AN ANALYSIS OF THE RELATIONSHIP BETWEEN K-5 ELEMENTARY SCHOOL TEACHERS' PERCEPTIONS OF PRINCIPAL INSTRUCTIONAL LEADERSHIP AND THEIR SCIENCE TEACHING EFFICACY

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Abstract

The purpose of this study is to analyze the relationship between K-5 elementary school teachers' perceptions of principal instructional leadership and their science teaching efficacy. The influence of background variables on both leadership and efficacy is also analyzed.

A sequential mixed methods approach was used in this study. The survey sample was comprised of teachers in the elementary divisions of schools from the nine international school regional associations. Teacher participation was obtained through an email containing an online survey link. Following the analysis of survey responses (N=356), in-depth interviews (N=17) were conducted. Reliability for the instructional leadership scale was found to be .94 (coefficient alpha) and .69 for the personal science teaching efficacy (PSTE) scale.

The results show a significant correlation between elementary school teachers' perceptions of principal instructional leadership and their PSTE levels, with the most significant correlation that between the study of a science-related major or minor at college and higher PSTE scores. Strong correlations were also found between PSTE levels and having principals who discussed goals at faculty meetings, participated in science curricular review, supported recognition of student progress, encouraged new skills and concepts, discussed student progress with faculty, and used assessments to see science progress towards easily understood goals. PSTE levels were also higher in schools where principals had grade or school level science coordinators in place and where they supported the use of science kits.

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Chapter 1: Introduction

Statement of the Problem

As schools begin to implement NCLB science requirements and current data from studies comparing science education standards are reviewed, there is a heightened interest in the factors affecting standards of science teaching. A major influence upon science teaching in elementary schools may lie in elementary school teachers' science self-efficacy, particularly as many graduates are not science specialists due to the nature of elementary education (Akerson & McDuffie, 2002). Central to this study, it is also pertinent that many graduate and experienced teachers in elementary schools raise issues of confidence when teaching science lessons (Ginns and Watters, 1999). There is a need for research into the opinions of elementary school teachers because it is they who must inspire the children they teach and as Alan Leshner, CEO of the American Association for the Advancement of Science states " If you ask successful scientists what brought them into science, every one of them says a teacher" (Perkins-Gough, 2006, p.10).

Principal leadership is seen as central to success by the National Science Foundation (1979, p.180), who state that "The principal serves a unique role of boss, shepherd and manager all rolled into one. He or she is usually the major factor in the school's operation…". In addition, New York Schools Chancellor Joel Klein, when outlining plans to bolster instructional leadership, said "As school leaders, principals are the key to overall school performance and to the kind of fundamental change that many of our schools require" (Gewertz, 2003, p.1). Southworth (2002, p.76) sums up the divergent views on leadership and the need for certain aspects to be a focus, in stating that "In short, despite leadership and management involving a diverse number of activities and processes and although it is differentiated in its character, instructional leadership is central to successful school leadership". The need for instructional leadership is further supported by the National Science Teachers Association (NSTA) who affirm the following in their Official Position Statement on Elementary School Science (NSTA, 2007a). They recommend that school administrators must be advocates for elementary science and that they must provide instructional leadership by building consensus for an elementary science program that reflects state and national standards and implementing and monitoring the progress of the science program. Administrators must also provide support systems by supplying appropriate materials, equipment, and space, recognizing exemplary elementary science teaching and encouraging special science events.

This suggests that the NSTA, as a central body for science teaching, recognizes instructional leadership as an important factor in successful science teaching. It is therefore necessary, when analyzing teacher self-efficacy, to factor in the influence of the school principal. Hallinger and Murphy (1985), state that future research into "the relationship between instructional management behavior and the following variables are needed most: student achievement, teacher behavior and school climate" (1985, p.238). Thus teacher behavior, in the form of self-efficacy, is a central component of the thesis.

Statement of Study Purpose and Research Questions

The purpose of this study is to analyze the relationship between K-5 elementary school teachers' perceptions of principal instructional leadership and their science teaching efficacy. The following questions were addressed and remained at the core of this research:

1. What is the relationship between K-5 elementary school teachers' perceptions of principal instructional leadership and their science teaching efficacy?
2. What other variables affect elementary school K-5 teachers' perceptions of their science teaching efficacy?

Rationale

Research suggests that positive changes in teacher behavior in science lessons with regard to instruction, can have a positive impact on student learning (Arambula-Greenfield, 1997) and basing the research for this study within U.S. international schools, would add a unique dimension. A study into the science self-efficacy of elementary school teachers allows analysis into the different areas that are affecting the confidence of teachers when they have to teach what is often an unfamiliar and uncomfortable subject. De Laat and Watters (1995) examined previous research into science teaching which suggests that a lack of strong background (Franz & Enochs, 1982), poor preparation in science content, (Anderson & Mitchener, 1993), inadequate facilities and equipment (Helgeson et. al, 1977), poor instructional leadership (Edmonds 1979) and teacher attitude (Koballa & Crawley, 1985) all contributed to ineffective science teaching. In recent years pressure on teachers has also been increased by high-stakes accountability systems focusing on language arts and mathematics, lowering the profile of science

(Spillane et. al., 2001), although, this changed from 2007, when states were required to measure students' progress in science. The U.S. Department of Education (2007, ¶5) states that "The new law also requires that beginning in 2007 states measure students' progress in science at least once in each of three grade spans (3-5, 6-9, 10-12) each year." With regard to this, Clymer and Wiliam (2006, p.36) caution "To be effective, however, assessment *for* learning must be integrated into assessment *of* learning systems."

Bybee & Stage (2005) found little progress was seen in science test scores in the 1990s. This highlights an urgency in the need for research into science in education and current reform issues, have raised the importance of elementary school teacher knowledge in science (Lowery, 2002). The pertinence of curricular research in the elementary school is mentioned by O'Donnell and White (2005, p.56) who state:

> The mandates of the No Child Left Behind Act (2002) to produce high levels of student performance and to staff schools with highly qualified (and skilled) teachers are perhaps the most challenging requirements in the history of education.

Furthermore, in 2004 Federal Reserve Chairman Alan Greenspan spoke of his concerns to congress regarding science and math saying that they were the foundation of economic growth (Federal Reserve Board, 2005). Thus, science teaching in school relates to life outside school. As Leshner noted (Perkins-Gough, 2006, p.10):

> You need at least a familiarity and comfort with science to tackle the many activities and issues of modern life. Even though you don't need to know the details of every scientific conundrum, you need an awareness of what is and isn't science.

There also appears to be a “science pipeline” problem from K-12 which needs addressing and “Scientists, business leaders, and educators now agree that more effort should be placed on K-12 science education, with increased emphasis at the elementary school level.” (Payne, 2004, p. 1).

Referring to such concerns and their impact on future U. S. students, Margaret Spellings (2006), as U. S. Secretary of Education, stated that

> Preparing for the future is a moral and economic imperative. Last year China's schools graduated more than 600,000 engineers and India's schools produced 350,000, compared with 70,000 in America. Do the math: their top 10 percent outnumbers all of America's. Many firms may agree with Intel chairman Craig R. Barrett: ‘If the world's best engineers are produced in India or Singapore, that is where our companies will go.’

Relating to this, Leshner notes that “…a failure of the US government – or society at large – to support science at a sufficient level could undermine our very eminence, let alone our preeminence in science.” (Perkins-Gough, 2006, p.12). This view is shared by Gerald Wheeler, executive director of the National Science Teachers Association, who adds “A nation’s ability to remain a leader relies on how well that nation educates its students in science and technology” (2006, p.31). Successful science teaching is therefore seen as key to both life outside school and the success of a nation’s economy as a whole. Current economic crises could increase the need for strong science graduates to lead innovation and technological developments.

The self-efficacy of teachers has been linked to many student outcomes such as achievement, motivation and greater classroom accomplishments from students within the classroom (Bleicher, 2004, Bandura, 1997). With regard to its effect upon teaching, de Laat and Watters (1995) note that teacher efficacy is a powerful predictor of the direction of teacher change. Factors affecting teacher efficacy include background knowledge, teacher education, professional development, the curriculum, resources and administrators. It is school leaders, such as principals, who by the nature of their positions perhaps have the greatest influence upon teacher efficacy, and the levels of confidence exhibited by faculty when teaching science to elementary school children.

The concept of self-efficacy has become more relevant to teaching through a variety of studies into its influence of instruction within the classroom (Gibson & Dembo, 1984, Riggs and Enochs, 1990, Hoy et al, 1990, de Laat and Watters, Tschannen-Moran et al, 1998, Tschannen-Moran & Woolfolk Hoy, 2002, Bleicher, 2004, Woolfolk Hoy and Kolter Hoy, 2006). Science self-efficacy in particular has also been a focus of study (Ginns and Watters, 1999, Ellsworth and Buss, 2000, Akerson & McDuffie, 2002, Shallcross et al, 2002, McNally, 2006). Successful school leadership also has a major influence upon student achievement (Marzano et al., 2005) and instructional leadership in particular has remained a frequently used model in practice, analysis and training (Hallinger, 2005, Marzano et al, 2005). There are also other background variables which can influence teachers, which can be in-school. These relate to teachers' own demographics or school demographics beyond principal influence. The above will therefore form the basis of this study.

Definition of Terms

Self-efficacy:

Developed from the work of sociologist Albert Bandera (1977, 1982, 1997), it can be simply stated as a person's belief in their ability to perform a particular behavior. With regard to the classroom, teacher efficacy is defined as "the extent to which the teacher believes he or she has the capacity to affect student performance" (Berman et. al. 1977, p.137).

STEBI:

This refers to the Science Teaching Efficacy Beliefs Instrument developed by Riggs and Enochs (1990) to investigate the science teaching efficacy beliefs of elementary school teachers.

Instructional Leadership:

This theory of leadership is often synonymously referred to by researchers as instructional management. Hallinger (2005) sees three dimensions for the instructional leadership role of the principal: defining the school's mission, managing the instructional program and promoting a positive school learning climate.

PIMRS:

This is the 50 item Principal Instructional Management Rating Scale (Hallinger, 1987), developed from the original scale designed by Hallinger and Murphy (1985). It was designed to measure perceptions of principal instructional leadership within schools.

International Schools:

The term relates to schools usually offering education to students who are not nationals of the host country, though many schools allow host nationals to also attend.

There is no requirement to learn the host language, and the majority of the schools in this study us a US based curriculum. The international schools in this research are all accredited members of one of the nine international school regional associations.

Elementary Schools:

While participants' schools may have pre-K or younger, for the purpose of this research it relates to students in a K-5 education.

Chapter 2: Influences on Elementary School Teachers' Science Self-Efficacy

Introduction

Effective science teaching in schools is strongly linked to teacher self-efficacy (Harlen and Holroyd, 1995, Shallcross et al., 2002, Ginns and Watters, 1999), it is therefore important to understand the factors influencing science teaching efficacy and their relative strengths. Principal instructional leadership has been identified as contributing to higher student achievement in schools, (Carter & Klotz, 1990, Hallinger & Heck, 2000, Hopkins, 2002, Southworth, 2002, O'Donnell & White, 2005) it is also seen as a key component of a successful science program (NSTA, 2007a) and has been linked to increased teacher efficacy (Hoy and Woolfolk, 1993). This study will provide a basis for recommending principal instructional leadership practices that might improve science teaching in the elementary school. The literature suggests that influential factors also include an elementary school teachers' background science knowledge (Harlen and Holroyd, 1995, Shallcross et al, 2002, Kallery & Psillos, 2005, Wheeler, 2006), the school curriculum (Spillane et al, 2001, Lunn, 2002, Bybee and Stage, 2005), teacher education (Meyer et al, 1998, Pontius, 1998, Wingfield et al, 2000, Woolfolk Hoy and Kolter Hoy, 2006, NSTA, 2007c), professional development (Arambula-Greenfield, et al., 1997, Woolfolk Hoy and Kolter Hoy, 2006, NSTA, 2007e), science resources (Fulp, 2002, Bybee and Van Scotter, 2006) and licensure requirements (Darling-Hammond, 2000, NSTA, 2007c). This study will analyze the strengths of these relationships and add to the literature. In this chapter, there is a discussion of self-efficacy, teacher efficacy and how this is relates to children in the classroom with regard science teaching. This is followed by references to leading research into leadership, developing to a definition of instructional leadership. The chapter ends with a review of research into leadership and background variables affecting science teaching efficacy.

Self-Efficacy

This theory has grown from the social behavior research of Albert Bandura (1977) in particular. He suggests that behavior is based on two factors. The first is that people develop generalized expectancies about action-outcome contingencies through their life's experiences (outcome expectancy) and secondly, they develop a more personal belief about their own ability to cope (self-efficacy) (de Laat & Waters, 1995). Self-efficacy could be simply stated as one's belief in one's abilities to perform a particular behavior (Pontius, 1998). Berman et al., (1977, p.137) define teacher efficacy as "the extent to which the teacher believes he or she has the capacity to affect student performance". A positive aspect of teacher efficacy and one which emphasizes its importance is the fact that it is cyclical (Woolfolk Hoy & Kolter Hoy, 2006), whereby a proficient performance creates a new mastery experience, providing new information that is processed to shape further efficacy beliefs.

The interest in teacher efficacy grew from studies by the Rand Corporation (Armor, et al, 1976), who published a study investigating various reading and writing interventions. They found that a teacher's sense of self-efficacy had a strong positive effect on student performance, and the amount of teacher change (Tschannen-Moran et al, 1998). Along similar lines, Bandura (1997) proposed four general sources for building information: verbal persuasion, vicarious experiences, physiological arousal and mastery experiences. He encapsulates his thinking in stating that people with a low sense of efficacy (a) avoid difficult tasks, (b) have low aspirations and weak commitment to goals,

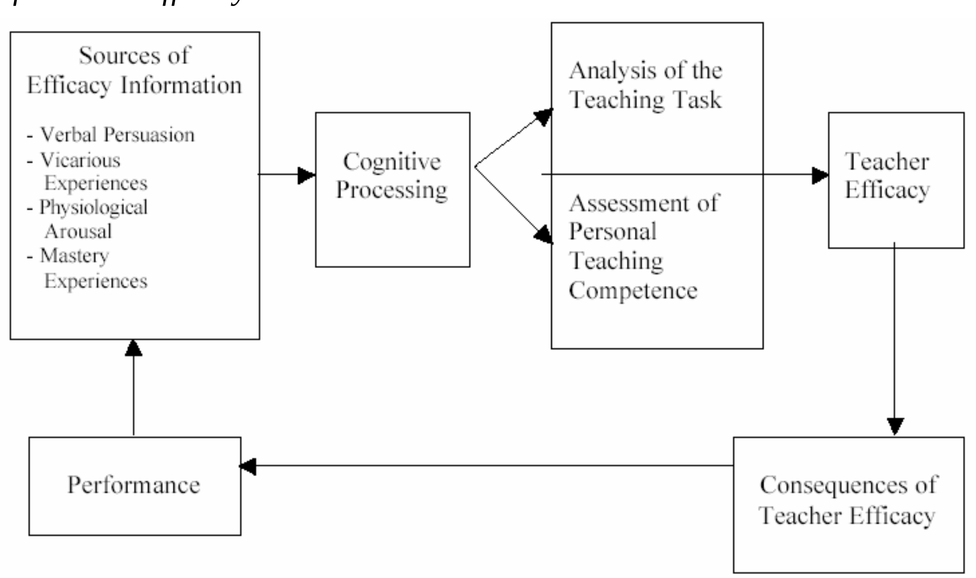
(c) turn inward on self-doubts instead of thinking about how to perform successfully, (d) when faced with difficult tasks, they dwell on obstacles, the consequences of failure, and personal deficiencies, (e) failure makes them lose faith as they blame their own inadequacies, (f) slacken or give up in the face of difficulty, recover slowly from setbacks, and easily fall victim to stress and depression. In contrast, Bandura found that people with a high sense of efficacy (a) approach difficult tasks as challenges to be mastered rather than threats to avoid, (b) are deeply interested in what they do, set high goals, and sustain strong commitment, (c) concentrate on the task, not on themselves, (d) blame failures on remediable ignorance, lack of skill, insufficient effort and (e) redouble effort in face of obstacles and soon recover confidence after a setback. Bandura (1997, p.2) adds that "This outlook sustains motivation, reduces stress, and lowers any vulnerability to depression."

Teacher Efficacy

In looking at teacher efficacy, Henson (2001, p.24) cites the following diagram from Tsannen-Moran et al (1998) to representing its multidimensional nature:

Fig. 2.1

Nature of Teacher Efficacy



One factor making teacher efficacy powerful is its cyclical nature (Woolfolk Hoy and Kolter Hoy, 2006), which is seen in Fig. 2.1. Greater efficacy leads to a greater effort and persistence, improving performance, however, the reverse is also true and can decrease efficacy. Gibson and Dembo (1984) applied early research to develop the teacher efficacy scale (T.E.S.). This grouped two factors, based upon Bandura's (1977) constructs. One factor was linked to a teacher's belief in their personal ability to bring about change regardless of external factors (outcome expectancy), a second factor related to a teacher's belief in personal responsibility for students' learning (personal teaching efficacy). The T.E.S. became the predominant instrument in the study of teacher efficacy (Henson, 2001), and Ross (1994, p.382) labeled it a "standard" instrument in the field.

Woolfolk Hoy & Kolter Hoy (2006, p.147) state "Teacher efficacy is context specific; teachers do not feel equally efficacious for all teaching situations". This reinforces the fact that different instruments needed to be designed to look into teacher efficacy in different teaching contexts. Working from this premise, Riggs and Enochs (1990) designed a 25 item Science Teaching Efficacy Beliefs Instrument (STEBI) (see Appendix A). It was designed specifically to investigate the science teaching efficacy beliefs of elementary school classroom teachers and the two constructs of "self-efficacy" and "outcome expectancy beliefs" were maintained. This was later reworded to apply to pre-service elementary teachers and became the STEBI B (Pontius, 1998). The original instrument, now named STEBI A, will form the basis of this study.

Teacher efficacy has been linked to many student outcomes (Tschannen-Moran & Woolfolk Hoy, 2002) which include achievement (Ashton & Webb, 1986, Ross, 1992), motivation (Midgeley, Feldfaufer & Eccles, 1989), and the sense of self-efficacy of the students (Anderson, Green & Lowen, 1988). Woolfolk Hoy and Kolter Hoy (2006, p.146) add that "Teaching efficacy, a teacher's belief that he or she can reach even difficult students to help them learn, appears to be one of the few personal characteristics of teachers that is correlated with student achievement". Thus it is an important area of study that analyzes factors having an impact within the classroom. Bandura (1997) concludes, through a review of the literature, that the evidence across studies is consistent in showing that 'perceived self-efficacy' contributes significantly to the level of motivation and performance accomplishments (Bleicher, 2004).

With regard to the effect of differing self-efficacy levels upon teachers, de Laat and Watters (1995, p.454) state "Previous research on self-efficacy applied to education suggests that this construct is a powerful predictor of the direction of teacher change". Teachers' efficacy beliefs also relate to their behavior in the classroom and affect their effort on teaching, their goals, their level of aspiration and how they deal with setbacks (Tschannen-Moran & Woolfolk Hoy, 2002). Teachers with strong efficacy are more open to new ideas (Guskey 1988, Stein & Wang 1988), have greater levels of planning, organization and enthusiasm (Allinder, 1994) and use more democratic classroom control techniques (Hoy et al, 1990). They also work longer with struggling students (Gibson & Dembo, 1984) are less critical of student errors (Ashton & Webb, 1986) and are less inclined to refer children to special education (Soodak & Podell, 1993). Higher efficacy levels have also been linked to a greater enthusiasm for teaching (Coladarci, 1992), the length of time teachers remain in the profession (Glickman & Tamashiro, 1982), lower stress (Parkay et al., 1988), increased parental involvement (Hoover et al, 1987) and positive attitudes toward staff development (Mellencamp, 1992).

Science Self-Efficacy in the Elementary School

It is notable that teachers bring different attitudes and perceptions to science lessons in the elementary classroom. Shallcross et al. (2002, p.1302) point to "a clear link between confidence and competence" in elementary trainee teachers' science performances. Ginns and Watters (1999) add that many experienced teachers, along with teachers who had recently completed their pre-service education, often expressed low self-efficacy regarding their teaching of science. As the main role of elementary teachers is to prepare their students to be literate adults, the majority of these are literacy specialists, so a lack of confidence should not be a surprise in many instances (Akerson & McDuffie, 2002). Ellsworth and Buss (2000) noted that previous teacher influence from their earlier schooling, confidence felt in science lessons when a child, the impact of family members' interest in science, the importance of current curriculum content relating to real life situations and issues with comprehension of content areas were all common themes of elementary teacher's views of their own science competence. These themes highlight the influence of family and school experience on personal interests when growing up.

The above has a knock-on effect upon the self-efficacy an elementary teacher might have within science lessons. McNally (2006, p.430) adds

> Supporting investigative work by pupils without having had the actual experience oneself was a cause for anxiety; there was often nothing to draw on. With little or no experience of *doing* science themselves, or even having contact with working scientists, many teachers' working knowledge of science is somewhat hollow.

