.30	0.92	0.71**	0.76**	0.74**	1		
5. Communication and inspiration	4.50	0.83	0.73**	0.78**	0.79**	0.88**	1	
6.Total	4.56	0.73	0.88**	0.91**	0.89**	0.91**	0.93**	1

**$p = .00$.

3.3. Effectiveness of school administration

To answer RQ2, we used descriptive statistics, including a *t*-test or a one-way ANOVA, depending on the type of each variable. Table 13 reports the means and standard deviations of the three dimensions for the effectiveness of school administration, and the correlations within each these. These results show that elementary school administrators generally perceived that their school administrations had acceptable effectiveness (mean = 4.95, while the full score is 6.00). However, the performance of Educational Resource Input (ERI) was worse than that of the other two constructs, Educational Implement Progress (EIP) and Educational objective outcome (EOO). That is, although technological leadership and ICT-integration pedagogy have gradually gained traction in Taiwan, educational resources and investments in the public elementary school system perhaps remain insufficient.

3.4. Correlation

To answer RQ3, we used Pearson's product–moment correlation coefficient to identify the correlation between the administrators' technology leadership strategy and the effectiveness of elementary school administration. The correlation coefficient between the two variables was significantly positive ($r = 0.71$, $r^2 = 0.51$, $p = .00$) (see Table 14). That is, the r^2 value (0.51) shows the amount of variance in Effectiveness of School Administration explained by Technology Leadership Strategies, and vice versa. A value of 0.51 indicates that the model explains an acceptable amount of variance, namely 51% variance in the data is explained by the model without qualification. As expected, the results empirically supported the hypothesis 1.

3.5. Regression

To answer RQ4, we used the linear regression method to check whether TLS could predict ESA or not. Table 15 and Fig. 5 show that the TLS scores could significantly predict the ESA ones. Statistically, the regression of ESA on TLS could be demonstrated as the original fitted equation (ESA = 0.57*TLS + 2.33), or the standardized regression equation ($\widehat{z}_{\mathrm{ESA}} = .71 z_{\mathrm{TLS}}, R^2 = .51$). This means that an individual's ESA is predicted by multiplying TLS by 0.57 and subtracting 2.33. In general, the proportional reduction in error (PRE) is used to calculate the effect size of regression analysis, and the PRE value in this work is the same as the coefficient of determination $r^2 = 0.51$ ($PRE = SS_{\mathrm{total}} - SS_{\mathrm{res}}/SS_{\mathrm{total}} = SS_{\mathrm{reg}}/SS_{\mathrm{total}} = r^2 = .51$). This also means that the total score of TLS could explain 51% variation of the total score of the ESA.

Results revealed that TLS can significantly predict ESA and thus empirically supported the hypothesis 2. We can speculate that when elementary school administrators do a better job with regard to their technology leadership strategies, they can also be more effective with regard to school administration. This partly extends the finding of Stuart et al. (2009) that the ICT knowledge of school leaders would positively influence their intention to champion school innovation. We believe that ICT and technology use experience benefit both technology leadership and the effectiveness of administration.

Table 8
Descriptive statistics – technology leadership strategies in different ages.

	Age	*N*	*M*	SD
1. Vision and management	(1) 30–39 years	61	4.26	0.92
	(2) 40–49 years	183	4.47	0.77
	(3) 50 or more years	79	4.66	0.83
2. Model and guidance	(1) 30–39 years	61	4.46	0.98
	(2) 40–49 years	183	4.65	0.80
	(3) 50 or more years	79	4.82	0.85
3. Supply and support	(1) 30–39 years	61	4.48	0.81
	(2) 40–49 years	183	4.71	0.80
	(3) 50 or more years	79	4.95	0.77
4. Evaluation and research	(1) 30–39 years	61	4.00	1.02
	(2) 40–49 years	183	4.21	1.00
	(3) 50 or more years	79	4.43	0.90
5. Communication and inspiration	(1) 30–39 years	61	4.20	0.97
	(2) 40–49 years	183	4.42	0.94
	(3) 50 or more years	79	4.61	0.85
6.Total	(1) 30–39 years	61	4.28	0.87
	(2) 40–49 years	183	4.49	0.79
	(3) 50 or more years	79	4.70	0.76

Table 9
One-way ANOVA – technology leadership strategies in different ages.