Analysis from the National Survey of Science and Mathematics Education (N.S.S.M.E.) (Weiss et al, 2001) from 655 participants revealed data pertinent to this research. Using this data, Fulp (2002) looked at the subjects within the curriculum in further detail noting that while less than 30% felt well prepared to teach the sciences, 77% indicated they were well qualified to teach language arts, 66% mathematics and 52% social studies. Harlen and Holroyd (1995) found that when asked to rate their confidence in teaching various curricular areas, 71% of 514 teachers in a survey said they were fully confident teaching both mathematics and English, but only 12% felt the same way for science. Within science, they found teachers were reasonably confident with “Living Things and Life Processes” and “Earth and Space”, but much less confidence about “Energy and Forces”. They also found male teachers more confident than female teachers with science; more recently qualified teachers more confident than experienced teachers; teachers with science backgrounds were more confident than those with none. In a separate study, Plourde (2002) found that 76% of teachers felt very well qualified to teach reading, roughly 60% math and social studies, 29% life sciences and fewer than 18% felt very well qualified to teach the physical sciences.

Relating to the areas above, teachers mould their experience, knowledge, confidence and competence to take their own standpoint toward science. Lunn (2002, p.657) identified six factors which could be used to help define a teacher’s standpoint regarding science teaching. These were scientism, naïve empiricism, new-age-ism, constructivism, pragmatism and skepticism. They are outlined in Fig. 2.2 below:

Fig. 2.2

Teachers' Perspective Regarding Science Teaching

Factor	Characterisation	Commentary
Scientism	Scientific method will lead to the truth. There are no mysteries that will not eventually yield. Science is the only way of finding out about the reality behind phenomena.	Uncritical enthusiasm for science and acceptance of scientific findings as fact.
Naive empiricism	Science proceeds by trying things out to 'see what happens', and is driven by data derived from such observations. Progress is represented by the steady accumulation of facts.	A lay view of science as process uninformed by theory.
New-age-ism	Progress in science is illusory. It consists in the development of new ways of talking about the world that are not intrinsically better than older ways, just different.	A kind of relativism, which has taken on board paradigm change, but sees it as change of linguistic or explanatory fashion rather than any kind of progress towards better explanations.
Constructivism	Science is rooted in attempts to construct explanations, which originate in discursive speculation and imagination. The explanations are of phenomena, which form part of theory-mediated experience.	Science as joint human sense-making and disciplined curiosity.
Pragmatism	Truth, coherence, and correspondence with 'reality' are not worth pursuing or are unattainable: what matters is the usefulness of science in helping us understand and influence our experience.	This could represent a frustration with philosophical nit-picking, or a positive philosophical position.
Scepticism	Science has no claims to specialness, and is no more likely to be true than common sense.	This could represent simple rejection of the non-commonsensical, or a kind of pan-epistemological relativism.

The above personal teaching beliefs interact with pedagogical styles and are also linked to background knowledge and confidence. These beliefs have an affect upon teachers' self-efficacy, thus the effectiveness of their science teaching.

Finally, drawing together many of the above areas, Harlen and Holroyd (1997, p.102) found that elementary school teachers' confidence in teaching science was influenced by (a) teachers' own school and personal experience, (b) the nature of initial and inservice experience, (c) the experience of pressure and curriculum overload, (d) the support available from colleagues and material resources and (e) teachers' views of their own professional capability. This highlights the many aspects that are held to bear on elementary teachers as they teach science in their classrooms.

A major influence upon all areas of school is principal leadership. In looking at school leaders and their influence upon teacher efficacy, it is imperative to reflect upon certain areas of leadership that make up the role of positions such as school principal.

Leadership

Before analysis of principal instructional leadership can begin there needs to be a deep understanding of the research into leadership and inherent issues therein to give a degree of contextual background.

Leadership and Management

It is useful to distinguish between leadership and management as these are central to the role of the principal and therefore to this study. Gardner (2000) notes that a manager holds a directive post in an organization, presiding over processes of organizational function, resource allocation and use of personnel. He adds that leaders distinguish themselves from managers by (a) thinking long term and beyond the horizon, (b) grasping relationships between the organization and external conditions, (c) influencing constituents beyond their jurisdiction, (d) emphasizing intangibles of visions, values and motivations, (f) possessing political skill to cope with conflicting needs of groups and (g) thinking in terms of renewal and revision.

Foster (1986, p.169) encourages caution when separating leadership and management and states:

> (Yet) the concept of leadership often receives poor treatment from scholars and educators alike. Often, it is mistaken for the ability to manage small groups in accomplishing tasks; at other times, as a means for improving production…. both views adopt a fundamentally mistaken approach to leadership insofar as they identify leadership with aspects of management, as they focus on task accomplishment, and as they neglect to deal with followers' needs and requirements.

In looking for a more concrete definition of leadership, Northouse (2007, p.2) adds:

> There are a multitude of ways to finish the sentence "leadership is…." In fact, Stogdill (1974) points out in a review of leadership research, there are almost as many different definitions of leadership as there are people who have tried to define it.

Northouse adds that "leadership is a process whereby an individual influences a group of individuals to achieve a common goal" (2007, p.3). Kotter (1996) sees leadership as processes creating and adapting organizations, while Fidler et al (1997) illustrate two main features of leadership, as (a) a sense of purpose and confidence are engendered in followers and (b) followers are influenced toward goal achievement. Gardner (2000) also notes that the leader is an integral part of the system, subject to the system's forces and that communication and influence flow between leader and follower.

Bennis (2003) identifies 4 critical characteristics of effective leadership. They are (a) the ability to engage others through the creation of a shared vision and (b) the possession of a clear voice that is distinctive to constituents, (c) operating from a strong moral code and belief in a higher good, and (d) the ability to adapt to relentless pressure to change from outside or within an organization. Northouse (2007) goes on to state that over 65 classification systems have been used to define leadership, but points to six key areas. The first is to focus on group perspectives, whereby the leader is the center of group changes and embodies the will of the group. The second is termed the personality perspective, where leadership is a combination of certain traits or characteristics held by the group and another relates to leadership as an act or behavior. In addition, he adds three more areas of a power relationship between leaders and followers, transformational processes moving followers to accomplish more than is usually expected of them and the skills perspective, whereby the capabilities making leadership possible are stressed.

Sergiovanni (1984b cited by Bush and Coleman, 2000) noted five hierarchical "forces". These were termed the (a) technical; the leader as "management engineer", (b) human: leader as "human engineer", (c) educational: leader as "clinical practitioner", (d) symbolic: leader as "chief" and (e) cultural: leader as "high priest". Kouzes and Posner (2002) identified five practices of exemplary leadership, whereby successful leaders were able to model the way, inspire a shared vision, challenge the process, enable others to act and encourage the heart. In looking at specific styles of leadership, Goleman sampled 3,871 business executives to identify six key leadership styles, which can be applied to different situations with varying degrees of positive effects. They are ranked as to the most positive to negative on climate (expressed as a correlation) (2000, p.81): (i) authoritative: mobilize people toward a vision (.54), (ii) affiliative: create emotional bonds and harmony (.46), (iii) democratic: build consensus through participation (.43), (iv) coaching: develop people for the future (.42), (v) pacesetting: expect excellence and self-direction (-.25) and (vi) coercive: demand immediate compliance (-.26)

The above lists and frameworks are valuable as an overview of the aspects of leadership. It is also valuable to look at such key theories to give an overview of some of the perspectives through which some theorists have viewed the subject in relation to the leadership within schools.

Educational Leadership Research

With regard to the leadership of principals within schools, Van de Grift and Houtveen (1999, p.373) state:

> Educational leadership can be defined as the ability of a principal to initiate school improvement, to create a learning-oriented educational climate, and to stimulate and supervise teachers in such a way that the latter may execute their tasks as effectively as possible.

Context has become a key aspect of instructional leadership (Hallinger, 2005), therefore it is valuable to look at literature relating to the different contextual roles of a school principal.

Leithwood, et al (2000, p.vii) note that;

> Around the world, schools, and the societies of which they are a part, are confronting the most profound changes, the like of which have not been seen since the last great global movement of economic and educational restructuring more than a century ago.

The Council of Chief State School Officers (2007, ¶1) in their standards for school leaders states that an administrator is an educational leader who promotes the success of all students by (a) facilitating the development, articulation, implementation, and stewardship of a vision of learning that is shared and supported by the school community, (b) advocating, nurturing, and sustaining a school culture and instructional program conducive to student learning and staff profession growth, (c) ensuring management of the organization, operations, and resources for a safe, efficient, and effective learning organization, (d) collaborating with families and communities, responding to diverse community interests and needs, and mobilizing community resources, (e) acting with integrity, fairness, and in an ethical manner, and (f) understanding, responding to, and influencing the larger political, social, economic, legal, and cultural context.

Leithwood et al (2000) list six categories of approaches a school head needs to use. These are (a) instructional: focus on behavior of teachers affecting students, (b) transformational: focus on commitment and capacities of organizational members, (c) moral: focus on leadership is on values and ethics of leaders themselves, (d) anticipative: group decision making is the central focus for leaders, (e) managerial: focus on the carrying out of functions, tasks facilitating the organization, and (f) contingent: assumes the important thing is how a leader responds to circumstances. School leaders would move between the various categories, as a situation would demand.

Law and Glover (2000, p.6) illustrate such movement between roles diagrammatically in Fig. 2.3, below:

Fig. 2.3

School Leaders' Movements Between Roles

Educational Leadership		
'Chief executive officer'	↔	'Leading professional'
↕ Internal role • *Strategist*: articulates organization's strategic focus and direction; acts as developmental catalyst. • *Manager*: allocates and coordinates a range of organizational functions. • *Arbitrator*: acts as organizational broker and referee	↔	↕ Internal role • *Mentor*: develops others- the professional guidance of staff. • *Educator*: demonstrates technical competence and personal teaching skills. • *Advisor*: supports and counsels pupils, parents, etc.
↕ External role • *Executive officer*: accountable to the governing body, LEA, government. • *Diplomat*: articulates mission and undertakes public relations with stakeholder communities and external bodies.	↔	↕ External role • *Ambassador*: organizational envoy in wide range of external professional activities. • *Advocate*: institutional spokesperson *vis-à-vis* educational and professional matters.

In a National Science Teachers Association document, Mechling and Oliver (1982) recommend that a principal must be a science leader, a curriculum analyst, a force in the selection or development of a new science curriculum, a provider of the wherewithal, a provider of in-service instruction, a monitor of progress in science programs, and a troubleshooter. They add that (1982, p.xv) "With support, encouragement and leadership from the principal, the science curriculum will probably flourish and grow. Without the principal's support it may wither and die." Leaders such as this must also control the five paradoxes of (a) purpose, (b) people, (c) change (d) action and (e) leading. They must therefore build a shared purpose, support faculty, perpetuate the present and reach for the future, utilize decision-making and this must come from all stakeholders (Deal and Peterson, 1999). Hallinger and Heck (1998, p.171) also suggest that "In the current image of school organization,… leadership not only influences individuals-it influences the organization system in which the individuals (e.g. teachers, students, parents) work". Good instructional management will lead to the development of each facet

School principals have a key role in the successful implementation of science within schools. Law and Glover (2000) look to Adair (1983) who asked what constituted effective leadership and identified five distinguishing characteristics. He states that a leader (a) gives direction, (b) offers inspiration, (c) builds teamwork, (d) sets an example, and (e) gains acceptance. There are also certain skills of self-management and interpersonal relationships relating to leadership, which can be split into six elements (Law and Glover, 2000). These are a leader's role in school, responsibilities, delegating, decision-making, time management and the management of stress. Johnson (1993) found through the self-assessment of 131 elementary school principals, the highest scores for effective leadership were (i) exercising exemplary behavior at school, (ii) making timely, appropriate and acceptable decisions, (iii) communicating with staff and (iv) providing an appropriate work environment for staff. They also found lower self-assessment ratings for (i) effectiveness in interacting outside school and (ii) responding to external expectations.

In their meta analysis, Marzano et al. (2005) ranked the following as the 10 key leadership responsibilities in order of correlation with student achievement: (i) situational awareness, (ii) flexibility, (iii) discipline, (iv) outreach, (v) monitoring and evaluating, (vi) culture, (vii) order, (viii) resources, (ix) knowledge of curriculum, and (x) input.

Effective leadership will have positive effects on teacher efficacy. There are also certain cultural influences upon a principal's leadership style (Bush and Coleman, 2000). In different countries there are different pressures and requirements upon society, often reflected in schools. As Reeves (et al), 1998 (p.36) state: "School leaders need to be able to draw on a repertoire of styles and skills which changes and develops over time and is shaped by context and culture." In looking at schools in an international context, it is valuable to consider Hofstede and Hofstede (2005), who in their IBM study noted the following common problems and solutions of social inequality, including the relationship with authority, the relationship between the individual and the group, concepts of masculinity and femininity, ways of dealing with uncertainty or ambiguity, which is related to the control of aggression and expression of emotion and long-term versus short term orientation. They added that even *within* cultures, differences lie in religion, ethnicity, gender, generation and class (or caste). These all influence a principal's approach to instructional leadership.

The internal emotions of a principal might also have a great deal of influence upon their own self-efficacy as leaders. Beatty (2000), who analyzed 1 male and 4 female educational leaders, found that positive emotions included "flow" through empowerment and collaboration, being able to give support, being known, and self-affirmation through using their abilities to overcome adversity. However, negative emotions included disempowerment if support not given, threatened by critical staff, pressure controlling emotionally charged situations, unpleasant work such as downsizing or reprimanding staff and disillusionment with the system due to external politics. In a similar vein, McBeath (1998) studied the areas of work giving school principals the most and least pleasure. The most enjoyable aspects were a love of the job, job satisfaction, working with people, interaction, engagement, sharing and the pupils. In contrast, their least enjoyable aspects were criticizing staff, dealing with redundancy, low status of teachers, misinformation about state education, administration, the pace of change and lack of time. Again, these all play a part in the makeup of school leaders, possibly affecting teachers' self-efficacy. The role of a principal is therefore key, although Mechling and Oliver caution that:

> While principals are responsible for providing top quality science experiences for the children who attend their schools, many feel they aren't well qualified to supervise science instruction. And, for many, science ranks low in the totem pole in comparison with other subjects. Though principals are curriculum leaders, they certainly are not required to be experts in science to be effective.
>
> (1982, p.xi)

A lack of science qualification is, however, another drawback in the instructional leadership model, as it relates to this study.

Shoemaker and Fraser (1981) reviewed ten studies of effective schooling, and found that principals were important for the effectiveness of their schools, and that, pertinent to this research, principals in the higher achieving schools were stronger instructional leaders. In a summary of literature on background and context effects upon leadership, Hallinger and Heck (1998) noted that socioeconomic factors of the school and community appear to influence principal leadership impact on school effectiveness, structures and social networks impact upon principal behavior, school size and teacher background do not generally influence secondary principals and that discussions of instructional issues, techniques and problems were more common in high than low-achieving schools. A school's administration and instructional leadership in particular needs to be considered among the other key factors influencing an elementary school teacher's science self-efficacy.

In looking at the theories that have grown within leadership and educational research, one can turn to Marzano et al., who state "many theories of leadership have been influential in guiding school leaders" (2005, p. 13). They outline certain key leadership theories that have evolved. These are (a) transformational and transactional leadership, (b) total quality management, (c) servant leadership, (d) situational leadership, and (e) instructional leadership.

Instructional leadership is analyzed in more detail, as it is the focus of this study. Smith & Andrews (1989 cited by Marzano et al., 2005) see instructional leadership as encompassing the four roles of resource provider, instructional resource, communicator, and being a visible presence. Blase & Blase (1999 cited by Marzano et al., 2005) state that characteristics of instructional leaders encourage and facilitate study of teaching and learning, facilitate collaboration among teachers, establish coaching relationships among teachers, use instructional research to make decisions, and use principles of adult learning. In addition, Glickman et al (1995 cited by Marzano et al., 2005) identifies instructional leaders as those who direct day-to-day assistance to teachers, develop collaborative groups in staff, utilize effective staff development activities, are central to curriculum development and use action research. Finally, Hallinger et al. (1983) identified three functions of instructional leaders as defining the school's mission, managing curriculum and instruction and promoting a positive school climate. This latter definition is the basis of this study.

Marzano et al. (2005, p.18) add that, “Perhaps the most popular theme in educational leadership over the last two decades has been instructional leadership…. Yet, despite its popularity, the concept is not well defined.” As a central component of this study, instructional leadership as it relates to elementary school principals is analyzed below.

Principal Instructional Leadership

Principal instructional leadership has been identified as a major factor contributing to higher student achievement in schools (Carter & Klotz, 1990, Hallinger & Heck, 2000, Hopkins, 2002, Southworth, 2002, O’Donnell & White, 2005) and it is the principal who is the main instructional leader (Wanzare & De La Costa, 2001, Sergiovanni, 1995). The U.S. Department of Education (2005, p.1) states that “Effective school leadership today must combine the traditional school leadership duties such as teacher evaluation, budgeting, scheduling, and facilities maintenance with a deep involvement with specific aspects of teaching and learning”. Many principals see instructional leadership as their main responsibility (Gorton & Schneider, 1991)

Following the Coleman Report (1966), which suggested that it was family background rather than the school that was the indicator of educational success, the effective schools movement looked to change that emphasis. It developed through “…research that supported the premise that all children can learn and that the school controls the factors necessary to assure student mastery of the core curriculum.” (Lezotte, 2001, p.1). Instructional leadership grew from the refinement and expansion of the effective schools correlates (Lezotte, 2001). During the 1980's in the United States, instructional leadership became identified as desirable for principals wishing to be effective (Hallinger and Murphy, 1985) and was "Spurred on by findings from research on effective schools" (Murphy, 1988, p.117). The growing interest, was given further momentum through new "leadership academies" devoted to principal leadership development (Hallinger, 2005) and, with transformational leadership, instructional leadership was the main conceptual model used with regard to principal leadership from 1980-1995 (Hallinger & Heck, 1998). Instructional leadership continues to be relevant today, and Hallinger (2005, p.221) adds

> …the instructional leadership construct is still alive in the domains of policy, research, and practice in school leadership and management. Indeed, since the turn of the twenty-first century, the increasing global emphasis on accountability seems to have reignited interest in instructional leadership.

O'Donnell & White (2005, p.67) note that their research showed "…principals must continue to determine how to best use their time to engage in the most essential instructional leadership tasks", as contemporary reform continues to place a premium on effective school leadership and management (Hopkins, 2002). There have been drawbacks, however in the growth of this as a leadership style, for those leaders who found it difficult to live up to the expectations, as Hallinger (2005, p.224) notes,

> Descriptions of these principals tended towards a heroic view of their capabilities that often spawned feelings ranging from inadequacy to guilt among the vast majority of principals who wondered why they had such difficulty fitting into this role expectation.

With regard to the attitudes of faculty toward principals, Smith & Andrews (1989, p.2) add that

> Research from a variety of fields suggests that professionals associate the conditions under which they work with job satisfaction…. It has also found that teachers' perception of the school principal as an instructional leader is the most powerful determinant of teachers' satisfaction with their professional role".

Woolfolk Hoy and Kolter Hoy (2006, p.147), state that "teachers' sense of personal efficacy is higher in schools where the other teachers and administrators have high expectations for students and where teachers receive help from their principles in solving instructional and management problems". Thus, instructional leadership may also impinge on a teacher's self-efficacy in a subject.

In current times of change with regard to curriculum and assessment, there is a particular need for school leaders to place an emphasis on nurturing the instructional environment and becoming curriculum leaders (Kayona, et al., 2004). In designing their instrument for the measurement of instructional management of principals, Hallinger and Murphy (1985) identified three dimensions of instructional management, which were originally separated into 11 functions. The dimensions and functions are shown in Fig. 2.4 below:

Fig. 2.4

Dimensions of Instructional Management

1. DEFINING THE SCHOOL MISSION
- Defining and communicating the leader's mission for the school, engendering a shared purpose and linking activities in classrooms throughout the school
a) Framing school goals: - Determining the areas where school staff will focus attention and resources through the school year
b) Communicating school goals: - The ways a principal communicates important school goals to teachers, parents and students
2. MANAGING THE INSTRUCTIONAL PROGRAM
- Working with teachers in the areas specifically related to curriculum and instruction
a) Supervising and evaluating instruction: - Ensuring school goals are translated into classroom practice
b) Coordinating curriculum - Aligning objectives with content taught in classes and achievement tests, coordinating curriculum across grades
c) Monitoring student progress - Emphasize standardized and criterion-referenced testing for student and program diagnostic purposes, evaluating results of school program change and making classroom assignments
3. PROMOTING A POSITIVE SCHOOL LEARNING CLIMATE
- The norms and attitudes of staff and students influencing learning in the school, primarily through indirect, though important activities
a) Protecting instructional time - Allowing teachers to have blocks of uninterrupted instructional time
b) Promoting professional development - Inform teachers of development opportunities, ensure development is linked to school goals and allows teachers to integrate skills into the classroom
c) Maintaining high visibility - Find time to increase interactions with students and teachers to discover information or communicate school priorities
d) Providing incentives for teachers - Set up a work structure rewarding and recognizing teachers' efforts through private praise or public recognition
e) Developing and enforcing academic standards - Reinforce the high expectations necessary for improving student learning through clearly defined, high standards
f) Providing incentives for learning - Creating a school climate appropriate for students to value academic achievement and improvements through frequent student reward and recognition

These functions were further delineated in Hallinger and Murphy's (1985) Principal Instructional Management Rating Scale (PIMRS), a 71 question instrument. A subsequent 50 question version of the PIMRS (Hallinger, 1987) (see Appendix B), will be used in this study.