	Source	SS	df	MS	*F*	Scheffé
1. Vision and management	Between	5.67	2	2.84	4.26*	(3) > (1)
	Within	213.25	320	0.67		
	Total	218.92	322			
2. Model and guidance	Between	4.63	2	2.31	3.20*	(3) > (1)
	Within	231.37	320	0.72		
	Total	236.00	322			
3. Supply and support	Between	7.81	2	3.91	6.17**	(3) > (1)
	Within	202.56	320	0.63		
	Total	210.37	322			
4. Evaluation and research	Between	6.31	2	3.16	3.27*	(3) > (1)
	Within	308.56	320	0.96		
	Total	314.87	322			
5. Communication and inspiration	Between	5.85	2	2.92	3.45*	(3) > (1)
	Within	271.41	320	0.85		
	Total	277.26	322			
6.Total	Between	6.01	2	3.00	4.72**	(3) > (1)
	Within	203.82	320	0.64		
	Total	209.83	322			

*$p < .05$ **$p < .01$.
In 7th column: (3) means age of participant is 50 or more years old; (1) means age of participant 30–39 years old.

4. Conclusions and implications

This study had addressed a number of issues. First, we have developed and validated an instrument based on relative references to assist school administrators to measure their performance in adopting technology leadership strategies, as well as the effectiveness of their administration. Admittedly, there are numerous alternatives for school principals as well as other divisions directors to administer the instrument in appropriate occasions, such as individual assessment, regular/annual performance evaluation, and formal school evaluation. One positive facet to surveying themselves by the instrument is that administrators can attempt to find out both of their strength and

Table 10
Descriptive statistics – Technology leadership strategies in different positions.

	Positions	*N*	*M*	SD
1. Vision and management	(1) Principals	76	4.82	0.64
	(2) Directors of academic-affairs division	63	4.67	0.71
	(3) Directors of student-affairs division	60	4.35	0.926
	(4) Directors of general-affairs division	68	4.36	0.81
	(5) Directors of counseling division	50	4.14	0.85
	(6) Directors of academic & student affairs division (in small schools)	6	3.61	0.81
2. Model and guidance	(1) Principals	76	4.99	0.67
	(2) Directors of academic-affairs division	63	4.78	0.76
	(3) Directors of student-affairs division	60	4.54	0.86
	(4) Directors of general-affairs division	68	4.49	1.01
	(5) Directors of counseling division	50	4.38	0.87
	(6) Directors of academic & student affairs division (in small schools)	6	4.47	0.46
3. Supply and support	(1) Principals	76	5.18	0.53
	(2) Directors of academic-affairs division	63	4.89	0.66
	(3) Directors of student-affairs division	60	4.46	0.81
	(4) Directors of general-affairs division	68	4.63	0.84
	(5) Directors of counseling division	50	4.32	0.93
	(6) Directors of academic & student affairs division (in small schools)	6	4.31	0.83
4. Evaluation and research	(1) Principals	76	4.61	0.79
	(2) Directors of academic-affairs division	63	4.31	0.95
	(3) Directors of student-affairs division	60	4.11	1.05
	(4) Directors of general-affairs division	68	4.14	0.96
	(5) Directors of counseling division	50	3.86	1.09
	(6) Directors of academic & student affairs division (in small schools)	6	3.64	1.00
5. Communication and inspiration	(1) Principals	76	4.85	0.70
	(2) Directors of academic-affairs division	63	4.59	0.78
	(3) Directors of student-affairs division	60	4.28	0.96
	(4) Directors of general-affairs division	68	4.28	0.98
	(5) Directors of counseling division	50	3.99	1.05
	(6) Directors of academic & student affairs division (in small schools)	6	4.19	0.78
6.Total	(1) Principals	76	4.89	0.59
	(2) Directors of academic-affairs division	63	4.65	0.68
	(3) Directors of student-affairs division	60	4.35	0.86
	(4) Directors of general-affairs division	68	4.38	0.85
	(5) Directors of counseling division	50	4.14	0.88
	(6) Directors of academic & student affairs division (in small schools)	6	4.04	0.68

Table 11
One-way ANOVA – Technology leadership strategies in different positions.