Smith and Andrews (1989) suggest three theories are at the heart of instructional leadership as it relates to school principals. These are role theory, expectancy theory, and adaptive-reactive theories. They add that "Taken collectively… the theories seem to provide a good foundation for explaining and changing principal behavior" (Smith & Andrews, 1989, p. 6).

O'Donnell and White (2005) state that the literature posits two views of instructional leadership. These are referred to by Sheppard (1996) as "narrow" and "broad". The narrow perspective is focused on such behaviors directly affecting curriculum, teacher instruction, staff development and supervision (Leithwood, 1994), where the main perspective involves all aspects affecting student learning (Hallinger & Murphy, 1985, Murphy, 1988). Such a perspective is illustrated by Smith & Andrews (1989, pp8-9) who state that the principal who displays strong instructional leadership (a) places priority on curriculum and instruction issues, (b) is dedicated to the goals of the school and school district, (b) is able to rally and mobilize resources to accomplish goals of the district and school, (c) creates a climate of high expectations in the school, characterized by a tone of respect for teachers, students, parents and community, (d) functions as a leader with direct involvement in instructional policy, (e) continually monitors student progress toward school achievement and teacher effectiveness in meeting those goals, and (f) demonstrates commitment to academic goals, shown by the ability to develop and articulate a clear vision of long-term goals for the school, and to strong achievement goals that are consistent with district goals and priorities. These principals also (g) effectively consult with others by involving the faculty and other groups in school decision processes, (h) mobilize resources such as materials, time, and support to enable the school and its personnel to most effectively meet academic goals and (i) recognize time as a scarce resource and creates order and discipline by minimizing factors that may disrupt the learning process.

In focusing on two areas of instructional leadership, Hopkins (2002), writing for the U.K.'s National College for School Leadership draws together two key skill clusters of (a) strategies for effective teaching and learning and (b) the conditions that support implementation, in particular staff development and planning. Hopkins (2002) adds that the following are key characteristics of instructional leaders: (a) an ability to articulate values and vision around student learning and achievement, and to make the connections to principles and behaviours and the necessary structures to promote and sustain them, (b) an understanding of a range of pedagogic structures and their ability to impact on student achievement and learning (c) an ability to distinguish between development and maintenance structures, activities and cultures, (d) strategic orientation, the ability to plan at least into the medium term, and an entrepreneurial bent that facilitates the exploitation of external change, (e) an understanding of the nature of organizational capacity, its role in sustaining change, and how to enhance it, (f) a commitment to promoting enquiry, particularly into the 'how' rather than the 'what", (g) a similar commitment to continuing professional development and the managing of the teacher's life cycle, and (h) an ability to engender trust and provide positive reinforcement.

In a similar vein, the U.S. Department of Education (2005) states that instructional leadership should include (a) prioritization, with teaching and learning at the top of list, (b) scientifically based research to assist selection and assessment of instructional materials, (c) focus on alignment of instruction, curriculum, assessment and standards, (d) data analysis from multiple sources and (e) culture of continuous learning for adults. Blasé and Blasé (1999, cited by Southworth, 2002) found three interrelated aspects to effective instructional leadership behavior following a survey of over 800 U.S. elementary, middle and high school teachers' views of the instructional leadership capabilities of their principals. These are talking, or conferencing, with teachers, promoting teachers' professional growth and fostering teacher reflection. They also found these are tied to three other principal behaviors that can have positive or negative effects. These are being visible praising results, and extending autonomy.

There is one caution with regard to the lists above, it must be noted that while they are valuable as an overview "Lists may help develop understanding, but that does not mean they are theories for action" (Southworth, 2002). These lists do, however, give some structure to the concept of instructional leadership as seen from different perspectives.

In a review of instructional leadership research, Hallinger (2005) notes that evidence suggests school principals contribute to school effectiveness and student achievement through their actions influencing school and classroom conditions. He adds that a principal's role in shaping the school mission contains "The most *influential avenue of effects*" (p.229, original italics), which relates to leadership vision and that the type of instructional leadership exercised by principals is affected by school context.

Successful leaders should work with stakeholders to fit a school's purpose to its environment. Hallinger (2005) adds that instructional leaders have an influence upon school outcome quality through the alignment of school structures and that "Instructional leaders both *lead* through building a mission and *manage* through activities that increase alignment of activities with those purposes" (p.229, original italics). He found that few studies found instructional leaders portraying the popular 1980s "hands-on" image of instructional leaders, although leaders are more involved in elementary schools and also that principal effects tend to be through school culture and modeling rather than direct supervision and teacher evaluation.

In relating to many of the factors of one of Hallinger and Murphy's (1985) three dimensions, "managing the instructional program", Hallinger (2005, p.230) concludes:

> There is little evidence to support the view that on a broad scale at either the elementary or secondary school level principals have become more engaged in hands-on directed supervision of teaching and learning in classrooms. The classroom doors appear to remain as impermeable as a boundary line for principals in 2005 as in 1980.

However, with regard to the remaining two factors, "defining a mission" and "creating school culture", Hallinger adds (2005, p.230);

> Yet, if we define instructional leadership more broadly to focus on the dimensions of *Defining a School Mission* and *Creating a Positive School Culture*, the picture is somewhat different. Research on instructional leadership suggests that these dimensions of the principal's leadership role are becoming integrated more firmly into the principal's role behavior.

This suggests that Hallinger has noted certain limitations with regard the management aspect of the instructional leadership model, while the more leadership-related defining a mission and creating a school culture have become more embedded in practice.

Distributed Instructional Leadership

During the 1980s, there appeared little discussion about the distributed leadership aspects of instructional leadership (Hallinger, 2005). In recent years, however, "the facilitative instructional leadership of the mid 1990s which empowers staff has superseded the top-down, principal driven model of leadership of the 1980s" (MacNeill, et al., 2003). This, one could say, has moved to redefine some of the aspects, and perhaps dilute the effect of principal instructional leadership. Elmore explains that some of it is through necessity by stating "The idea behind distributed leadership is that the complex nature of instructional practice requires people to operate in networks of shared and complementary expertise rather than hierarchies that have a clearly defined division of labor." (2002, p.24). MacNeill, et al. (2003, p.4) state that "A more realistic model of instructional leadership needs to acknowledge that within schools there are multiple layers of instructional leadership, not just that ascribed to principles. This devolution of power may have some effect upon the nature of principal leadership within this study and will be considered within the limitations. As Woolfolk Hoy and Kolter Hoy (2006, p.2) note "…instructional leaders need to spend time in classrooms as colleagues and engage teachers in conversations about learning and teaching". Furthermore, teachers are more effective if they collaborate (Schomoker, 1996), which the leader needs to facilitate. NSTA (2007b, ¶2) adds that "Science leaders must cultivate a leadership network consisting of principals, lead teachers, science department heads….” This draws out the fact that in some areas, where the principal does not have technical skill, such as science, there is a greater need for the distributed nature of leadership in schools. In such distribution, the modern principal is therefore aware that “teachers play a vital and growing role in providing instructional leadership” (Northwest Association of Accredited Schools, 2007, ¶7). As Bennis states (2003, p. xviii)

> Great leaders and followers are always engaged in creative collaboration. We still tend to think of leaders, like artists, as solitary geniuses. In fact, the days when a single individual, however gifted, can solve our problems are long gone.

The model of instructional leadership, has evolved to become more distributed in its nature, and will continue to do so. Jackson (2000) and Fullan (2002) note that school improvement is a journey, wherein certain types of leadership may be more pertinent for other phases of the journey; instructional leadership still appears to be a key aspect of the modern school principal practice.

Factors Affecting Teachers' Science Self-Efficacy

Principal Leadership

School administrators, in particular principals, have a significant influence upon the professional development of teachers (Bredeson & Johansson, 2000). They add that “One of the primary tasks of school principals is to create and maintain positive and healthy teaching and learning environments for everyone in the school, including the professional staff” (p. 386). Administrators also have an influence upon the self-efficacy of students by raising expectations and through helping teachers in solving instructional and management problems. They are responsible for creating learning organizations (Woolfolk Hoy & Kolter Hoy, 2006).

Bredeson and Johansson (2000) highlight four areas where principals have the opportunity to have a significant impact upon teacher learning, which are (a) the principal as an instructional leader as learner, (b) the creation of a learning environment, (c) direct involvement in the design, delivery and content of professional development and (d) the assessment of professional development outcomes. They add that "…highly effective principals work to move teachers toward greater levels of independence and professional autonomy." (p. 386) Such independence is a quality of teachers with strong self-efficacy, as mentioned earlier.

There are also influences the principals have on new teachers' efficacy. Ginns and Watters (1999, p. 17) state that beginning teachers "… need the continuous support of peer teachers, school principals and science teacher educators to identify and analyze successful teaching episodes in order to enhance their professional development." Traditional school administration, however, can at times offer little help to teachers, as is highlighted by Tsannen-Moran & Woolfolk Hoy (2002, p. 6),

> Because of the traditional isolation of the teaching profession, and the dearth of meaningful feedback from administrators in traditional supervisory practice, perhaps it is not surprising that teachers do not look to these as primary sources to inform their efficacy judgments.

The self-efficacy of principals *themselves* may also influence teacher efficacy. Smith et al (2006) found that principal self-efficacy levels tend to increase with the complexity of the job. They found they tended to spend a greater time in management rather than facilitating instructional effectiveness, while the majority of principals felt their efforts to promote an effective learning environment were productive. This positive view is a good sign, as self- efficacy is often affected by stress, and in recent years, pressures from the high stakes testing following the implementation of no Child Left Behind in U.S. schools must have increased stress levels for administrators. Other factors affecting principal self-efficacy include help from role models, district expectations and organizational support (Osterman & Sullivan, 1996) and professional development for principals regarding teacher supervision (Licklider & Niska, 1993). Self-efficacy may also be an important factor in explaining the under representation of women in positions of school leadership (Imants & DeBrabander).

With regard to principals affecting professional development, Bredeson and Johansson (2000) cite DuFour and Berkley (1995, p.2) who stated that "Focusing on people is the most effective way to change any organization. In fact, it can be argued that organizations do not change, only individuals change". DuFour and Berkley (1995) offer 10 suggestions to principals looking to promote organizational development through professional development. These are (a) create consensus on the school and what it's trying to become, (b) identify, promote and protect values, (c) monitor the critical elements of the school improvement effort, (d) ensure systematic collaboration throughout the school, (e) encourage experimentation, (f) develop a commitment to professional growth, (g) provide one-on-one staff development, (h) provide staff development programs that are purposeful and research based, (i) promote individual and organizational self-efficacy, and (j) stay committed to continuous improvement and the goal of becoming a learning organization.

In looking at the influence of a school's organization, Chubb (1988, p.24) states that "school performance is unlikely to be significantly improved by any measure or set of measures that fails to recognize that schools are institutions - complex organizations composed of interdependent parts, governed by well established rules and norms of behavior, and adapted for stability". Bolman & Deal (2003) highlight the complexity, illustrating 4 frames through which an organization may be viewed; the structural, human resource, political and symbolic frames. They add that organizations are complex, surprising, deceptive and ambiguous. Therefore strong leadership is key. Fuller and Izu (1986) also found that when organizational beliefs matched the beliefs of teachers, this led to higher teacher efficacy. Furthermore, Hoy and Woolfolk (1993) found teacher efficacy was enhanced by the influence of the principal, academic emphasis and institutional integrity. It appears that a school's organization, through the principal, has an influence on teacher efficacy. Newmann et al (1989), who looked at organizational factors affecting a school's sense of efficacy, community, and expectations stated that "The most powerful organizational effects were students' orderly behavior, the encouragement of innovation, teachers' knowledge of one another's courses, the responsiveness of administrators, and teachers' helping one another."

Successful school leaders, note Deal and Peterson (1999), can shape a school's culture by (a) developing a student-centered mission, (b) strengthening current positive cultural elements, (c) building on established traditions and values, (d) recruiting, hiring and socializing staff that will promote a positive culture, (e) using history to fortify core values and beliefs and (f) sustaining core norms, values and beliefs through the school. A successful instructional leader may enable this to happen, and raise self-efficacy in the process.

Teachers' Background Knowledge

In moving beyond the influence of the principal, one can also consider the influence on science teaching efficacy of the science knowledge teachers bring with them into the classroom. Wheeler (2006, p.31) states that "teachers need to know the science they teach…. They can't teach what they don't know" In National Science Foundation supported study, Stake and Easley (1978, p.19) outlined the importance of a science background knowledge for elementary school teachers:

> Although we found a few elementary teachers with a strong interest and understanding of science, the number was insufficient to suggest that even half of the nation's youngsters would have a single elementary school year in which their teacher would give science a substantial share of the curriculum and do a good job of teaching it.

In looking at teachers' background knowledge, it is valuable to begin with the training process, and focus on where teachers' specialties lie. The 2000 N.S.S.M.E. study (Weiss et al, 2001), found that only 4% of elementary school teachers who teach science have science or science education undergraduate degrees (Fulp, 2002). The majority (86%) have majors in education. As Shallcross et al (2002) state, "trainees often lack… breadth in their own science education" (p.1293) and add that those who do have scientific knowledge, usually possess training in the biological sciences as opposed to physical or chemical. They also state that "many primary teachers and trainees hold scientific ideas which are closer to those of children than scientists" (p. 1293). Regarding background science knowledge, Harlen (2006) notes that "for some time it has been recognized that the teacher's knowledge of the subject matter is vital to primary pupils' opportunity to learn science" (p.1). The result of a scarcity of girls enrolling in sciences over the years (Arambula-Greenfield, et al., 1997), combined with the higher proportion of female teachers in elementary schools which is up to 80% in the U.S. (Lovinger, 1999), has also had an influence on the number of faculty with science backgrounds. Arambula-Greenfield (1997, p.1) adds that "…even females who like science often indicate a dislike for the traditional teaching methods that characterize high school and college science courses"

Once in the classroom, it is not simply a case of *possessing* the knowledge, but also its *application*. The vital importance of pedagogical knowledge needs to be brought into the equation (Summers et al, 2001) and there needs to be a balance between this and subject knowledge. Harlen and Holroyd (1995) found that "about a third of the teachers identified their own lack of background knowledge as a source of problems" (p.6). They also listed three levels of understanding of background knowledge, based on the depths of teachers' awareness of the "big ideas" within the areas they teach at school. These are ideas commonly understood by teachers, ideas less commonly understood, but where understanding is readily developed, and ideas not commonly understood and where understanding is difficult or time-consuming to develop. They found teachers varying widely between the levels, with many of those studied misunderstanding the ideas they were to trying develop in their pupils. This can cause difficulties for teachers in the classroom when expected results do not occur or equipment breaks down, negatively affecting self-efficacy. A lack of background knowledge can also affect how teachers organize, implement and deliver tasks. Kindergarten teachers' background knowledge of science was shown in research by Kallery & Psillos (2005) to be rather low and this again is linked to the fact that many elementary teachers are usually "generalists, without specialty… in either science content or pedagogy" (Akerson and McDuffie, 2002, p. 3).

There are positive correlations between levels of confidence with teaching science and understanding in the context of the subject (Kallery and Psillios, 2001), which points to science specialists feeling more at ease being able to draw responses from children as opposed to non-specialists who may not have the confidence to allow children free reign to explore concepts.

Lack of knowledge or poor attitudes to science can lead to problems in practice. One that may arise is the tendency for many teachers to teach as they themselves were taught (Volkmann, 2005), which often leads to simply telling the facts of science with little thought to the conceptual or procedural aspects of the sessions. Such issues are exacerbated in teaching inquiry-based science, which is far from the way in which most teachers were taught (Davis, 2005). At many schools, elementary faculty use prepared programs with kits in each class for each topic. Each kit has many areas where the need for teaching inquiry-based science is a key component. This can raise concerns with teachers. Volkmann et al (2005) noted the following issues relating to teaching inquiry-based sessions; (a) Teachers who don't share similar instructional goals, (b) Teachers becoming frustrated when children don't meet goals or develop inquiry skills, (c) Teacher difficulty in constructing activities, discussions and assessments to knowledge expansion, (d) Teachers' socio-emotional and cognitive challenges hindering children's progress and (e) Handling frustrations of students when they are asked to make evidence-based claims.

Furthermore, when leading the science lessons, many teachers often use such coping strategies as compensating for doing less low-confidence aspects of science by doing more of a higher confidence aspect (e.g., stressing the process aims in science rather than the concept development aims and doing more biology/nature study and less physical science or heavy reliance on kits, prescriptive texts and pupil work-cards). They may also place an emphasis on more expository teaching and underplaying discussion, or rely on an over-dependence on standard responses (e.g., 'good question – how would you find the answer?') to less understood content-related questions (Harlen and Holroyd, 1995).

In addition to this, a lack of knowledge often affects good practice when it limits a teacher's ability to anticipate the direction in which pupils' scientific learning might proceed (Shallcross et al, 2002) and be able to offer advice or extension activities. As Murcia (1999, p.1124) states "Teachers need to understand the nature of science so they can model appropriate behaviors and attitudes".

School Curriculum

Another factor affecting elementary school science teaching efficacy is the influence of the curriculum upon the classroom activities. It is often felt that the lack of a set national curriculum has hindered the progress of science within the U.S. system and this has caused science scores to fall behind many other countries; U.S students are given a broad, but thin education in comparison with many of their counterparts (Bybee and Stage, 2005). However, a set national curriculum, such as that legislated in the U.K., does allow elementary school teachers with non-science backgrounds to gain confidence through the necessity of *having* to teach (and therefore learn) stipulated subject areas (Lunn, 2002). Recent curricular innovations in the U.S. such as the mandated NCLB science in 2007 (U.S. Department of Education, 2007) may add to pressures upon teachers to change their practice, possibly decreasing self-efficacy. As Spillane et al, (2001, p.918) note

> The past decade has witnessed considerable efforts to improve the quality of science instruction in America's schools, with school reformers arguing that all students should do more intellectually rigorous science work. Raised expectations for students' academic work have increased the expectations for teachers' instructional practice, expectations that imply substantial changes for existing classroom pedagogy. National and state standards along with new assessment systems press teachers to revise their teaching. Because of the nature and magnitude of the reforms, most teachers struggle to understand their substance and their implications for practice

Teacher Education

The importance of teacher education relating to science teaching is referred to by the National Science Teachers Association (NSTA) (2007c, ¶1) who consider that "strong, performance-based science program and science teacher licensure standards to be essential for all science teachers…" Wingfield et al (2000) found that suitable site-based science teaching enhanced the feelings of self-efficacy of trainee teachers and which has implications for teacher training programs. Meyer et al (1998) note that after their first year, the quality of the science information new teachers gained had increased, which led to higher confidence levels and better teaching methodology within their classrooms. However, they did not report an increase in the *breadth* of science knowledge, rather an increase in the *depth* within certain areas of the subject. Thomas and Pederson (2003, p.1) state “Indications are that pre-service teachers beliefs, attitudes and practice may be linked to previous experiences”. They also highlight that trainee teachers learning a great deal through observing good science teaching practice, using them as frames of reference when they begin practice. Woolfolk Hoy and Kolter Hoy (2006) found that prospective teachers tended to increase in their personal sense of efficacy as a result of completing student teaching, and Wenglinsky & Silverstein (2006, p.26) add that “Many studies show a close correlation between student achievement in science and teacher preparation in science… Of the many steps needed to improve science education, none is more important than improving teacher training.”

Relating to self-efficacy, the need for a confident beginning to a new school teacher’s career is emphasized by Pontius (1998, p.3), who writes,

> Self-efficacy, or one’s belief in one’s abilities to perform a particular behavior, has implications for pre-service and beginnings teachers who may have had limited experience with students. Belief in one’s ability to teach or teach a particular subject can help fuel success in the first stages of a teaching career.

The first year of a teacher’s career is key to future confidence and success and there need to be adequate induction programs promoting collaboration with other classroom teachers (NSTA, 2007d). The encouragement of such collaboration is a major role of an instructional leader.

Professional Development

As knowledge and experience can increase confidence, thus professional development programs also have an influence upon elementary science teachers’ self-efficacy levels. Woolfolk Hoy and Kolter Hoy note “Any experience or training that

helps teachers succeed in the day-to-day tasks of teaching will give them a foundation for developing a sense of efficacy in their career" (2006, p.147). With regard to this aspect of education, Sparks and Hirsh (1997, p.1) state that "Reports issued by governmental bodies, business groups, and various commissions emphasize the central role staff development must play in school reform efforts". There is a great deal to be gained through in-service programs which emphasize hand-on, discovery-oriented science techniques (Arambula-Greenfield, et al., 1997, NSTA, 2007e). There is a need for professional development programs, but studies have suggested that it takes over 80 hours of focused professional development to provide teachers with levels of proficiency sufficient to improve students' learning outcomes (Nelson & Landel, 2006). Fulp (2002, p.8) noted that over 50% of the teachers interviewed in the 2000 N.S.S.M.E. Study (Weiss et al, 2001) had received professional development in the last three years,
It appears that these relate to mainly workshop-based study. When looking into which *areas* of science instruction the teachers received instruction, the N.S.S.M.E. study found a high level of technology being studied, but less of a push toward increasing science knowledge, which may have increased science self-efficacy. There is also a low level of inquiry being taught, going beyond knowledge, and relating to valuable pedagogy.