	Source	SS	df	MS	*F*	Scheffé
1. Vision and Management	Between	23.40	5	4.68	7.59***	(1) > (3)
	Within	195.52	317	0.62		(1) > (4)
	Total	218.92	322			(1) > (5)
						(1) > (6)
						(2) > (5)
2. Model and Guidance	Between	16.24	5	3.25	4.69***	(1) > (4)
	Within	219.75	317	0.69		(1) > (5)
	Total	236.00	322			
3. Supply and Support	Between	31.18	5	6.24	11.03***	(1) > (3)
	Within	179.20	317	0.57		(1) > (4)
	Total	210.37	322			(1) > (5)
						(2) > (5)
4. Evaluation and Research	Between	21.89	5	4.38	4.74***	(1) > (5)
	Within	292.98	317	0.92		
	Total	314.87	322			
5. Communication and Inspiration	Between	27.87	5	5.57	7.09***	(1) > (3)
	Within	249.39	317	0.79		(1) > (4)
	Total	277.26	322			(1) > (5)
						(2) > (5)
6.Total	Between	23.10	5	4.62	7.85***	(1) > (3)
	Within	186.72	317	0.59		(1) > (4)
	Total	209.83	322			(1) > (5)
						(2) > (5)

*$p < .05$ **$p < .01$ ***$p < .001$.
In 7th column: (1) principals; (2) directors of academic-affairs division; (3) directors of student-affairs division; (4) directors of general-affairs division; (5) directors of counseling division; (6) directors of academic & student affairs division (in small schools).

weakness of applying TLS to improve performance. Second, we found that the elementary school administrators' technology leadership strategies were significantly related to the effectiveness of school administration. Third, and the most important, the key finding of the study was that the overall performance of technology leadership strategies could significantly predict the effectiveness of school administration. Our findings are consistent with the claim of North Central Regional Educational Laboratory (2009) that appropriate technology use can not only be very beneficial in increasing educational productivity, but can also improve the effectiveness of school administration. Nevertheless, this study has several limitations that should be noted. In addition, suggestions for future research are also given, as follows.

4.1. Limitations

First, when we adopted stratified random sampling to select 82 elementary schools, only the administrators, such as the principals and directors of each division, were invited to take part in the survey. The administrators were asked to consider the overall effectiveness of school administration, including: (1) Educational Resource Input (ERI), such as the 6th item: "I believe that the atmosphere in my school is open and creative." (2) Educational Implement Progress (EIP), such as the 4th item: "The administrators always encourage teachers to innovate teaching." (3) Educational Objective Outcome (EOO), such as the 11th item: "Members of the local community appreciate and support our teaching habits and administration." Although our approach reduced the complexity and expense of this work, the subjective measures of TLS and ESA in this study may have weakened the accurate results of investigating. When these respondents rate their performance both of the TLS and ESA survey, they were probably influenced by social desirability or respond set. However, it is perception of one's ability that is more likely to influence behavior rather than their objective ability in the context of behavioral intention (Bandura, 1977). Our finding that TLS is positively related to ESA is also consistent with the TAM2 theorized that both social influence processes (subjective norm, voluntariness, and image) and cognitive/subjective instrumental processes (job relevance, output quality, result demonstrability, and perceived ease of use) significantly influenced user acceptance. That is, the more effective administration is, the better technology leadership strategies may be rated by themselves. Even so, it is suggested that other members of the elementary school, such as teachers,

Table 12
t-test – Technology leadership strategies in different experience of studying topics of technology.

		N	*M*	SD	*t*	*p*
1. Vision and management	(1) More than once	258	4.53	0.78	2.10*	0.04
	(2) Never	65	4.29	0.95		
2. Model and guidance	(1) More than once	258	4.71	0.83	2.12*	0.03
	(2) Never	65	4.46	0.93		
3. Supply and support	(1) More than once	258	4.76	0.79	1.66	0.10
	(2) Never	65	4.58	0.86		
4. Evaluation and research	(1) More than once	258	4.27	0.96	1.47	0.14
	(2) Never	65	4.06	1.08		
5. Communication and inspiration	(1) More than once	258	4.45	0.92	0.81	0.42
	(2) Never	65	4.34	0.98		
6.Total	(1) More than once	258	4.54	0.78	1.76	0.08
	(2) Never	65	4.35	0.89		

*$p < .05$.