Elementary School Science Resources

Teacher efficacy is also affected by the provision of adequate resources and schools can draw from many textbooks and prepared science programs. In the 2000 N.S.S.M.E. study (Weiss et al, 2001), it appears that such kits and books were utilized in over 60% of elementary schools. Fulp (2002) adds that only 56% of elementary teachers rate materials "good" or better. There are certain packaged science programs, such as

FOSS and SciSS that can be of great value to teachers who are lacking in confidence when teaching science. These can enable more inquiry-based science occur within the elementary school classroom. As Bybee and Van Scotter (2006, p.46) state, “To understand science, students need to *do* science by participating in activities, completing projects, investigating questions, and discussing interactive readings”. These are key to good practice. As Leshner adds “The question is not only what qualifications the teacher has, but also what the teacher does in the classroom.” (Perkins-Gough, 2006, p.14).

Licensure Requirements

External requirements stipulated by the government also influence teachers’ confidence in class. These include the licensure requirements to begin the process of becoming an elementary school teacher, which do not stipulate a science background, as is stated on the U.S. Department of Labor website (2007) which notes “Almost all States require applicants for a teacher’s license to be tested for competency in basic skills, such as reading and writing, and in teaching.” With regard to this, Darling-Hammond (2000) in a study of 50 states found that the quality of teachers, as measured by whether a teacher was certified or had a major qualification in their teaching field, was associated with student performance. She added that “Among variables assessing teacher "quality," the percentage of teachers with full certification and a major in the field is a more powerful predictor of student achievement than teachers' education levels (e.g., master's degrees)” (2000, ¶112).

Other Factors

There are certain other factors which also have an influence upon teacher efficacy. These might come from within the school, such as classroom size, the design of classrooms and the school atmosphere, expectations, demographics, location (Leathwaite, 2005) and school culture (Bolman & Deal, 2006). A rural teacher and an urban teacher, for example, may possess differing levels of self-efficacy in the classroom (Jinks & Lord, 1990) and cultural differences may also be involved (Hofstede & Hofstede, 2005). A teacher could also be influenced by their own family background, whether their parents were themselves scientists, or whether they received encouragement from parents (Turner et al, 2004). The career stage of an elementary school teacher might also have an influence upon their self-efficacy (Tsannen-Moran & Woolfolk Hoy, 2002), as would the level of evaluation in place within the school (Leathwaite, 2005). Gender is also an influence (Riggs, 1991, Arambula-Greenfield, 1997), as is the guidance that new teachers are given when they begin in education and the levels of curriculum guidance and encouragement of differentiation within the classes. However, contradicting this, Tsannen-Moran & Woolfolk Hoy (2002) found little difference in efficacy beliefs based on gender, race or age.

One further factor that must be acknowledged is that the teacher might simply teach science well because they are intrinsically good teachers and spend time studying notes and background resources, which increase their self-efficacy in teaching science (McNally 2006). Such characteristics of effective teachers would include their knowledge, clarity and organization, planning for clarity, clarity during the lesson and warmth and enthusiasm (Woolfolk Hoy & Kolter Hoy, 2006).

Teachers' Classroom Practice

The factors affecting science teaching efficacy can influence the number of hours spent in the classroom teaching science. In considering the whole school day, the time spent on teaching science does not tend to be as high as language arts or mathematics (Fulp, 2002). The science teaching hours may rise following the introduction of the N.C.L.B. requirements, further affecting science teaching efficacy. Teachers also bring different styles of teaching into their science lessons, which Volkmann et al (2005, p.850) saw as three orientations; the didactic (transmit the facts), discovery (students discover targeted concepts) and guided inquiry (members of group share responsibility for understanding the physical world). Didactic methods would appear on reflection of the previous research to be chosen by those with lower science teaching efficacy. This method however, gives children less opportunity for discovery, which is where so much science learning occurs and may affect student motivation, which is key for effective teaching and learning (Woolfolk Hoy and Kolter Hoy, 2006). As McNally (2006, p.423) states “The case for more practical investigative science in the classroom is well established”. Current research suggests that only when students directly examine their own theories and directly confront the shortcomings do they truly understand the concepts (Hewson, et al. 1998), then conceptual change can occur. Good teaching is key, for as Saunders and Rivers (1996) in a study of fifth graders in Tennessee found, students are negatively affected by having several ineffective teachers for three or more years in a row. Students must go through six stages for this to occur: initial discomfort with their own ideas and beliefs, attempts to explain away inconsistencies between their theories and evidence presented to them, attempts to adjust measurements or observations to fit personal theories, doubt, vacillation and conceptual change (Nissani & Hoefler-Nissani, 1992, cited in Woolfolk Hoy and Kolter Hoy, 2006). The practice of such pedagogy relies on a degree of teaching ability, knowledge and confidence in the subject. As

Woolfolk Hoy and Kolter Hoy add "Constructivist approaches to mathematics and science emphasize deep understanding of concepts (as opposed to memorization), discussion and explanation, and exploration of students' implicit understandings" (2006, p.203).

There is also a requirement for a good deal of creativity in modern classrooms, allowing children to develop good critical thinking skills to lead them to develop techniques such as abstract thought where they can combine imagination with scientific methods to propose theories and draw conclusions (Murcia, 1999). However, as Posnanski (2005, ¶9) found in a study of Milwakee public elementary school teachers "…most teachers were not promoting teaching inquiry teaching – hands – on activities allowing the students to test their own ideas about scientific phenomena." In contrast, it appears that school principals are in support of "hands-on" or inquiry based science, which is often seen as best practice (National Research Council, 1996) as Nabors (1999) found when in a survey she discovered the majority of elementary principals are in favor of what she terms "hands-on" science.

In looking at the teaching methods employed by teachers, Fulp (2002, p.13) found that K-2 teachers spent much less time reading from books, listening and taking notes, and more time in sessions in a hands-on situation. In such "hands-on" science situations, it was noted that students were still more likely to be following specific teacher instructions than designing or implementing their own investigations. This suggests that even though best practice appears to be taking place, there are still factors affecting true investigative science in the elementary school.

Finally, looking at the situation of teacher self-efficacy within the whole school context, Tschannen-Moran & Woolfolk Hoy (2002, p.6) found that although there may be concerns, elementary school faculty do have comparatively higher scores regarding teaching efficacy than teachers of other ages. They note that

> Elementary teachers had the highest overall sense of efficacy among elementary, middle, and high school teachers. The strength of these efficacy beliefs was sustained across all three subscales. Elementary teachers were more confident in their capabilities to manage classroom behavior effectively than those who taught older students. The younger were the students being taught, the greater the efficacy to engage both very capable and struggling students, with elementary and preschool teachers demonstrating higher efficacy for *Student Engagement*. And elementary teachers had the greatest confidence across all levels that they knew and were able to implement appropriate *Instructional Strategies*.

This bodes well for future developments for elementary school teachers regarding improving science teaching efficacy through teacher education, in-service training, their influence upon other factors and finally, positive principal instructional leadership.

Good leadership has an influence at many levels of the school and the components of instructional leadership are seen as leading to best classroom practice in science teaching. A detailed study into the influence of principal instructional leadership upon elementary school teachers' science self-efficacy will add valuable data to the literature reviewed in this chapter.

Chapter 3: Methodology

Research Questions

The research in this study examines the relationship between K-5 elementary school teachers' perceptions of principal instructional leadership and their science teaching efficacy. The goal of the study is to understand the leadership experiences and background variables that might affect elementary school teachers' science self-efficacy. In this chapter, the research design, participants, data collection, data analysis, design flexibility and limitations are summarized.

The study addressed the following research questions:

1. What is the relationship between K-5 elementary school teachers' perceptions of principal instructional leadership and their science teaching efficacy?
2. What other variables affect elementary school K-5 teachers' perceptions of their science teaching efficacy?

Research Design

The study design utilized mixed methods and drew from both quantitative and qualitative methodology. As Creswell (2003, p. 4) states "To include only quantitative and qualitative methods falls short of the major approaches being used today in the social and human sciences". Surveys and interviews were utilized in the study. The survey was a simple descriptive (and correlational) design, useful for "describing the characteristics of a sample at one point in time” (Mertens, 1997). The semi-structured interviews allowed survey responses to be further analyzed and gave deeper interpretation to the meanings (Kvale, 1996).

Implementation was through a sequential explanatory strategy in two phases. In the initial phase, a questionnaire was used for the whole sample and the second phase involved a representative sample for interviews. Interview design was influenced by the survey data. The two methods were integrated in the interpretation phase of the study and priority in analysis was given to the quantitative data.

The Survey

The Science Teaching Efficacy Belief Instrument (STEBI), developed by Enochs and Riggs (1990) for the use with elementary school teachers. The scale was used to assess science teaching efficacy in the study (see Appendix A). The STEBI is designed specifically to investigate the science teaching efficacy beliefs of practicing elementary school classroom teachers. It consists of 25 questions, with responses ranging from strongly agree to strongly disagree. 13 items are designed to address teachers' level of belief that they can teach science (Personal Science Teaching Efficacy or PSTE) and 12 assess the respondents' belief that their teaching will have a positive effect on the students they are teaching (Science Teaching Outcome Expectancy or STOE). The instrument is a five-point Likert scale and high scores on the PSTE or STOE indicate a strong self-belief in the teacher's ability to teach science. Enochs and Riggs (1990) carried out a reliability analysis in which the PSTE produced an alpha coefficient of .92 and the STOE coefficient was .77. The STEBI-A and STEBI-B instruments have since been utilized by a number of researchers (Richardson and Liang, 2008). In this research, only the 13

PSTE questions were used, unchanged from the original instrument. As Enochs and Riggs (1990, p.633) state, “factor analysis clearly demonstrated that the scales measured two discrete and homogeneous constructs”, which supports the independent use of the PSTE construct within the research instrument for this survey.

The second survey scale consisted of the 18 items that explored the key aspects of instructional leadership in the respondents’ schools that were considered sources of science teaching efficacy. As Edmonds (1979) states, the lack of instructional leadership has been shown to be a cause of ineffective science teaching. In addition, Hoy and Woolfolk (1993) found teacher efficacy was enhanced by the influence of the principal and Fuller and Izu (1986) noted that when organizational beliefs, as outlined by the principal, matched the beliefs of teachers, this led to higher teacher efficacy. The rationale behind the choice of these questions is based in the work into instructional leadership of Hallinger and Murphy (1985), and the Principal Instructional Management Rating Scale which they developed and validated. The original instrument is a list of 71 items that allow for the analysis of what Hallinger and Murphy (1985) identified as the 10 key dimensions of instructional leadership. In 1987, Hallinger subsequently developed a 50 question version of the PIMRS. The instrument was analyzed for this research, and 18 questions focusing on the key aspects of instructional leadership were chosen. These questions retained a balance of the 10 factors in the 50 question survey (see Appendix B) and were chosen following consultation with practicing elementary school teachers. In order to focus some of the key questions to science, 6 PIMRS questions were altered to focus responses to science teaching. In addition, as this was not the full PIMRS survey (Hallinger, 1987), this section is termed “instructional leadership questions”.

The PIMRS is the most fully tested framework of instructional leadership (Hopkins, 2002), the one most used in empirical investigations (Hallinger, 2005) and is relevant because “Researchers who reviewed prior variations of instructional leadership definitions found that Hallinger and Murphy conceptualize instructional leadership comprehensively” (O’Donnell & White, 2005, p.58). The 10 factors of the instrument each achieved a reliability coefficient of at least .75 as a test of the instruments internal consistency (Hallinger and Murphy, 1985). This research tool has been central to over 110 empirical studies, which have moved from being purely used in the U.S. to use in North America, Europe and Australasia (Hallinger, 2005).

The trend in its use is highlighted below:

1983-1988 20 studies

1989-1994 41 studies

1995-2000 26 studies

2001-2005 29 studies

Hallinger (2005, p.228) adds “As the PIMRS instrument became more widely known, the availability of reliable instrumentation and the timeliness of the topic of instructional leadership generated many additional studies”. It is a popular and well trusted instrument.

The final 12 survey questions were designed to search for background sources of efficacy. Ramey-Gassert, et al. (1996) describe such background variables related to science teaching efficacy as science activities in and out of school, teacher preparation, and science teaching experiences. Research has also alluded to self-efficacy being influenced by background knowledge (Kallery and Psillios, 2001), teacher education (Meyer et al, 1998, Pontius, 1998, Wingfield et al, 2000, Plourde, 2002), in-service training (Arambula-Greenfield, et. al., 1997, Fulp 2002), and length of service (Ginns and Watters, 1999). Survey respondents were therefore asked to report their elementary school size, in-school organizational details relating to science and their own science background, gender, grade level teaching, years teaching and years working with their current principal.

All 43 survey questions are listed in Appendix C. The PSTE and instructional leadership questions consisted of 5-point Likert-style questions, with responses from Strongly Agree (5 pts), Agree (4 pts), Undecided (3 pts), Disagree (2 pts) to Strongly Disagree (1 pt). The "undecided" category was retained to maintain the integrity of the two instruments with the original PSTE and PIMRS instruments. On the survey, negatively worded items were included and scored in the opposite direction. The demographics section consisted of closed and semi-closed questions. In the final online "Survey Monkey" questionnaire, questions 1-13 were termed "Science Teaching Survey", and questions 14-31 termed "Leadership Survey" in order to put teachers at ease and avoid jargon.

The Interview

The questions on the interview schedule (see Appendix D) were designed to further analyze key areas of the teachers' perceptions of instructional leadership in their schools and add validity to the research through triangulation. There was also focus on other factors that had been shown in the literature review to be associated with differing levels of science teaching efficacy. Following survey response analysis, some alterations were made to the original list of questions after consultation with practicing elementary school teachers. As Kvale (1996, p.129) states "Each interview question can be evaluated with respect to both a thematic and dynamic dimension: thematically with regard to its relevance to the research theme, and dynamically with regard to the interpersonal relationship in the interview." This statement implies that valuable information beyond that of the survey could emerge to corroborate or enhance details, which was the case in this research. The questions were open in nature and funneled to focus on the key questions in the latter half of the interview.

Synthesis of Literature Review, Areas of Analysis and Instrument Question

Correlation between multiple sources from relevant literature and instrument design strengthened content validity. Table 3.1 illustrates the links between the areas of analysis, literature search, research question and research instrument question.

Table 3.1

Synthesis of Literature Review, Areas of Analysis and Instrument Question

Areas of analysis	Relevant Authors from Literature Review	Research Question	Survey Ques. No.	Interview Ques. No.
Personal Science Teaching Efficacy	Bandura (1977, 1982, 1997), Berman et. al. (1977) Gibson and Dembo (1984), Pontius (1998), Tschannen-Moran et. al. (1998), Enochs and Riggs (1990), de Laat and Watters (1995), Ross (1994), Henson (2001), Shallcross et. al. (2002), Tschannen-Moran & Woolfolk Hoy (2002), Bleicher (2004), Woolfolk Hoy & Kolter Hoy (2006)	1	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13	6, 7, 13
Instructional Leadership: Framing the School Goals	Edmonds (1979), Hallinger and Murphy (1985), Hallinger (2005), NSTA (2007)	1	14, 15	8, 9, 10
Instructional Leadership: communicating the school goals	Edmonds (1979), Hallinger and Murphy (1985), Hallinger (2005), NSTA (2007)	1	16	8, 9, 10
Instructional Leadership: supervising and evaluating instruction	Edmonds (1979), Hallinger and Murphy (1985), Hallinger (2005), Leithwaite (2005), Woolfolk Hoy & Kolter Hoy (2006), NSTA (2007)	1	17, 18, 19	8, 9, 10
Instructional Leadership: coordinating the curriculum	Edmonds (1979), Hallinger and Murphy (1985), Murcia (1999), Nabors (1999), Hallinger (2005), McNally (2006), NSTA (2007)	1	20, 21, 32, 33, 34	8, 9, 10
Instructional Leadership: monitoring student progress	Edmonds (1979), Hallinger and Murphy (1985), Hallinger (2005), NSTA (2007)	1	22, 23	8, 9, 10

Instructional Leadership: protecting instructional time	Edmonds (1979), Edmonds (1979), Hallinger and Murphy (1985), Hallinger (2005), NSTA (2007)	1	24, 25	8, 9, 10
Instructional Leadership: maintaining high visibility	Edmonds (1979), Hallinger and Murphy (1985), DuFour & Berkley (1995), Hallinger (2005), NSTA (2007)	1	26, 27	8, 9, 10
Instructional Leadership: providing incentives for teachers	Edmonds (1979), Hallinger and Murphy (1985), Hallinger (2005), NSTA (2007)	1	28, 29	8, 9, 10
Instructional Leadership: promoting professional development	Edmonds (1979), Hallinger and Murphy (1985), Arambula-Greenfield, et. al. (1997), Fulp (2002), Hallinger (2005), NSTA (2007)	1	30, 41	8, 9, 10, 11
Instructional Leadership: providing incentives for learning	Edmonds (1979), Hallinger and Murphy (1985), Hallinger (2005), NSTA (2007)	1	31	8, 9, 10
Science resources in school	Fulp (2000), Akerson and McDuffie (2002), Tschannen-Moran & Woolfolk Hoy (2002), Bybee & Stage (2005)	2	20, 21, 32, 33, 34	3
Teachers' own science experiences in education	Harlen & Holroyd (1995), Elsworth & Buss (2000), Weiss et. al. (2001), Akerson and McDuffie (2002), Plourde (2002), Fulp (2003), Davis (2005), Kallery & Psillos (2005), Volkman et. al. (2005), Harlen (2006), McNally (2006), U.S. Dept. of Education (2007)	2	35, 36	1, 2, 3, 4, 5, 6, 7
Experience in teacher training	Meyer (1998), Pontius (1998), Wingfield et. al. (2000), Shallcross et. al. (2002), Thomas & Pederson (2003)	2	35, 36	12
In-service training	DuFour & Berkley (1995), Arambula-Greenfield, et. al. (1997), Bredeson & Johnson (2000), Weiss et. al. (2001), Fulp (2002), Hallinger (2005), NSTA (2007)	2	41	11
Outside interests in science	Akerson and McDuffie (2002), Turner et. al. (2004)	2	35, 36	6
Years teaching in schools	Ginns & Watters (1999), Tschannen-Moran & Woolfolk Hoy (2002)	2	42, 43	
Gender	Riggs (1991), Arambula-Greenfield (1997), Tschannen-Moran & Woolfolk Hoy (2002)	2	37	
Grade level topics taught	Harlen & Holroyd (1995), Akerson and McDuffie (2002), Lunn (2002)	2	37	

Participants

The survey sample comprised the elementary divisions of schools from the nine international school regional associations who, following initial contact, allowed the research to proceed.

The regions surveyed were:

1. Mediterranean Association of International Schools (MAIS)
2. Near East South Asia Council of Overseas Schools (NESA)
3. East Asia Regional Council of Overseas Schools (EARCOS)
4. European Council of International Schools (ECIS)
5. Central and Eastern European Schools Association (CEESA)
6. The Association of American Schools of Central America (AASCA)
7. Association of Columbian and Caribbean American Schools (ACCAS)
8. Association of American Schools in Mexico (ASOMEX)
9. Association of International Schools in Africa (AISA)

Schools within these regions were chosen because association membership offers a degree of standardization within a global framework.

Data Collection

Initial Contact with Schools

Principals at the elementary schools in the above regions were contacted for ethical reasons and permission to conduct research in their schools was requested by email (see Appendix E). They were asked whether the teachers in their elementary schools taught their own science lessons. If a positive response to the research was returned, a follow-up cover letter was forwarded as an email by the principal to their faculty. This contained a secure link to the online survey instrument, and was a University of Minnesota URL, thus increasing response rate through associations of academic rigor and security. The email explained the survey process, assuring levels of confidentiality with responses and offering an opportunity to have access to the final survey results when completed (see Appendix F). If the elementary school teachers did not teach their own science, the survey did proceed in that school.

The Survey

Surveys were distributed and accessed through the internet and utilized the "Survey Monkey" online secure survey facility. Standard procedures in terms of advance notice of the survey and timely reminders were used to maximize the response rate. The following strengths of this method are cost-savings, ease of editing and analysis, faster transmission time, easy use of pre- letters, higher response rate, more candid responses, potentially quicker response time with wider magnitude of coverage (Colorado State University, 2007). This method was also seen as the most effective way to survey this population.

The Interview

Following survey analysis and revisions to interview schedules, faculty respondents were requested for interview through a third email forwarded by participating principals (see Appendix G). They took place both face-to-face and over the telephone and were digitally recorded with all data transcribed. Once analytical qualitative coding had grouped the interview factors, both sets of data were integrated. In this form of triangulation, weaknesses inherent with the qualitative method were offset by strengths in the quantitative method and vice-versa (Creswell & Plano Clark, 2007).

Data Analysis

With the quantitative data, correlation analysis was carried out on the survey responses to study the strength and direction of the relationship between variables by calculation of the Pearson product moment correlation. Regression analysis also analyzed the relationship between dependent and independent variables through calculation of coefficient of determination and beta weights. Reliability was checked through Cronbach's Alpha (α) to assess internal reliability within the instrument, ANOVA tests were performed on the Country of Origin data and t tests on the two-way comparisons.

Qualitative data was analyzed through a step-by-step process (Cresswell (2003). Transcribed data was read for a general sense of the information, and notes were made in margins. This was followed by coding and the placing of material under headings. Central themes were then identified and key quotes which enhanced quantitative data were highlighted.

Design Flexibility

There was flexibility within the design regarding the possibility of insufficient survey data. Every effort was made to ensure a sufficient response rate through initial contact, reminders and a user-friendly online survey interface. The wording of survey questions was non-complex and the number of questions was kept to a minimum to allow for easy, quick completion. Should this have fallen short, a second survey and email would have been sent in the following school year. Had responses been low, there was also the possibility of replicating the survey with U.S. based schools, where the issue of science assessment was more pertinent as it had been recently mandated in the NCLB proposals. These results could have been added to, or compared with the U.S. International school data. As sufficient data was received these alternatives were not required.

There was also the prospect that interviewees may have been unavailable or unwilling to participate, or there may have been issues with regard the process of the interviews. There were two periods of lost telephone recording due to poor reception, however, this was not an issue due to the large data from other interviews. Incomplete surveys were at times received, but these were at a minimum and a high response rate meant that this was a small factor. A final consideration of design flexibility was linked to possible areas of financial difficulty. The budget allocated allowed for sufficient financial cover, and the use of internet and associated technology considerably lowered costs. As Couper (2001) stated, "The Internet has truly democratized the survey-taking process".

Limitations

Reliability

The use of the internet for data collection could raise reliability issues. Dillman and Bowker (2001) note that coverage error, sampling error, measurement error and nonresponse error are particularly prevalent in internet-based surveys. However, the fact that faculty in the international schools to be surveyed would all have access to the Internet reduced such coverage error. With regard to sampling error, the whole population of the schools where research was permitted was surveyed. Measurement and non-response errors were reduced through prior contact with school principals which also encouraged a high return. Links with recognized international school regional associations and the University of Minnesota also increased return rates. Issues with layout, confidentiality and technical problems may have been present (Gunn, 2007), and this could have affected completion of surveys. There were some principals who expressed reservations about their faculty analyzing their performance. Research did not take place in these schools. Other principals also cited lack of faculty time as a reason for not allowing participation. Technological issues that occurred included emails to principals being blocked, but these were reduced through emailing principals directly or by using the individual school web sites. The university email address, being ".edu" also reduced the incidence of being blocked. Responses by principals back to the university email were increased by lifting all filters on the email account.

Another limitation relates to convenience sampling. This effect was reduced by initially contacting all association member schools worldwide, and by encouraging all K-5 Grade teachers to participate rather than focusing on one grade. There may have been issues of reliability relating to the analysis of the qualitative data. These were reduced through assistance from other researchers who checked coding strategies. With regard to such data, the researcher had grouped "science" and "non-science" courses for one of the items considered. As such there has had to be some subjectivity, but groupings were reviewed by peers. With regard to statistical significance, two items may be significant at the 0.01 level, but due to the large sample size, these have a relatively small size effect. This must, therefore, be considered when examining relationships from the quantitative analysis of this study..

Bias may have affected reliability with regard responses from this researcher's school, and response bias could have been heightened due to the fact that it may only be principals or teachers interested in the research interested who might initially have responded. The fact that all respondents were from international schools, where there is no statutory requirement to use a standardized science curriculum, also affects the degree to how far the information gained could be applied to US mainland schools who are using NCLB. Furthermore, western interview conventions are culturally specific (Melles, 2004), which needed to be considered in the interview component. In addition, the majority of the responses were from female teachers and this researcher, as a male, needed to be aware of gender bias. This was also a possible constraint of the literature review, as the field has been dominated by male writers (Southworth, 2002).

A further factor that may have affected reliability relates to measurements within this study of principal instructional leadership, which may have been diluted through some principals using more distributed instructional leadership models. MacNeill, et. al (2003, p.4) state that "A more realistic model of the instructional leadership needs to acknowledge that within schools there are multiple layers of instructional leadership, not just that ascribed to principals". The literature review revealed more instances of such distributive styles in recent years, and as MacNeill et. al (2003, p.5) add "A strong argument can be made that the facilitative instructional leadership of the mid 1990s, which empowers staff has superseded the top-down, principal driven model of instructional leadership of the 1990s". Thus a leader's score for some items may be associated as much with the science coordinator as with the principals themselves. Reliability may have been affected through the time a teacher has worked with a principal, although this was reduced by conducting both survey and interviews at the end of the school year. There was also the issue that science may have been taught in different ways in different schools, such as a PYP school using a different, perhaps more easily taught, method than a non-PYP school.

As Hallinger and Murphy (1985, p.218) wrote "managerial behavior is strongly influenced by organizational and societal contexts…. There is no reason to believe that instructional management differs in this respect". Thus, the contextual differences between the schools may be so great that drawing conclusions may be restrictive. Again, drawing only from accredited international schools has helped to reduce such limitations. Finally, as Southworth (2002, p.74) states "We cannot know what effective leadership means unless and until we include the stakeholders' perspectives and their constructions of leadership". There would have been further depth added by surveying the principals' own views of their leadership, however constraints of time did not permit this.

Validity

Construct validity was retained as the PSTE and PIMRS instruments had both been peer-reviewed since 1980 and 1987. Internal validity might have been affected through either the Hawthorne effect or by selection bias. Utilizing mixed methods and some forms of collaboration with colleagues and triangulation increased validity, and as response rates were high for this survey, statistical error issues were reduced.

Mertens (1997, p.105) notes, "the validity of the instrument is contingent on the honesty of the respondents". This, combined with the fact that some of the questions were based on the teachers' own perceptions of instructional leadership or efficacy, could have lead to issues of accuracy. Finally, some of the demographic questions required reflections back to a respondent's childhood, which could have also affected validity as "Memory has a way of making the past consistent with the present as people amend their ongoing autobiographies". (Josselson, 1987, p. 9). The above limitations to reliability and validity were all considered and reduced as far as possible as the research progressed.

Chapter 4: Results of the Study

Study Background

Research Questions

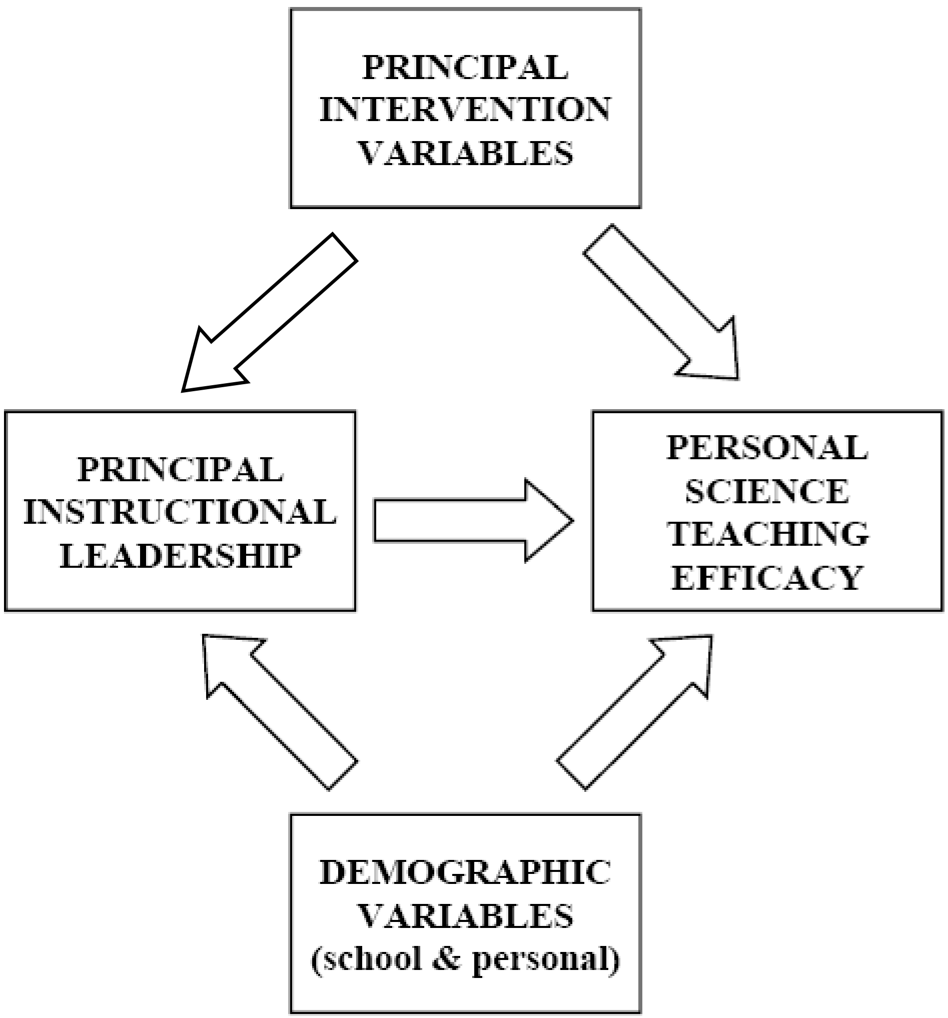
In this investigation, the research questions below framed the study of background literature and the development of study themes:

1. What is the relationship between K-5 elementary school teachers' perceptions of principal instructional leadership and their science teaching efficacy?
2. What other variables affect elementary school K-5 teachers' perceptions of their science teaching efficacy?

This chapter outlines data gathering techniques for survey and interview and highlights the faculty distribution among schools. It focuses on each research question in turn, beginning with research question one, the relationship between instructional leadership and PSTE. This section is followed by a focus on research question two, the relationship between background variables and PSTE. Finally, relationships are drawn between background variables and instructional leadership. With regard to research question two, the literature review led to the grouping of three background variables that have an influence upon K-5 elementary school teachers' perceptions of their personal science teaching efficacy. For the purpose of analysis, these are termed a) *principal intervention variables* (intervention variables deriving from the principal's instructional leadership), b) *school demographic variables* (school demographic variables beyond a principal's direct instructional leadership) and c) *personal democratic variables* (demographic variables personal to the respondents). It is valuable to at this stage to illustrate probable influences between the variables in diagrammatic form, as in the path model, Fig. 4.1.

Fig. 4.1

Path Model



At the model's core is the relationship between principal instructional leadership and personal science teaching efficacy. Fig 4.1 also illustrates the direction of influence the independent variables have upon the dependent variable of PSTE. These relationships will be focused upon in more detail at the end of this chapter as a path analysis, following calculation of beta coefficients.

Data Gathering Process

Data gathering began with the use of the University of Minnesota email system to contact elementary school principals at all schools within the 9 international school regional associations to request permission for a survey to take place (Appendix E). For ethical reasons, permission for research was sought from principals because a large portion involved questions about their own leadership styles. Gaining principal permission was also a method to legitimize the study in the eyes of participating schools' faculty and add a degree of personalization, which could increase response rates. 90 principals responded that they would permit the study. A follow-up email (Appendix F) was sent with an embedded link to a questionnaire on the Survey Monkey web site. Principals were requested to forward this to their elementary school faculty. This led to a total of 1,241 faculty receiving the option of taking part in the online survey. The survey was sent out at the end of the school year to allow all respondents to have worked with their principals for at least a full year. Regions with participating schools are broken down in Table 4.1:

Table 4.1

Distribution of Faculty in Survey

International School Regional Association	Schools in Survey	Faculty in Survey	School Number
Mediterranean Association of International Schools (MAIS)	4	55	1-4
Near East South Asia Council of Overseas Schools (NESA)	12	156	5-17
East Asia Regional Council of Overseas Schools (EARCOS)	32	503	18-49
European Council of International Schools (ECIS)	9	156	50-58
Central and Eastern European Schools Association (CEESA)	6	67	59-64
The Association of American Schools of Central America (AASCA)	1	10	65
Association of Columbian and Caribbean American Schools (ACCAS)	3	43	66-68
Association of American Schools in Mexico (ASOMEX)	1	22	69
Association of International Schools in Africa (AISA)	21	194	70-90
Total	90	1,241	

Individual elementary schools' faculty sizes are listed in Table 4.2

Data Analysis

The Survey

In the survey, the initial 13 questions focus on aspects of personal science teaching efficacy. These have been taken unaltered from the Personal Science Teaching Efficacy (PSTE) section of the Science Teaching Efficacy Belief Instrument (STEBI), developed by Enochs and Riggs (1990). These are followed by 18 questions focusing on the key aspects of instructional leadership, taken from the Principal Instructional Management Rating Scale (PIMRS) (Hallinger, 1987). The PIMRS questions have minor alterations to 6 questions to focus responses to science teaching, but the 18 questions retain a balance of the 10 factors in the original 50 question survey. These are followed by 12 questions in a demographics section which focus on background variables. These are principal intervention variables, personal demographic variables and school demographic variables. Once certain keyed questions had been recoded, the survey data was analyzed through SPSS 15 and Pearson correlations and beta weights were calculated between the 13 items of personal science teaching efficacy, the 18 items of instructional leadership and the background variables. For respondents who completed all of sections 1 or 2 of the survey, a PSTE and instructional leadership score was attained by finding the mean of their responses.

Response rates from the 1,241 in the survey (taken from lowest response for each item) was as follows:

- Responded and completed some aspect of survey: 356 respondents at 28.7%
- Completed PSTE section (initial 13 survey questions): 335 respondents at 27%
- Completed instructional leadership section (following 18 questions): 291 respondents at 23.4%
- Completed instructional leadership and PSTE with fully completed demographic (all 43 questions): 274 respondents at 22.2%.

Reliability analysis of the 18 questions forming the instructional leadership scale has produced a coefficient alpha of 0.94, and the 13 questions making up the PSTE scale produced a coefficient of 0.51 (see Appendices H and I). While Hair *et al.* (1998) suggest the values of 0.60 to 0.70 to be the lower limit of acceptability, this lower PSTE coefficient is within boundaries of Kehoe (1995) who stated that 0.5 was acceptable in a short (10-15 item) survey. However, in further analysis of the PSTE items, it was noted that an increase in alpha would come by deleting the item “I know the steps necessary to teach science concepts effectively”. This would raise the alpha to .61. The additional removal of the item “I understand science concepts well enough to be effective in teaching elementary science” would further raise the alpha to .69. Other deletions would not significantly raise the alpha. Cortina (1993) noted the importance of taking the number of measure items into account when evaluating what constitutes acceptable levels of coefficient alpha. Supporting this, Fields (2002, p.xix) states

> Measures with more items will yield higher coefficient alpha values than measures with fewer items, other things being equal. Thus, scales with fewer items are preferable to scales with many items given comparable alpha values and construct validity estimates.

Running new statistical analyses on the new overall averages for PSTE through SPSS without these two items revealed no significant change in the Pearson Correlations. For example, in Table 4.3 (below), Instructional Leadership Average became .209 from .211, however these did not alter at 2 significant figures, remaining at .21. In addition, in Table 4.4, items such as “Discusses goals at faculty meetings” moved from .230 to .228 and “Science coordinator designated for grade” (.220 to .216) also remained the same at 2 significant figures. Further new calculations of values of individual instructional leadership items also revealed insignificant or no changes on the new PSTE averages without these two items. The items “I know the steps necessary to teach science concepts effectively”, and “I understand science concepts well enough to be effective in teaching elementary science” were therefore removed and the revised data was reworked in SPSS.

The Interviews

An interview schedule was designed and adapted based on survey responses. A third email was then sent to the principals of the 90 schools in the survey to request interview participants (Appendix G). This had a link to the University of Minnesota email and principals were requested to forward this to faculty. 20 positive interview responses were received. Due to lack of availability or poor communication links, only 17 respondents were interviewed. The 14 interview questions (see Appendix D) and responses were recorded on a digital voice recorder and transcribed. Key themes were found between the interviewees, and pertinent quotes within themes were highlighted. Background details of interviewees are listed in Table 4.2:

Table 4.2

Interviewee Background Details

Interviewee Number	School Number	ES Size	Grade	Years with Principal	Years in Education	Gender	Country of Origin
1	5	650	2nd	2	12	Female	US
2	5	650	5th	1	13	Female	US
3	5	650	4th	2	14	Female	US
4	58	400	N/R	3	15	Female	US
5	5	650	2nd	2	13	Male	US
6	10	500	1st	2	12	Female	US
7	41	55	4th	1	N/R	Female	US
8	44	1,092	3rd	2	16	Female	US
9	52	600	5th	1	7	Female	US
10	62	500	2nd	2	10	Female	US
11	62	500	4th	2	9	Female	US
12	26	800	3rd	2	12	Male	US
13	28	580	N/R	1	20	Female	US
14	14	30	K	2	31	Female	US
15	8	300	2nd	1	12	Female	US
16	8	300	4th	1	20	Female	India
17	52	600	K-5	2	8	Female	US

N/R: No response decipherable

Survey results were analyzed alongside interview questions to increase triangulation. The survey data is presented below with embedded supporting interview quotes. At the end of the research question sections, related themes from the 17 interviews are outlined.

Research Question One

What is the relationship between K-5 elementary school teachers' perceptions of principal instructional leadership and their science teaching efficacy?

The relationship between Instructional Leadership and PSTE

Analysis of fully completed surveys revealed a Pearson correlation of .21 between the independent variable of the teachers' instructional leadership scores and the dependent variable of teachers' PSTE scores. The relationship is significant at the 0.01 level as shown in Table 4.3:

Table 4.3

Variables: Average of all Instructional Leadership Items and Average of all PSTE Items

Variable	Pearson Correlation	Mean Faculty Member Score	Standard Deviation	Freq.
Instructional Leadership Average (Independent Variable)	.21**	3	0.87	291
PSTE Average (Dependent Variable)	.21**	3.81	0.64	291

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

At 3.81, the overall mean scores for the PSTE reveals a higher than average overall personal science teaching efficacy score. The respondents also score 3 as a mean of the instructional leadership items as they apply to their principals. There are variations within these two scores, which will be analyzed in the following section.

Certain themes are common to the 17 interviews which emerge relating to this aspect of research question 1. The responses support a positive relationship between principal instructional leadership and teachers' PSTE levels. Interviewees mention the following themes as central to how school leadership could raise PSTE levels; the ability of a principal to promote professional development, to use scheduling which would allow for collaboration, to set agreed science goals, hire faculty with science backgrounds, to become more involved with both in-school and extra-curricular science activities.

Dimensions of Relationship with Instructional Leadership to Teachers' PSTE Scores

The dimensions of the instructional leadership relationship with teachers' PSTE scores can be analyzed to add depth to research question 1. The following data emerged regarding correlations between the 18 survey items of the instructional leadership scale and teachers' PSTE:

Table 4.4

Ranking of Pearson Correlation for Instructional Leadership Items to PSTE Averages

Rank	Independent Variable	Pearson Corr.	Standard Dev.	Freq.
	Breakdown of Instructional Leadership Items:			
1	Discusses goals at faculty meetings	.23**	0.61	291
2	Science coordinator designated for grade	.22**	0.62	291
3	Participates in science curriculum material review	.21**	0.63	291
4	Supports faculty recognition of student progress	.18**	0.63	291
5	Encourages new skills and concepts	.17**	0.63	291
6	Meets with teachers to discuss student science progress	.15**	0.63	291
7	Uses assessments to see progress to science goals	.14**	0.64	291
8	Develops easily understood goals	.15**	0.63	291
9	Feedback illuminates strengths/weaknesses in science	.13*	0.63	291
10	Reviews student work in evaluation	.14*	0.63	291
11	Classroom discussions of student or faculty issues	.13*	0.64	291
12	Leads or attends instructional in-service	.14*	0.64	291
13	Protects instructional time of faculty	.13*	0.64	291
14	Informal observations of science lessons	.11*	0.63	291
15	Uses data for goal setting	.10	0.63	291
16	Compliments teachers privately on performance	.10	0.64	291
17	Rewards faculty with recognition in files	.09	0.64	291
18	Talks informally with faculty and students	.07	0.64	291

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

The correlations in Table 4.4 are analyzed below in order of significance. Interview themes central to the research question are highlighted at the end of the section.

Significant Correlations at the .01 Level. A key link to higher PSTE scores emerged, which related to “goals”. The focus on goals is linked to 3 of the most significantly correlating items at the .01 level. The highest correlation, *Discusses goals at faculty meetings* (.23) is a sign of leadership giving a clear direction, which can lead to improvements in all aspects of a school’s curriculum. It is also notable that 4 of the above items are among the 6 that are directly related to science. This suggests that a focus on science can lead to higher levels of personal science teaching efficacy. Relating to goals, one interviewee states:

> I think certainly facilitating discussion among teachers, to have the staff talk and come to some talk in a way that we can come together and understand what is a science goal. A goal to teaching science. To focus on methodology, what is appropriate, what is our goal. And that’s a conversation that I feel is particularly lacking in science…. what is the goal, and materials that can support that, that are geared to supporting that goal.