Table 13
Descriptive statistics – effectiveness of school administration.

Constructs	*M*	SD	1.	2.	3.	4.
1. Educational resource input	4.82	0.67	1			
2. Educational implement progress	5.01	0.65	0.71**	1		
3. Educational objective outcome	4.96	0.61	0.77**	0.80**	1	
4.Total	4.95	0.59	0.87**	0.92**	0.95**	1

**$p = .00$.

Table 14
The correlation between TLS and ESA ($N = 323$).

Constructs	VM	MG	SS	ER	CI	Total TLS
ERI	0.62**	0.64**	0.66**	0.61**	0.66**	0.70**
EIP	0.53**	0.51**	0.54**	0.48**	0.52**	0.57**
EOO	0.65**	0.64**	0.68**	0.61**	0.66**	0.71**
Total ESA	0.65**	0.64**	0.68**	0.61**	0.66**	0.71**

**. Correlation is significant at the 0.01 level (2-tailed).

students, parents, and even supervisors, still should be consulted in the future research to give consideration to other views. If possible, some corresponding, objective, equitable, and external criteria, such as those used in authoritative or official evaluations, may be required to improve the validity of this work.

Anderson and Dexter (2005) argued that each of the different actions or decisions identified as characteristic of technology leadership may have a measurable outcome in terms of the degree of technology integration in the school. From this perspective, we could rationally expect that technology leadership strategies would have more considerable effects on the technology-supporting environment, rather than on the comprehensive effectiveness of school administration. However, there must be some overlaps between the effectiveness of a technology-supporting environment and school administration. For example, an administrator is likely to agree that resource distribution and application in the school are fair and effective (ERI3: The distribution and application of resources in my school have been fair and effective.) if he/she, as a school technology leader, is highly confident that he/she did a good job with regard to this (VM6: I can sensibly allocate technological resources to promote effectiveness of school administration.). Given that "what administrators do depends on what they think their overt behaviors are the result of covert thought processes." (Leithwood & Steinbach, 1994, p. 94), researchers define expertise in terms of problem-solving processes, and then use these processes as a lens through which expert administrative practice may be understood (Perez & Uline, 2003). Even though the survey carried out in this work was subjective rather than objective, this study empirically examined the actual behaviors of school leaders based on the suggestions of earlier research (Stuart et al., 2009). We argue that the more technology leadership knowledge and competence such leaders have, the more actively they implement the strategies in practice. This is consistent with earlier findings that weaknesses in ICT implementations, such as a lack of technology integration in schools, are partly attributed to low ICT competence, which in turn, may be due to inadequate professional development (Brockmeier, Sermon, & Hope, 2005). A longitudinal study will be required in the future to investigate how technology leadership strategies are gradually developed and influence the effectiveness of administration or other educational outcomes over time.

In addition, although this study attempted to develop the instruments according to a careful procedure, more qualitative approaches are needed to discover other important factors. Future research can also expand the pool of participants by encompassing secondary schools or universities to investigate technology leadership strategies and the effectiveness of school administration in other parts of education.

Finally, the sample size and method are also limitations of this work. With only 323 respondents from 82 elementary schools, it may not be possible to extend the findings of this work to other schools in Taiwan and beyond. There is thus an opportunity for future research to advance the findings by examining more schools or those in other nations.

4.2. Conclusion and suggestions

The results of the data analysis statistically validated the research hypotheses 1 and 2. That is, the more skillfully elementary school administrators implement technology leadership strategies, the more effective school administration is likely to be. We also found that the school administrators are better at implementing technology leadership strategies as they grow older. These findings base on the theory of the diffusion of innovation, which argues that invention, communication, time and consequences emerge sequentially after an innovation has been initiated by someone inside the organization, have enlightened us on the necessity of providing continued technological training for principals and school administrators. According to the technology acceptance model, principals should endeavor to seek subvention or

Table 15
Coefficients[a] of linear regression between TLS and ESA ($N = 323$).

Model		Un-standardized coefficients			Standardized coefficients	*t*	Sig.
		B	Std. error	Beta			
1	(Constant)	2.33	0.15			15.41	0.00
	TLS	0.57	0.03			17.52	0.00
				0.71			

[a] Predictors: (Constant), TLS.