There is also a significant correlation between high PSTE scores and schools having *a science coordinator designated for grade* (.22). One interviewee notes “There needs to be some guidance from the principal or a coordinator in terms of making teachers knowledgeable about what expectations are from school about what they are teaching”

A principal who *participates in science curriculum material review* (.21) also correlates with high PSTE scores. In interviews, it was often suggested that attendance in science meetings was not always taken on by principals, but a more distributed form of instructional leadership may be present. For example, an interviewee said that:

> I know that my assistant principal…she is on the vertical team with us. We are on the curriculum team and I am on the science committee and she comes in and I know she takes ideas back.

A second interviewee refers to leaders allowing teams common discussion time by stating that their principal:

> …is more of a leader and encourages teams to collaborate and cooperate and work together. And I think that those teams take that to heart. We also discuss the learning and teaching of kids and I think that you are not only expected as a team to discuss how kids learn with reading and writing skills… but also with science and where you are in science and what you might be doing and we do that sometimes as a team as well. You know…we talk about where we are and what lessons have we worked on.

These two science-related items illustrate how offering good support and allowing teams common planning time can influence teacher PSTE. This can also influence classroom practice.

The items *discusses goals at faculty meetings*, *supports faculty recognition of student progress* (.18) and *encourages new skills and concepts* (.16) are wide-reaching traits of instructional leadership and these will support faculty members who are trained and able to adapt to teaching science well, as they would for other subjects. The positive effect of good basic pedagogy, even without background knowledge is mentioned by an interviewee who states:

I definitely do not feel qualified for the content. I really don't have it down. I'm using the science notebooks, doing labs, the vocab and stuff. But the kids ask really amazing questions and a lot of the times, I don't have a clue which is kind of OK because it's science and I can put it back in their hands and have them…. but I do not feel confident about my own science content knowledge

These final two items also suggest a leader who is in touch with not only the direction of curriculum development, but also faculty needs.

Significant Correlations at the .05 Level. Significant correlations with high PSTE levels were noted for *feedback illuminates strengths/weaknesses in science* (.13), *classroom discussions of student or faculty issues* (.13), and *reviews student work in evaluation* (.14). This suggests that instructional leaders who spend time in the classroom give the support needed to raise levels of PSTE. This might also be seen in self-efficacy levels of the same respondents, relating to other aspects of the curriculum. *Leads or attends instructional in-service* (.14) is also correlated to higher PSTE, suggesting again, a principal who is in touch. This interviewee mentions the time factor in both carrying out lessons and preparation:

…it's just back to that the getting the materials together issue…you know…having enough time to do the prep…and…sometimes if I feel like I haven't had enough time to prep perfectly then it is hard to feel as confident as going into it like you have to…dance a little faster.

While another adds:

I think the least (enjoyable) thing is the time. Just because (science) seems to always fall through the crack that it is not the most important thing to get done. If

> I have to stop something that day, I might drop off Math or Reading…no…it would be the Science

A third interviewee notes that “Time is a huge factor in our school” and while another states “Um, I don’t know if you’ve noticed in the international schools, our time is very limited, compared to American schools.”

A significant correlation at the .05 level between PSTE scores and *protects instructional time of faculty* (.13) supports this. Another area of significance at .05 level occurs with the item *formal observations of science lessons* (.11). Principals who can spend time visiting classes, are more adept at giving support in all aspects of the curriculum. However, it appears it is often difficult for such visitation time to be made available. As this interviewee states,

> normally science is done in the afternoon and most principals plan their schedules to come, to observe the teachers…I believe…during the morning parts because by afternoon they got discipline issues, they already have committees or meetings set up and so I feel like they try to hitch what they feel is the important time to evaluate.

The above quote shows how creative scheduling is a key component, in the eyes of the elementary teachers interviewed, of good leadership.

Other Correlations. A less significant, yet still positive, Pearson correlation was found between the PSTE averages and *uses data for goal setting* (.10). This could suggest that the data assists in planning science sessions, leading to higher PSTE levels. However, science data is not always a priority, as is mentioned by this interviewee who states, “Most schools have a literacy component or a math component and I think those are very highly structured. Reading tests and math tests. I don’t see many science tests.”

The final three items, *compliments teachers privately on performance* (.10), *rewards faculty with recognition in files* (.09) and *talks informally with faculty and students* (.06) have no direct focus on science teaching and are more associated with personal relations, rather than the curriculum. This, in itself, can raise levels of confidence in general teaching ability, which could raise PSTE levels. It is through casual discussion that issues and concerns may be raised, and this could avoid the scenario outlined by this interviewee:

> I think that the teachers aren’t teaching science as much as they would like to think they are supposed to be. For instance in our units that are labeled as science units, some teachers tend to everything but some of the experiments because they don’t want to do the hands on things and so therefore, they are reluctant and save it to the last minute and don’t get around to it. I think some people feel inadequate in their science background or in their way to teach procedures or help kids nail into the material.

Mean Scores for Instructional Leadership Items

Ranking and analysis of the mean scores for each item further illuminates research question 1. The scores in Table 4.5 show that the higher correlating items are not the most commonly observed instructional leadership items in the view of the faculty members surveyed:

Table 4.5

Ranking of Mean Instructional Leadership Item Scores

Rank	Independent Variable Breakdown of Instructional Leadership Items:	Mean I. L. Score
1	Encourages new skills and concepts	3.74
2	Leads or attends instructional in-service	3.68
3	Discusses goals at faculty meetings	3.53
4	Protects instructional time of faculty	3.51
5	Compliments teachers privately on performance	3.48
6	Talks informally with faculty and students	3.45
7	Supports faculty recognition of student progress	3.44
8	Develops easily understood goals	3.41
9	Uses data for goal setting	3.09
10	Classroom discussions of student or faculty issues	3.02
11	Science coordinator designated for grade	2.99
12	Rewards faculty with recognition in files	2.92
13	Participates in science curriculum material review	2.76
14	Reviews student work in evaluation	2.64
15	Uses assessments to see progress to science goals	2.09
16	Feedback illuminates strengths/weaknesses in science	2.03
17	Informal observations of science lessons	1.96
18	Meets with teachers to discuss student science progress	1.76

Certain items listed above, such as *meets with teachers to discuss student science progress*, *participates in science curriculum material review*, *science coordinator designated for each grade* and *uses assessments to see progress to science goals* score low in the overall averages. Considering these items correlate significantly at the .01 level with higher PSTE scores these could, if focused on by a principal, have a great effect on raising faculty PSTE scores. These low scoring science-based items may also relate to low confidence of principals in the subject. One interviewee speaks of her principal, who “is worried about what parents are asking us about our science program because it’s not necessarily his strength or what he is most comfortable with. That’s why I feel the leadership is not quite strong in the area of science.”

The above four items, which were altered from the original PIMRS questions to tie the instructional leadership questions to science, rank in the lower end of all the items. An apparent low priority for science is suggested by one interviewee, who stated that:

> while we all know that science is important, there is the feeling that we have to be able to read write and do math….so much of our energy and professional development and leadership energy is making sure we are doing those very well. And I think science really just ends up taking a back seat.

In a similar vein another interviewee notes:

> I would think, one it would depend on the grade asked. …language arts and math in certain grades science is not as important, if the kids can't read and do math, you and I know both that it's very important. Then I think because the children have had so much language arts they need more time for language arts.

In relating the observed low priority toward professional development, she adds that "the elementary school and the elementary principal have a lot of pressure on them to really make sure that the teachers are experts at reading, writing and math and not necessarily science." There is also the fact that in international schools, language is seen as a priority. Another interviewee says "I think our focus is a lot on language and math….science is not dealt with as it should be in the US, and there is more focus on language, art and even social studies than science."

The top 8 items in the mean scores of Table 4.5 appear significantly higher than others, and of these, *discusses goals at faculty meetings*, *supports faculty recognition of student progress*, *encourages new skills and concepts* and *develops easily understood goals* also had significant correlations at the .01 level with high PSTE scores. Thus, good principals mentioned in the survey are currently influencing PSTE through best instructional leadership practice as well as through focusing on purely science goals. This interviewee indicated the wider aspects of instructional leadership in stating that:

> ….if you also look at an instructional leader, which we have here, (they) will bring science up indirectly, which I think a lot of teachers don't see and they don't see the indirect relationship between a great instructional leader and how it improves all the areas of instruction. Not just reading, writing, and math but how…what they are doing in those exercises and all the work they are pulling into reading and writing carries over into science as well.

Interview Themes for Research Question 1

Central themes from the interviews which are linked to this section of research question 1 include increasing the assessment of science and utilizing better resources and support staff. Working with a strong program (FOSS was mentioned many times) and working with a specialist are also areas that a leader could focus on to raise PSTE levels. Many interviewees cite prepared kits as their reason for having some degree of confidence in teaching science. With regard to the principals' choice in curricular models, the adoption of the International Baccalaureate Primary Years Program (PYP*)* is often raised. In this program, science is more integrated, thus not allowing for kits to be readily used, are often mentioned as restricting growth of science programs and this can lead to reducing levels of confidence. PYP is a popular program in international schools, but as many interviewees state, it also relies on a high degree of background knowledge during unit design. This can lessen science curricular content if a teacher designing a unit is less confident. Elementary school teachers also feel that their principals can do more to make time available for the preparation and teaching of science.

It was stated in more than one interview that elementary school principals' priorities would always be reading, writing, and math. Furthermore, a lack of science background and confidence of principals was mentioned as a reason for science not being seen as a priority. It is also notable that over half those interviewed suggest they had never received any guidance in science from their principals, though some did have science coordinators in middle management positions. The majority of the interviewees also state they had have had no science professional development in their schools, but significantly, professional development is often cited as a solution to raising levels of confidence in science teaching. Interviewees also mention that there is less professional development in international schools than in the US because their school's parents do not push for it and that there are also fewer universities nearby to offer training in US curriculum for international school faculty.

Research Question 2

What other variables affect elementary school K-5 teachers' perceptions of their science teaching efficacy?

Research question 2 is analyzed with PSTE as dependent variable, and secondly with principal instructional leadership as the dependent variable. In both cases, the background variables of principal intervention, personal demographics and school demographics are considered in turn as independent variables.

Relationship Between Background Variables and PSTE Scores

Table 4.6 shows the ranking for Pearson correlations between PSTE scores as dependent variables and demographic items as independent variables.

Table 4.6

Ranked Pearson Correlations for Background Variables and PSTE Scores

Independent Variable	Pearson Correlation	Standard Deviation	Significance (p value)	Freq.	Background Variable Type
Science Major or Minor	.27**	0.62	.00	303	Personal
Science Kit in School	.16**	0.64	.00	306	Principal
Coordinator in Grade	.14*	0.64	.00	308	Principal
Coordinator in School	.11*	0.64	.00	308	Principal
Gender	.11	0.64	.00	306	Personal
Science In-service Days	.08	0.64	-	296	Principal
Science req. for College	.06	0.64	.00	307	Personal
Years With Principal	.04	0.64	-	304	School
Years in Education	.02	0.64	-	306	Personal
Grade Currently Teaching	.02	0.65	-	276	School
Elementary School Size	-.01	0.64	-	283	School

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

There is also a valuable perspective to be gained from integrating data from the average PSTE scores for the above items. Table 4.7 below lists the two way responses, where a yes/no answer was requested.

Table 4.7

Average PSTE Scores for Two-Way Comparisons

	PSTE Ave.		Frequency		Valid %		St. Dev.		Sig.:
Demographic Factor	Yes	No	Yes	No	Yes	No	Yes	No	P val.
Science Kit in School?	3.92	3.72	159	147	52	48	0.63	0.64	0.00
Coordinator in Grade?	4.0	3.76	237	71	76.9	23.1	0.62	0.64	0.00
Coordinator in School?	3.90	3.75	192	116	62.3	37.7	0.57	0.68	0.00
Science Major or Minor at College?	4.41	3.73	253	50	83.5	16.5	0.57	0.37	0.00
Science Required for College?	3.84	3.75	117	190	38.1	61.9	0.63	0.66	0.00

Reliability of the above responses was checked through a T Test, and all showed a p value of 0.00. As $p < .05$, one can reject the null hypothesis, strengthening the evidence of the data for this sample. Analysis of the background variables is presented below in three sections; principal intervention variables, personal demographic variables and school demographic variables.

Principal Intervention Variables. The presence of a *science kit in school* (.16) is the most statistically significant item correlating with high faculty PSTE scores that is associated with principal intervention. The presence of a science kit is a key area where a principal can have an influence, either by its introduction or continuation of use. As one interviewee stated, "Well, I only ever use FOSS and I love FOSS, because everything is there. I don't have to go shopping; I don't have to look through a house to find things. I just…it's all there for me." The possible lack of variety in kits, however, is raised by another interviewee:

> Well…these FOSS kits we are using is the first time I have ever used a prepared kit and I was…I have to be honest, when we started last year, it was like arrgghh, it's going to be so canned; there won't be any room for…you know…and it needed a lot of exploration. But I really loved it actually. They are good.

Most of the kits mentioned in the interview are "FOSS" kits (Full Option Science System), which are popular in international schools. Table 4.7 (above) illustrated that over half the schools utilize some form of science kit and that their presence does appear to increase the mean PSTE scores. These prepared sets seem to give support to teachers of all levels. A third interviewee added that her confidence was increased by using the kits, and that “Of course I could expand on the labs they gave... Better than researching ones of my own, like on the internet. I don’t have time.”

There is also a statistically significant correlation, though at the lower .05 level, between having a *science coordinator in each grade* (.14) and high PSTE scores. The presence of an expert for support appears to be a boost for some of those interviewed. One interviewee stated that:

> I think we need more support with our kits. More…just…someone who has more of a science background and understanding and then who puts together these kits and who…when you tell them you need something or when you need a resource they understand the link and the relationship between what you are teaching and the thing you need instead of the disconnect.

Utilizing a subject specific coordinator is an area many principals try to focus on to aid in disseminating leadership, and is supported by the averages in Table 4.7

Similar survey responses are recorded for having a *coordinator for science in the school* (.11). Table 4.7 also shows notable differences between the PSTE averages. Data analysis reveals that the presence of a school-wide coordinator is more common, with 62% of schools using one. The higher levels of correlation to this choice of middle management suggest that if more elementary schools introduced a grade level science specialist, PSTE scores could rise.

With a Pearson correlation of .08, a higher *number of science in-service days* has a positive correlation with higher PSTE scores, but not at a significant level. This again is a key area where a principal may have an influence through booking science specialists to speak with faculty. The Table 4.8 shows that while the large majority of schools surveyed had had no science in-service days since the survey participants arrived to teach there, those schools which do, tend to have slightly higher PSTE averages:

Table 4.8

Average PSTE Scores for Numbers of In-service Days Respondents attended at their Schools

Science In-service days at current school	PSTE Average	Frequency	Valid Percent	Standard Deviation
0	3.77	211	71.3%	0.65
1	3.64	25	8.4%	0.73
2	4.11	21	7.1%	0.59
3	3.85	16	5.4%	0.58
4	3.69	7	2.4%	0.49
5	3.70	7	2.4%	0.44
6	3.97	6	2.0%	0.50
7	4.55	1	.3%	-
8	3.82	1	.3%	-
9	4.45	1	.3%	-

Science in-service was seen as a positive by most interviewees. This interviewee draws a link between science teaching and professional development, noting “I think the leadership style we have here strongly promotes professional development and…and…those two feed down to student achievement in different curricular areas.” However, a typical response came from a second interviewee, who said “in this particular school, we’ve had a lot of professional development in general topics, teaching in general, but not science in particular. In past schools, I don’t think I’ve ever gone to a science in-service training.” The value of professional development in elementary school science is highlighted by another interviewee who says “I think good professional development would be a good start to raise comfort levels, to get teachers doing actual experiments to show that it’s fun and that it’s not something that takes time, cleanup or how to organize the lessons." Another interviewee states that confidence in a changing subject such as science relates to the following:

> I honestly think the big part of it is the ongoing professional development because there is a social perception that it's a high tech world and it's always changing and you go to stay on top of it and so I think to be a good science teacher you need to also be taking…trying to stay on top of it and so these professional development processes would definitely help that.

The above areas all highlight variables that the principal, through leadership, can influence. The second area of background variables analyzed is linked to variables of personal demographics.

Personal Demographic Variables. The most significant correlation between all background variables and teachers' personal science teaching efficacy relates to whether teachers had a *science major or minor* at college (.27). There is also a marked difference in the PSTE levels of those teachers who did and did not have a science major or minor (see Table 4.7). While the survey respondents may have all received some science training at college, it seems that the background of the major or minor studies is a crucial factor in later confidence. As this interviewee states, teacher confidence was linked to…

> …their background knowledge. Some people know more about science than other and some people are just more sciency than others. I am more of a linguist and I'd rather teach reading and writing but other people are more sciency. They are the ones who have more confidence.

Another interviewee brought together knowledge and training in stating "I took one class in how to teach science. It was an intensive course over the summer…was one month course…and…it was…an excellent class but I am just…am lacking in background knowledge." This suggests that the professional development might have been supportive, but not with regard to increasing knowledge. As the previous interviewee mentioned, perhaps some teachers are simply more "sciency", and PSTE is not as greatly affected by principal instructional leadership as it is by other, background variables. This is further analyzed through regression in the path analysis diagram.

A third interviewee adds, "I think my college education was wonderful. I went to a school in the States. Like I said I had a science scholarship, so I had to have one science class a semester". Another interviewee adds that:

> In general I'm fairly strong. I took quite a bit of biology over the years., physics and physical sciences were my strongest, I did tutor during college. I would say, um, as far as understanding science and how to go about scientific exploration, I feel fairly comfortable

This final interviewee recalls college science training to experience in school in stating "I don't think that anyone comes out of college very prepared….the more you teach it the more confident you become."

The breakdown of the most familiar major or minor subject choices at college also suggests that science backgrounds lead to higher PSTE scores (see Appendices J and K). It is also interesting to note in Appendix H that the most common college majors were Elementary Education (35%), Education (14%), Psychology (5%) and History (4%); none of which might be considered a science major. This might support a belief that elementary school teachers do not tend to be science specialists. There are mainly positive interview responses regarding the standard of science courses in teacher education. One interviewee covers typical responses, in stating that she "…had one science class. They introduced us to FOSS, and it introduced us to inquiry and although science wasn't "my thing" it did, it was really well taught and did give me the basis of inquiry."

Another area where there was a positive correlation is linked to the *gender* of the participants (.11). This indicates a correlation between male teachers and higher PSTE scores. The averages are illustrated in Table 4.9:

Table 4.9

Average PSTE Scores for Gender of Respondents

	PSTE Ave.		Frequency		Valid %		St. Dev.		Sig.:
Demographic Factor	Fem.	Male	Fem.	Male	Fem.	Male	Fem.	Male	P val.
Gender	3.77	3.96	253	53	82.7	17.3	0.64	0.63	0.00

The differences between male and female respondents seen in both correlation and averages tables could be related to perceived confidence levels between genders, or the fact that more males choose to study science subjects, thus entering schools with higher confidence levels in the subject.

There is a low positive correlation between *science required for college* entrance (.06) and higher PSTE scores. Table 4.7 reveals a slightly higher average score for those who needed science to enter college, but it is notable that for the large majority of the teachers surveyed, science was not a requirement for college. If this were a requirement, perhaps PSTE scores would rise.

There are also slight positive correlations, though not significant, between PSTE and *years in education* (.02) (see the Appendix J). The value of experience in teaching was mentioned by this interviewee:

> Over the years I have gained a lot of confidence. I have been teaching the fourth grade for about five years now. So I am very confident but if I move to any other grade I will have to equip myself in terms of knowledge and experience it, learning myself.

A second interviewee notes:

> I would say confidence both comes from experience, having had experience with science, and also having support of either materials that make sense to them and support their own understanding, or that supports their thinking about process how students develop scientific thinking.

This illustrates the value of experience when looking for better ways to teach. Adding to this, another interviewee notes that "To me it really comes down to experience and training…. Training and field experience." and adds "I do feel very confident when teaching science because of practice, I think."

A final area of study relating to personal demographics is the respondents' *country of origin*. Respondents originate from 31 different countries (see Appendix K). The ranked list in Table 4.10 focuses on countries represented by 5 or more respondents.

Table 4.10

Ranked Average PSTE Scores for Respondents' Countries of Origin

Country of origin	PSTE Average	Frequency (n>5)	Valid Percent	Standard Deviation
Philippines	4.13	6	1.9%	0.39
India	3.90	5	1.6%	0.37
UK	3.80	17	5.5%	0.54
US	3.79	195	63.1%	0.66
Canada	3.79	20	6.5%	0.72
Australia	3.68	19	6.1%	0.43
New Zealand	3.55	9	2.9%	0.85
Mexico	3.51	6	1.9%	0.55

ANOVA tests on this data revealed a p value of .554. As $p < .05$, one cannot reject the null hypothesis

This shows that while the vast majority of those surveyed are from the U.S. (63%), the U.S. respondents still averaged well over the "median" score of 3 on the total PSTE scores. This suggests a good overall level of confidence. National traits may have affected the data as some respondents may draw from cultural traits, leading to them appearing more or less confident in responses.

*School Demographic Variables***.** There is a low correlation between *years with principal* (.04) and PSTE, which could suggest that the longer a person has been working with the principal, they are more confident, and the leader is more in tune with their needs with regard to science (see Appendix L) A very low correlation of .02 was found with the *grade currently teaching* (see Appendix M), which links teaching higher grades and higher PSTE scores. This may have a connection with science being taught as a separate subject in many of the higher elementary school grades, which leads to slightly more specialization. Furthermore, with regard to elementary *school size,* (-.01) smaller elementary schools were seen to have a very low correlation to higher PSTE scores, which could be tied to the availability of resources or support staff being more on hand to assist (see Appendix N).

Relationship between Background Variables and Instructional Leadership Scores

Table 4.11 shows the relationship between instructional leadership as the dependent variable and the demographic items as the independent variables.

Table 4.11

Pearson Correlations for Background Variables and Instructional Leadership Scores

Independent Variable	Pearson Corr.	Standard Dev.	Freq.	Background Variable Type
Coordinator in Grade	.25**	0.43	291	Principal Intervention
Coordinator in School	.24**	0.48	291	Principal Intervention
Science Kit in School	.20**	0.50	291	Principal Intervention
Science In-service Days	.19**	1.5	291	Principal Intervention
Years in Education	.17**	9.80	291	Personal Demographic
Elementary School Size	-.12*	2.5	283	School Demographic
Science Major or Minor	.11	0.37	291	Personal Demographic
Science required for College	-.08	0.48	291	Personal Demographic
Grade Currently Teaching	-.07	1.70	276	School Demographic
Gender	.06	0.38	291	Personal Demographic
Years With Principal	-.02	1.7	291	School Demographic

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

This section focuses on the relationship between instructional leadership scores and background variables. With regard to these scores for instructional leadership, it is important to note that 6 of the 18 questions on the instructional leadership section of the survey focus on science in particular, so the scores reflect instructional leadership as it relates to science. There were five background variables that appeared to be significant at the .01 level. In addition to the Pearson correlations, valuable data can be drawn in from other sources, and Table 4.12 below lists the two-way item comparisons and averages. Reliability of the responses was checked through a T Test, and all showed a p value of 0.00. As $p < .05$, one can reject the null hypothesis, strengthening the evidence of the data for this sample.

Table 4.12

Average Instructional Leadership Scores for Two-Way Item Comparisons

	I. L. Ave.		Frequency		Valid %		St. Dev.		Sig.:
Demographic Factor	Yes	No	Yes	No	Yes	No	Yes	No	P val.
Science Kit in School?	3.17	2.83	145	159	47.7	52.3	0.85	0.86	0.00
Coordinator in Grade?	3.38	2.87	70	236	32.9	77.1	0.72	0.87	0.00
Coordinator in School?	3.25	2.83	116	190	37.9	62.1	0.82	0.86	0.00
Science Major or Minor at College?	3.20	2.95	253	50	83.5	16.5	0.83	0.86	0.00
Science Required for College?	2.94	3.08	117	190	38.1	61.9	0.87	0.86	0.00

Principal intervention variables, personal demographic variables and school demographic variables and are analyzed in turn below.

Principal Intervention Variables. The highest four correlating items in table 4.11 are all principal intervention variables, in particular the items relating to the presence of a *science coordinator in the grade* (.25) and a *science coordinator in the school* (.24). This could be because the teachers are receiving good distributional leadership from principals. The value of a coordinator raised by one interviewee who says "But my team, the three of us, talk a lot especially with Mary (the science coordinator) So she was really helpful. So she was kind of a guide…if any guidance in science…it was from Mary." In Table 4.12, instructional leadership scores average higher for the faculty members with a coordinator than those without.

There might also be a realization by teachers that the school head cannot be an expert in all fields, and indeed is probably an expert in language arts rather than science. A good principal recognizes this and may defer direct involvement to a specialist. Principal confidence in science is mentioned by this interviewee:

> …the principal who feel more themselves confident in the areas of science they probably question me less or question the curriculum less because they can see it themselves and they can understand what is coming in. So I think our principal probably stays out of it and I don't know if that's directly related to this perception of himself as a scientist or as a teacher of science.

There is also the time factor within schools, and strong instructional leaders might also be seen to be using accordion models of message sending through science coordinators to faculty. Thus support is given, and the perception of good instructional leadership is present. Another interviewee adds, "My principal relies heavily on us as curriculum units' PYP coordinators…he is very good at questioning and looking at overall programming and saying to us where is the science in that unit"

Table 4.11 above highlights a statistically significant correlation between the presence of a *science kit in the school* (.20) and the perception of good instructional leadership. This relates to the desire for faculty to be receiving good supplies for science lessons. The kits are easy to stock and would give the perception of a leader who, while maybe not a science specialist, is aware of the need to give the faculty good resources.

In Table 4.12, faculty members with a science kit in their school rate their principals higher in total on the instructional leadership score. This may reveal satisfaction in a leader that answers requests for more resources and support from staff. The introduction of such new and complex resources also needs front loading and good instructional leaders would offer some training. One interviewee recalls the introduction of FOSS kits to their school:

> We have an outstanding, like I said, lab instructor but even she was not trained on the FOSS kits…. no one came and said that this is a good idea, this is a bad idea and no one introduced the whole kit even when they adopted a new program. I think in the States they do find trainers when you adopt a new program, so they at least will for a week someone comes and train you on the new program.

A final area of significant correlation with principal intervention variables at the .01 level is the *number of science in-service days* (.19) faculty members have attended at their school. A good instructional leader needs to offer support to the faculty not only through specialist colleagues and resources, but also through professional development. Those principals scoring high in instructional leadership tend to provide science in-service days for faculty. The utilization of in-service days is seen as a positive leadership trait. Table 4.13 reveals the majority had had no science in-service, but instructional leadership average scores do appear trend upward with the increase in days.

Table 4.13

Instructional Leadership Average Scores for the Number of Science In-service Days in School

Science In-service days at current school	Instructional Leadership Average	Frequency	Valid Percent	Standard Deviation
0	3.76	211	71.3%	0.82
1	3.6	25	8.4%	0.81
2	4.11	21	7.1%	0.80
3	3.89	16	5.4%	0.74
4	3.70	7	2.4%	0.95
5	3.68	7	2.4%	0.77
6	3.97	6	2.0%	1.17
7	4.54	1	.3%	-
8	3.85	1	.3%	-
9	4.46	1	.3%	-

A lack of science training was supported by data from the interviews. As a typical comment, an interviewee stated that "In this particular school, we've had a lot of professional development in general topics, teaching in general, but not science in particular. In past schools, I don't think I've ever gone to a science in-service training."

Personal Demographic Variables. In looking at individual variables, the number of *years in education* (.17) for respondents is seen as having a statistically significant correlation with good instructional leadership at the .01 level. Reasons for this may include a higher level of confidence in teaching, thus a lower need for support from principals. Conversely, however, it might be argued that a more experienced teacher is more critical of their leaders, which could show that there is a high level of instructional leadership being practiced in international schools in the opinion of more experienced faculty. Grouping the data from Appendix O reveals the following average scores in Table 4.14:

Table 4.14

Instructional Leadership Average Scores for Respondents' Years in Education

Years in Education	Instructional Leadership Average	Frequency	Valid Percent
1-10 yrs	2.86	128	41.8%
11-20 yrs	3.15	109	35.6%
21-30 yrs	3.23	45	14.7%
31-40 yrs	3.41	24	7.8%

This shows a trend where the number of years teaching increases the perception of instructional leadership being present in the school.

A slight correlation is seen between having a *science major or minor at college* (.11) and faculty perceptions of instructional leadership, which might relate to having a little more confidence in their own abilities, therefore requiring a little less support from their principals. There are no key observations when looking at the breakdown of individual subjects within this sector, but a slight increase in scores overall is noted in Table 4.12. There are slight negative correlations between *science required for college* teacher education programs (-.08), but no significant difference is noted in the overall response averages, as seen in table 4.12.

Gender (.06) was also slightly positively correlated, with more males correlating with good instructional leadership. This slight difference is corroborated in the overall average scores calculated in Table 4.15 below:

Table 4.15

Instructional Leadership Average Scores for Respondents' Gender

	I. L. Ave.		Frequency		Valid %		St. Dev.		Sig.:
Demographic Factor	Fem.	Male	Fem.	Male	Fem.	Male	Fem.	Male	P val.
Gender	2.96	3.10	253	53	82.7	17.3	0.88	0.79	0.00

Finally, in looking respondents' *country of origin*, the instructional leadership averages in Table 4.16 are noted in those countries with more than 5 respondents:

Table 4.16

Instructional Leadership Average Scores for Respondents' Countries of Origin

Country of origin	Instructional Leadership Average	Frequency (n>5)	Valid Percent	Standard Deviation
Mexico	3.80	6	1.9%	0.73
India	3.50	5	1.6%	0.67
Philippines	3.46	6	1.9%	1.20
Canada	2.94	20	6.5%	0.85
US	2.94	194	63.1%	0.85
New Zealand	2.89	9	2.9%	0.81
UK	2.80	17	5.5%	0.84
Australia	2.76	19	6.1%	0.82

ANOVA tests on this data revealed a p value of .082. As $p < .05$, one cannot reject the null hypothesis

While the country of origin data is limited in that respondents' country of schooling was not considered, the data above could suggest that faculty who have been educated in schools similar to the US system (Canada, US, New Zealand, UK and Australia) they are now teaching in have a lower view of their principals' instructional leadership capacities.

School Demographic Variables. In looking at school-level variables out of the control of principal instructional leadership, there is a negative correlation with *elementary school size* (-.12) and the perception of good instructional leadership practice at the .05 level. This item is broken down further in Appendix P. It suggests a slight correlation between positive perceptions of instructional leadership and smaller schools. In a smaller school, the principal may have more time to spend in the classrooms. One interviewee mentions this in stating "I think the principal's role is to make a schedule that accommodates and makes science more of a priority". Smaller schools, especially those with labs, could possibly offer more time for science.

There might also be more flexibility in a smaller school to schedule principal visits to science classes in particular. This interviewee mentions that even though visiting time is scheduled, busy principals cannot make it to classes:

> A case like the assistant principal walking (in) when I am doing the lab that she really enjoyed when she taught First Grade. 'Oh…you doing this activity and I'm wondering how you guys doing it!' So she is interested in it and would like to see what kind of lesson plans do I have? As far as coming in and observing on those days, I think even if they planned it something seems to come up during the day.

Instructional leadership relationship with the *grade currently teaching* (-.07) leans slightly toward a higher correlation with the younger years, but there is little variation between the averages produced when comparing grades to each other (see Appendix Q). A very slight negative correlation between *years with principal* (-.02) and faculty perceptions of instructional leadership is noted. The data is supported with the averages shown in Appendix R. This may be linked to positive first impressions of newer leaders with regard to instructional leadership as it pertains to science in classrooms, or indeed suggest that faculty may become jaded with the same leaders for long periods.

Interview Themes for Research Question 2

With regard to the key interview themes for research question 2, many respondents cite a lack of science background knowledge as a key influence on the confidence they had in the classroom. Also, few interviewees could recall any science at all from when they were at elementary school, while a few more recalled science at middle school and most remember some high school science. Levels of enjoyment in these sessions also varies. It is significant that many respondents, while citing a lack of science knowledge, feel they had enough knowledge to be able to teach science in the elementary school. In looking back at their science training in teacher education courses, most of the 17 interviewees had experienced at least one course, and all have positive memories of the teaching standards within these courses.

There is a split between those teachers who were confident in teaching science, but not confident with the background knowledge, and those teachers who are confident with both the teaching of science and their own background knowledge. There is also a strong feeling from interviewees that confidence levels will increase with practice in teaching elementary school science. Having a general aptitude for learning science is seen by many interviewees as a reason for high PSTE levels, as is a general love of science or simply being a well prepared elementary school teacher exhibiting best practice.

Path Analysis

It is valuable to look at the links among the variables and items in diagrammatic form through path analysis. "Path analysis is used mainly in the attempt to understand comparative strengths of direct and indirect relationships among a set of variables" (Stoelting, 2002, ¶1). Regression analysis was studied with the outcome variable PSTE, the key endogenous variable principal instructional leadership and exogenous control variables being the instructional leadership items and relevant demographic items. "Exogenous variables in a path model are those with no explicit causes… Endogenous variables include intervening causal variables and dependents…. The dependent variable(s) have only incoming arrows" (NCSU, 2008, ¶6).

The calculated beta coefficients are shown in Tables 4.17 and 4.18 below:

Table 4.17

Path Analysis Beta Coefficients: PSTE as Dependent Variable

Independent Variables	Beta Coefficient	Standard Deviation	T	Sig.: P val.
PIMRS Average	.14	.06	1.97	0.05
Coordinator in School	.03	.10	0.46	0.65
Coordinator in Grade	.04	.12	0.46	0.65
Science Kit in School	.10	.09	1.37	0.17
Science Required for College	.08	.09	1.28	0.20
Science Major or Minor	.24	.12	3.84	0.00
Gender	.09	.11	1.34	0.18
Elementary School Size	.01	.02	0.19	0.85
Science In-service Days	.05	.03	0.83	0.41
Years with Principal	.04	.03	0.60	0.55
Years in Education	-.03	.01	-0.49	0.63
Grade Currently Teaching	.03	.03	0.38	0.70

Significant at $p < .05$

Table 4.18

Path Analysis Beta Coefficients: Instructional Leadership as Dependent Variable

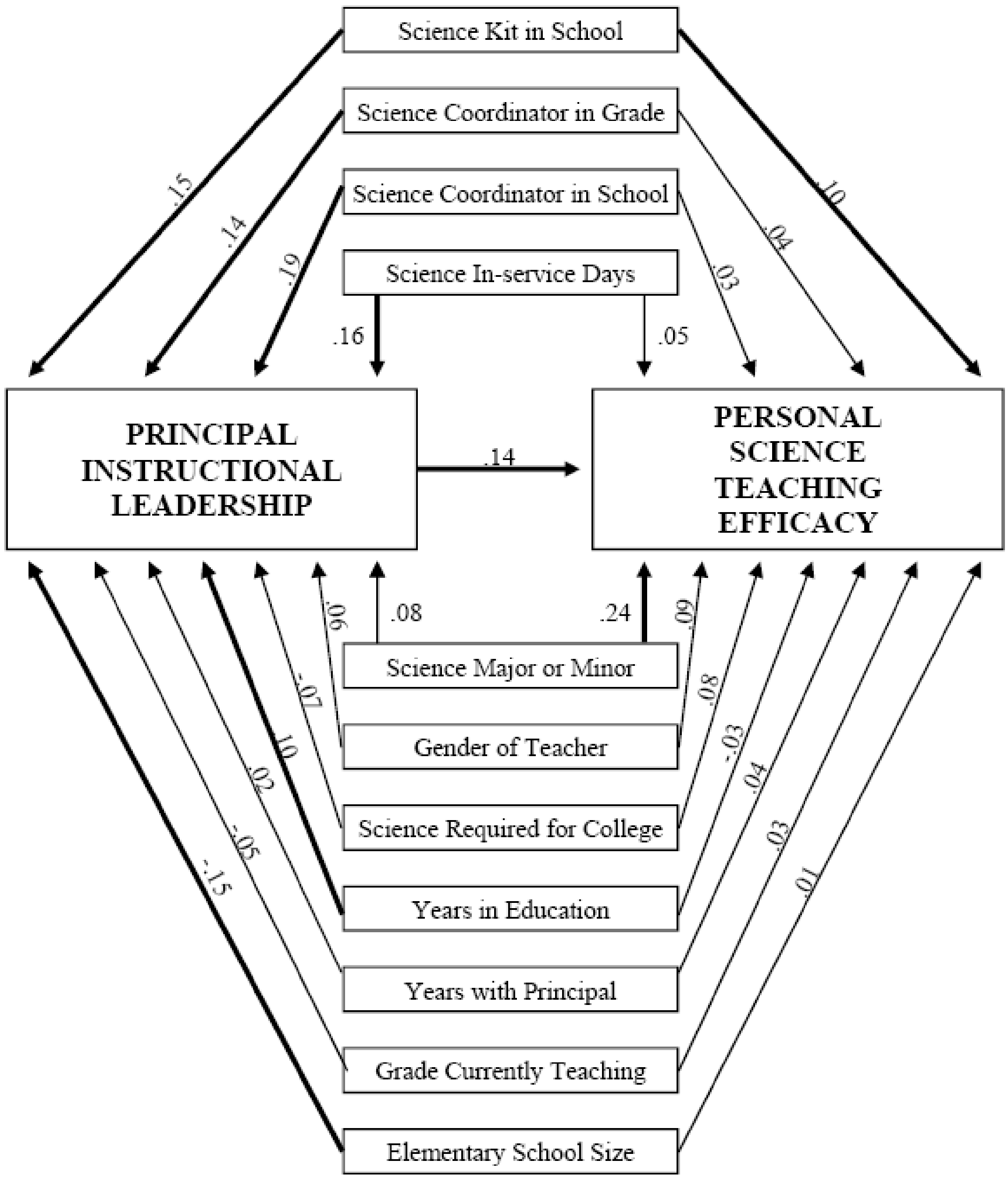
Independent Variables	Beta Coefficient	Standard Deviation	T	Sig.: P val.
Coordinator in School	0.19	0.11	2.87	0.00
Coordinator in Grade	0.14	0.14	1.97	0.05
Science Kit in School	0.15	0.11	2.26	0.03
Science Required for College	-0.07	0.11	-1.10	0.27
Science Major or Minor	0.08	0.14	1.28	0.20
Gender	0.06	0.13	0.94	0.35
Elementary School Size	-0.15	0.02	-2.40	0.02
Science In-service Days	0.16	0.03	2.65	0.01
Years with Principal	0.02	0.03	0.24	0.81
Years in Education	0.10	0.01	1.51	0.13
Grade Currently Teaching	-0.05	0.03	-0.84	0.40

Significant at $p < .05$

Using the beta coefficients, a path analysis diagram was constructed. This is shown in Fig. 4.2. In the diagram, PSTE is the dependent variable, instructional leadership is the key endogenous variable, and the exogenous variables are the background factors. The latter have been itemized and their individual path coefficients are illustrated in the form of beta weights, based on regression analysis. To aid comparison, items with beta weights .10 or more are joined by bold lines.

Fig. 4.2

Path Analysis



The diagram above illustrates the influence of principal instructional leadership on PSTE (.14). There is also a notably higher path coefficient between the study of a science major or minor on PSTE (.24), suggesting this is also an important influence, beyond instructional leadership. Both of these have significance at $p < .05$. Two other background variables of science kits in schools (.10), and gender (.09) also appear to have influence on PSTE, although these are not significant at $p < .05$.

With regard to items influencing principal instructional leadership, the following had high beta weights and significance at $p < .05$; science coordinators in schools, science coordinators in grades, science in-service days, science kits in school and school size. Years in education also has a higher beta weight, but no significance at $p < .05$.

Inter-Item Correlation Analysis

Inter-item correlations within the instructional leadership scale are shown in Appendix S, with the highest Pearson correlations in bold. In looking at these strongest correlations, *uses assessments to see progress to science goals* and *meets with teachers to discuss student science progress* have a significant correlation with each other (.75). There are also highly significant correlations between *talks informally with faculty and students* and *classroom discussions of student or faculty issues* (.70), and *informal observations of science lessons* and *feedback illuminates strengths/weaknesses in science* (.70). The first of these pairs relates to progress, the second to discussions and the third relates to faculty evaluation. These correlations may add weight to the reliability of the scale.

Inter-item correlations within the PSTE scale are shown in Appendix T. The three highest correlations are among negatively weighted items. They are between *when a student has difficulty understanding a science concept, I am usually at a loss as to how to help the student understand it better* and *I wonder if I have the necessary skills to teach science* (.62), *I don't know what to do to turn students on to science* and *I wonder if I* *have the necessary skills to teach science* (.60) and *I generally teach science ineffectively* with *even when I try very hard, I don't teach science as well as I do most subjects* (.60). The grouping together of negative items suggests a degree of reliability within this instrument.

Appendix U shows the strength of correlations among the individual demographic factors. As might be expected, there is a statistically significant correlation between having a *science coordinator in the grade* and having a *science coordinator in the school* (.38). There is also a statistically significant correlation between having a *science kit in the school* and a *grade level science coordinator* (.38) and the presence of a *school level science coordinator* (.16). These are linked, as it is a coordinator who may push for science kits, or who may have been initially employed to facilitate the use of a new kit. The statistically significant *school size* correlation to *science coordinator in grade* (.28) suggests that principals are aware of the need for some form of distributed leadership model in larger elementary schools. In addition, the presence of a *science coordinator in the school* has a statistically significant correlation with the number of *science inservice days* (.24). This would suggests a coordinator can add weight to an argument to bring support in to struggling faculty. This has a correlation with higher PSTE scores as discussed previously. There is also a statistically significant correlation with *gender* and *grade level currently teaching* (.20) suggesting male teachers are more present in higher grades.

Key Research Findings

In reflecting on the data analysis in Chapter 4, a central finding was the statistically significant correlation between elementary school teachers' perceptions of principal instructional leadership and the teachers' PSTE. There were also statistically significant correlations between PSTE and principals who discuss goals at faculty meetings, designate science coordinators for grades, participate in science curricular review, support recognition of student progress, encourage new skills and concepts, discuss student progress with faculty, and use assessments to see science progress towards easily developed goals.