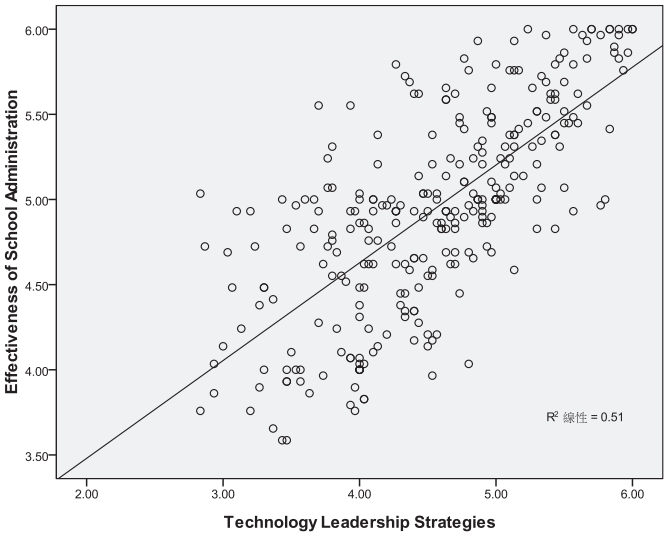

Fig. 5. Simple scatter-plot with regression line between TLS and ESA.

financing for new technology that would benefit the school, as well as advocate establishing a campus with wireless or optical fiber internet to eliminate the obstacle of adopting technology. Insofar as technology integration and school-based leadership are now essential parts of educational innovation, this study has provided empirical evidence that integrating technology into strategic leadership for elementary school administrators could improve the effectiveness of school administration.

On practical suggestion for educational organizations, such as schools, would be that when administrators have strong beliefs in the usefulness of technology innovation, they are more likely to carry out technology leadership actions or strategies, which may then improve the overall effectiveness of administration. We can measure the beliefs about technology usefulness and innovation held by administrators through particular items within our instrument such as VM6, MG1, MG3, MG5, SS6, ER1, and CI1. For instance, the question of MG1 describes as "I realize that faculties with better technology can communicate more effectively." could be a specific indicator for researcher to judge how the respondent evaluates technology usefulness. Of course we can adopt TSL instrument to screen the novices when selecting new administrators for school. For any school technology leadership strategy to succeed, leaders must build and clearly declaim the collective vision and actually demonstrate desirable experience of benefiting from technology application. One victory can trigger off a chain of shifts.

As technology leaders in schools, the principals and directors of various divisions must strive to improve their capability of utilizing TLS, particularly the strategies of evaluating and researching. We recommend that a long-term school-based technology training program or advancing project based on collective visions should be developed to effectively enhance the abilities of all school administrators. We urge young principals and directors of various divisions to experience new technology and then apply it appropriately to improve not only the quality of instruction but also the effectiveness of administration. For elder school leaders, our suggestion would be that they should actively attend all sorts of educational/technological workshop/conference to communicate and share with others. We suppose that one indisputable benefit of experiencing in a learning organization with professional interaction is providing access to the great. Consequently, all school administrators in different positions should consistently be open to all updated knowledge and relevant capabilities to become versatile leaders.

A suggestion for educational departments or authorities is that they should provide more technology leadership training programs, conferences, or meetings for school administrators, both pre-service and in-service, to help them become more competent technology coordinators and leaders. We strongly recommend that the educational authorities should ensure that all school administrators, and especially principals, are able to attend long-term training programs, no matter where they are currently working. Specifically, regarding the pre-service training for aspiring administrators and educational leaders, we propose that the primary theme of training should at least comprise Model and Guidance (MG) as well as Educational Resource Input (ERI). Concerning the training programs for new administrators, we recommend that the essential issues about Vision and Management (VM), Supply and Support (SS), and Educational Implement Progress (EIP) need to be included to aid better performance. Furthermore, in consideration of the conferences for experienced administrators, Evaluation and Research (ER), Communication and Inspiration (CI), and Educational objective outcome (EOO) are strongly suggested to be thoroughly introduced and discussed because they can benefit not only the empowerment of senior leaders but also various educational outcomes of school. In addition, efforts should be made to encourage both enterprises and stakeholders to support educational technology plans on the basis of reciprocal resource exchanges, as such moves would enhance corporate social responsibility.

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