Additional survey findings showing statistically significant correlations to higher PSTE are linked to teachers who have studied science related majors or minors at college. There were also statistically significant correlations relating to the presence of a science kit at a school and the utilization of science coordinators at grade and school level. Notable correlations were also found between teacher gender, the requirement for science to enter college and the use of science in-service days to PSTE though these were not statistically significant.

Calculation of weights of influence on PSTE through examination of beta coefficients suggests principal instructional leadership has a statistically significant influence. However a higher level of background influence relates to the study of a science major or minor by teachers when at college. The use of science kits in schools and teacher gender also appear to have a marked degree of influence. Statistically significant influences upon principal instructional leadership are science coordinators in schools, science coordinators in grades, science in-service days, science kits in school and school size.

Analysis of interviews revealed that the teachers saw principals as being central to raising PSTE levels through the promotion of professional development, use of scheduling that would allow for team planning and collaboration time, setting agreed science goals, hiring faculty with science backgrounds, increasing assessment of science and utilizing resources and support staff. Some interviewees stated that principals often lack confidence in science, need to become more involved with in-school and extra-curricular science, rarely gave guidance in science and had reading writing and math as priorities.

Interviewees mentioned few positive memories from early years schooling, but most had had valuable teacher education science experiences, and felt they could teach elementary science to a reasonable level even if not fully confident. Some felt that the PYP curriculum structure, as it did not lend itself to kits, could lower confidence levels and reduce science content in the classroom. Finally, higher confidence levels were mentioned in relation to science kits, more background knowledge, professional development, classroom experience, science aptitude and lesson preparation.

Chapter 5: Summary and Discussion

Introduction

The purpose of this research was to examine the relationship between K-5 elementary school teachers' perceptions of principal instructional leadership and their science teaching efficacy. This chapter consists of a summary of data collection procedures, major findings, implications for current policy and practice, and recommendations for future research.

Summary of Research

The data from this research were obtained through a mixed methods approach utilizing surveys. Respondents were drawn from member schools of nine international school regional associations. The following questions remain central to the research:

1. What is the relationship between K-5 elementary school teachers' perceptions of principal instructional leadership and their science teaching efficacy?
2. What other variables affect elementary school K-5 teachers' perceptions of their science teaching efficacy?

The quantitative component of the research consisted of a 43 question survey. The survey begins with 18 questions that were selected and adapted from the Principal Instructional Management Rating Scale (PIMRS) (Hallinger, 1987). This scale was followed by 13 questions in the PSTE section, taken unaltered from the Science Teaching Efficacy Belief Instrument (STEBI) (Enochs and Riggs, 1990). The survey ends with 12 questions, searching for background variables, which were selected following a comprehensive review of current theory.

A secure link to an electronic survey was sent to K-5 faculty members of 90 schools drawn from the nine international school regional associations. Following permission from elementary school principals who forwarded the survey, data analysis was carried out on the responses of the 356 participants. An interview schedule was subsequently designed to both clarify and develop responses from the survey. Twenty survey participants were subsequently interviewed.

Major Findings of the Research

Results of the study indicate there is a statistically significant correlation between elementary school teachers' perceptions of principal instructional leadership and the teachers' PSTE. Analysis of data from the instructional leadership scale reveals items that correlate significantly with PSTE levels. These items are the discussion of goals at faculty meetings, designating science coordinators for grades, participating in science curricular review, supporting recognition of student progress, encouraging new skills and concepts, discussing student progress with faculty, and using assessments to see science progress towards easily developed goals.

Principal intervention variables with statistically significant correlations to PSTE are the presence of grade or school science coordinators and the use of science kits in the school. In looking at personal demographic variables, the most statistically significant correlation found in the study is between faculty members who had a science related major or minor at college and higher PSTE levels. Data from the path analysis suggest that the highest levels of influence on PSTE are instructional leadership and the study of a science related major or minor at college.

There is also a positive, though not statistically significant, correlation between gender and PSTE. There were two other background variables that, while positive, were notable in that analysis returned lower than expected correlations to PSTE levels. The first relates to the requirement for science to enter teacher education. There was also a lower than expected correlation between PSTE scores and science in-service days.

Interviewees mention key areas relating to instructional leadership and higher PSTE levels in schools. These are the perceived need for principals to promote professional development, use scheduling that would allow for team planning and collaboration time, establishing agreed science goals, hiring faculty with science backgrounds, and becoming more involved with in-school and extra-curricular science activities.

Increasing assessment of science goals and more utilization of resources such as science kits and using science support staff is also suggested. With regard to curriculum, the use of the International Baccalaureate Primary Years Program was often mentioned in connection with a reduction in science content. The need for background content during in-school PYP unit design was highlighted, the lack of which may lead faculty to avoid more complex science areas in favor of more familiar life science modules.

Interviewees note that many principals have reading, writing, and math as priorities, and some mentioned that their principals appeared to lack confidence in providing instructional leadership for science. Over half of the interviewees had never received any guidance in the sciences from their principals, though the presence of a science coordinator was said to be helpful. Professional development was cited as a solution to raising teacher confidence levels, but many teachers related their lack of proximity to universities for relevant training as being a reason for lower levels of science professional development in their schools.

Other factors that interviewees frequently mentioned relate to their own backgrounds. Many respondents cited a lack of science knowledge as central to their lack of science instruction strategies. Although many cited a lack of knowledge, however, they still felt they were able to teach science to their classes with reasonable success. With regard to teacher education, most of the interviewees had attended a science course, and all had positive memories of these courses. There was also a strong feeling that more years teaching elementary school science, possessing a general aptitude for learning science and being well-prepared elementary school teachers were linked to higher PSTE scores.

Relationship of Major Findings to Literature

Areas where this study enhances and supports previous research are highlighted in this section. It focuses on principal instructional leadership, significant principal instructional leadership items, and major related background variables.

Principal Instructional Leadership

The statistically significant correlation between principal instructional leadership and PSTE supports previous research suggesting principal instructional leadership can contribute to higher student achievement in schools (Shoemaker & Fraser, 1981, Carter & Klotz, 1990, Hallinger & Heck, 2000, Hopkins, 2002, Southworth, 2002, O'Donnell & White, 2005), and its link to increased teacher efficacy (Hoy and Woolfolk, 1993). This research also supports Ginns and Watters' (1999) finding that teachers in elementary schools raised issues of confidence when teaching science lessons. Previous research linking effective science teaching in schools to teacher self-efficacy (Harlen and Holroyd, 1995, Shallcross et al., 2002), the finding that 'perceived self-efficacy' contributes to motivation and performance (Bleicher, 2004), and the finding that poor instructional leadership contributed to ineffective science teaching (Edmonds, 1979) are also supported by the results of this study.

Significant Principal Instructional Leadership Items

In this research it was found that certain items on the instructional leadership survey had statistically significant correlations with higher PSTE scores. These items related to principals who discussed goals at faculty meetings, had a designated science coordinator, participated in science curricular review, recognized student progress, encouraged new skills and concepts, discussed student progress with faculty, and used assessments to see science progress towards easily developed goals. These results are linked to those of Johnson (1993), who noted that communicating with staff was a key component of effective leadership, and Blasé and Blasé's (1999) finding that principals who were visible, praised results and extended autonomy were practicing key aspects of effective instructional leadership. These higher ranking instructional leadership items also correspond with the findings of Marzano (2005) who noted that principals who were monitoring and evaluating practices, providing necessary materials, involving teachers in decisions and were knowledgeable correlated strongly with student achievement. Smith & Andrews (1989) also found that successful instructional leaders were those who communicated with teachers, encouraged new instructional strategies, utilized staff development, were knowledgeable of the curriculum and monitored student progress, all of which bear similarities to the major correlations in the leadership items in this research.

Major Related Background Variables

In this study, PSTE correlated most strongly with teachers who had studied a science major or minor. Darling-Hammond (2000) found a more powerful predictor of student achievement than teachers' education levels was the percentage of teachers with a major in the field being taught, which is supported by this research. This study also supports studies that have drawn positive correlations between confidence in teaching science and understanding in the context of the subject (Harlen and Holroyd, 1997, Kallery and Psillios, 2001), and that have found strong background science knowledge was an influential factor toward successful science teaching (Franz & Enochs, 1982, Harlen and Holroyd, 1995, Shallcross et al, 2002, Kallery & Psillos, 2005, Wheeler, 2006). The research also found that many elementary school teachers tended not to be science specialists, as found by Akerson & McDuffie (2002).

The statistically significant correlation between the presence of a science kit and higher PSTE scores in this research supports other researchers’ findings that science resources influence science teaching (Helgeson et. al, 1977, Fulp, 2002, Bybee and Scotter, 2006). There is also a similarity in the percentage of international schools surveyed using kits, at 52%, to research from Fulp (2002) that found 60% of schools in the US used a science program. Furthermore, in this research, interviewees stated that good resources were important for higher confidence levels in science, as was found by Harlen and Holroyd (1997).

Statistically significant correlations in this research were found between the presence of science coordinators at grade and school levels and higher PSTE scores. This supports National Science Teacher Association recommendations that there is a need for the cultivation of a leadership network from principals through department heads (NSTA, 2007b). Findings in this research are also linked those of Harlen and Holroyd (1997), who noted that elementary teachers' confidence in science was influenced by support that was available from colleagues.

Implications for Practice and Policy

The findings of this research have implications for both leadership practice and policy and these will be discussed in turn. With regard the leadership practice of elementary school principals, a focus on the higher correlating items on the survey should raise confidence levels in science teaching.

There are also implications relating to the background science knowledge of faculty. When hiring, principals may want to determine the science background of prospective faculty members, although in the current international school climate, principals are finding the applicant pool for all elementary teaching positions shrinking. With regard scheduling and curriculum implications, principals could allocate more science teaching responsibilities to stronger science teachers in the elementary school, possibly switching classes or team-teaching with other faculty.

The use of science coordinators correlates with higher PSTE scores, which also has implications for leadership. There was a slightly higher correlation with the use of grade level coordinators, suggesting more of a need at the grade level rather than having one coordinator for the school. School level science coordinators also raise the profile of science education within a school, and organize curriculum design, in-service days and faculty collaboration. With regard to international schools, principals may wish to focus attention on curriculum development and strengthening science content in PYP programs. In addition, creative instructional leadership could increase cross-disciplinary science links.

School principals are also central to decisions of budget allocations for resources. Therefore the correlations between science kit use and higher PSTE levels is relevant. These kits are expensive and need constant maintenance. Leaders may feel that the presence of a kit, if well introduced and supported, is worth the financial commitment. International schools, however, often have problems with re-ordering consumable items and finding items such as live animals. There is also the added factor that many international schools have shrinking student roles and are tightening budgets, so resources may suffer. Many interviewees also expressed a desire for more in-service days, which they felt would improve science teaching. In-service levels may be further reduced due to budget constraints upon principals due to the current international economic climate.

With regard to policy, the positive correlation between having science majors and minors in college and higher PSTE scores highlights an area that has implications for teacher education, licensure requirements, and in-service training. Within teacher education, there may be a need for more opportunities for prospective and in-service elementary school faculty to attend science courses to raise knowledge levels, or increase requirements for such in-service programs to include science content. These could also take into consideration some of the correlations noted between gender and PSTE levels.

With regard to the US, the fact that NCLB legislation now has a science component is relevant, and elementary school teachers may be struggling to teach new areas of science. This may improve through higher PSTE levels if government bodies allocate funding through budgets to support science teaching. In the international context, regional organizations such as NESA may also see a need to raise PSTE levels for science education and look to disseminating information and running training sessions at regional conferences.

Strengths of This Study

This study utilized both qualitative and quantitative research methods. Such a mixed methods approach added depth to the data collected. The implementation of a sequential explanatory strategy in two phases also allowed for revisions and developments to occur to the interview and to follow up with areas of interest emerging from the survey.

The survey had high response rates, which is a reflection of the ease of access to and completion of the online survey instrument and initiating cooperation from school principals also ensured high rates of response. The survey host, "Survey Monkey" is also a familiar tool to many, and utilizing the university email system added legitimacy to the initial email. In addition, all schools had internet access, which reduced coverage error. The use of recognized and peer reviewed instruments also increased reliability of the research.

A further strength of this research is that it was carried out in an international school population, which is unique in the context of PSTE research. Both survey and interviews were initiated at the end of the school year, which allowed all faculty to have worked with their principal for at least one full year. There were schools from each of the nine international school regional associations, ensuring a breadth of opinions from a range of nationalities, while it was also standardized as all the member schools need some form of accreditation. Finally, the response rate of 28.7% increases reliability of research conclusions.

Limitations of this Study

Limitations arose due to non-response error, as it may have only been confident or interested faculty members who completed the survey, or confident principals who permitted it. The survey itself may have been left incomplete by some, while others may have been concerned with clicking on an external Internet link. Reliability issues may have occurred because some of the initiatives to raise the profile of science in the schools may have been implemented by prior school principals. In addition, some faculty members had only spent one year with the principal, and these opinions will differ from a teacher of longer standing.

Bias could have been a factor in some of the interviews due to this researcher being male, or through knowing a small proportion of the respondents. The respondents, coming from a wide range of educational and cultural backgrounds, may have interpreted some of the questions in different ways. Many schools had science coordinators, and this form of distributive leadership may have affected the respondents' perspective of their principal's leadership, and respondents were not all using the same science curriculum or teaching the same topics.

Recommendations for Future Research

With regard to future research, a subsequent survey may be designed with additional items in the instructional leadership scale. Factors such as a principal's national background could increase the scope of the cultural aspect of the study. There may also be factors added relating to a principal's experience or gender. It may be valuable to include reflections of survey respondents on their own levels of instructional leadership or PSTE. It may also be illuminating to include stakeholders' perceptions of their own definitions of leadership.

An identical longitudinal study in schools with the same principals may reveal valuable results if changes are put in place following the conclusions of this research. There would also be constructive data collected from a case study, which would allow for more analysis into the dynamics of one school. The major findings relating to science background could be analyzed in more detail than time permitted for this research. There could also be studies of PSTE levels before and after science education programs in schools, colleges or through in-service.

The influence of school context on both instructional leadership and PSTE is raised in this research. Therefore future researchers could analyze schools' internal and external school contexts. There could also be analysis of the influence of the science subject being taught, which may point to differing PSTE levels for different topic areas, and follow-up studies may replicate the study in US schools that are currently teaching to NCLB standards-based assessments. Finally, this research could be replicated in the same 90 schools, but with middle and high school science teachers and principals. This would allow comparisons to be drawn between what are often generalists teaching some science and specialists teaching only science.

Conclusion

The focus of this study is the analysis of the relationship between K-5 elementary school teachers' perceptions of principal instructional leadership and their science teaching efficacy. A statistically significant correlation is found between principal instructional leadership and teachers' PSTE levels. Certain aspects of instructional leadership are found to be statistically significant in explaining PSTE levels. These are a principal's ability to discuss easily understood goals at faculty meetings, encourage new skills and concepts, use assessments to see progress to science goals, support faculty recognition of student progress, participate in science curriculum material reviews, and discuss student progress in science with faculty.

The influence of background variables on elementary school teachers' PSTE levels is also analyzed. Statistically significant principal intervention variables include the employment of a grade or school level science coordinator and the support of science kits in the school. The most statistically significant correlation found in this research is that between having a science major or minor at college and higher PSTE levels. This finding may have implications for teacher recruitment strategies.

The key areas of elementary school leadership identified above can all lead to better science teaching practice through changes in policy and help create higher levels of teacher science efficacy. Such findings have important implications for teachers, school leaders, and policymakers.

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Appendices

Appendix A

Elementary Teacher's Science Teaching Efficacy Belief Instrument (Riggs & Enochs, 1990)

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters to the right of each statement.

SA = Strongly Agree A = Agree UN = Uncertain D = Disagree SD = Strongly Disagree

1. When a student does better than usual in science, it is often because the teacher exerted a little extra effort.
2. I am continually finding better ways to teach science.
3. Even when I try very hard, I don't teach science as well as I do most subjects.
4. When the science grades of students improve, it is most often due to their teacher having found a more effective teaching approach.
5. I know the steps necessary to teach science concepts effectively.
6. I am not very effective in monitoring science experiments.
7. If students are underachieving in science, it is most likely due to ineffective science teaching.
8. I generally teach science ineffectively.
9. The inadequacy of a student's science background can be overcome by good teaching.
10. The low science achievement of some students cannot generally be blamed on their teachers.
11. When a low achieving child progresses in science, it is usually due to extra attention given by the teacher.
12. I understand science concepts well enough to be effective in teaching elementary science.
13. Increased effort in science teaching produces little change in students' science achievement.
14. The teacher is generally responsible for the achievement of some students in science.
15. Students' achievement in science is directly related to their teacher's effectiveness in science teaching.
16. If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher.
17. I find it difficult to explain to students why science experiments work.
18. I am typically able to answer students' science questions.
19. I wonder if I have the necessary skills to teach science.
20. Effectiveness in science teaching has little influence on the achievement of students with low motivation.
21. Given a choice, I would not invite the principal to evaluate my science teaching.
22. When a student has difficulty understanding a science concept, I am usually at a loss as to how to help the student understand it better.

23. When teaching science, 1 usually welcome student questions.
24. I don’t know what to do to turn students on to science.
25. Even teachers with good science teaching abilities cannot help some kids learn science.

Appendix B

The Principal Instructional Management Rating Scale (Hallinger, 1987)

PART I: Please provide the following information about yourself:

(A) School Name: ____________________________
(B) Years, at the end of this school year, that you have worked with the current principal: 1 5-9 more than 15 2-4 10-15
(C) Years experience as a teacher at the end of this school year: 1 5-9 more than 15 2-4 10-15

PART II: This questionnaire is designed to provide a profile of principal leadership. It consists of 50 behavioral statements that describe principal job practices and behaviors. You are asked to consider each
question in terms of your observations of the principal's leadership over the past school year. Read each statement carefully. Then circle the number that best fits the specific job behavior or practice
of this principal during the past school year. For the response to each statement:
5 represents Almost Always
4 represents Frequently
3 represents Sometimes
2 represents Seldom
1 represents Almost Never
In some cases, these responses may seem awkward; use your judgment in selecting the most appropriate response to such questions. Please circle only one number per question. Try to answer every question.
Thank you.

To what extent does your principal . . . ?

I. FRAME THE SCHOOL GOALS
1. Develop a focused set of annual school-wide goals
2. Frame the school's goals in terms of staff responsibilities for meeting them
3. Use needs assessment or other formal and informal methods to secure staff input on goal development
4. Use data on student performance when developing the school's academic goals
5. Develop goals that are easily understood and used by teachers in the school

II. COMMUNICATE THE SCHOOL GOALS
6. Communicate the school's mission effectively to members of the school community
7. Discuss the school's academic goals with teachers at faculty meetings
8. Refer to the school's academic goals when making curricular decisions with teachers
9. Ensure that the school's academic goals are reflected in highly visible displays in the school (e.g., posters or bulletin boards emphasizing academic progress)

10. Refer to the school's goals or mission in forums with students (e.g., in assemblies or discussions)

III. SUPERVISE & EVALUATE INSTRUCTION
11. Ensure that the classroom priorities of teachers are consistent with the goals and direction of the school
12. Review student work products when evaluating classroom instruction
13. Conduct informal observations in classrooms on a regular basis (informal observations are unscheduled, last at least 5 minutes, and may or may not involve written feedback or a formal conference)
14. Point out specific strengths in teacher's instructional practices in post-observation feedback (e.g., in conferences or written evaluations)
15. Point out specific weaknesses in teacher instructional practices in post-observation feedback (e.g., in conferences or written evaluations)

IV. COORDINATE THE CURRICULUM
16. Make clear who is responsible for coordinating the curriculum across grade levels (e.g., the principal, vice principal, or teacher-leaders)
17. Draw upon the results of school-wide testing when making curricular decisions
18. Monitor the classroom curriculum to see that it covers the school's curricular objectives
19. Assess the overlap between the school's curricular objectives and the school's achievement tests
20. Participate actively in the review of curricular materials

V. MONITOR STUDENT PROGRESS
21. Meet individually with teachers to discuss student progress
22. Discuss academic performance results with the faculty to identify curricular strengths and weaknesses
23. Use tests and other performance measure to assess progress toward school goals
24. Inform teachers of the school's performance results in written form (e.g., in a memo or newsletter)
25. Inform students of school's academic progress

VI. PROTECT INSTRUCTIONAL TIME
26. Limit interruptions of instructional time by public address announcements
27. Ensure that students are not called to the office during instructional time
28. Ensure that tardy and truant students suffer specific consequences for missing instructional time
29. Encourage teachers to use instructional time for teaching and practicing new skills and concepts
30. Limit the intrusion of extra- and co-curricular activities on instructional time

VII. MAINTAIN HIGH VISIBILITY
31. Take time to talk informally with students and teachers during recess and breaks
32. Visit classrooms to discuss school issues with teachers and students

33. Attend/participate in extra- and co-curricular activities
34. Cover classes for teachers until a late or substitute teacher arrives
35. Tutor students or provide direct instruction to classes

VIII. PROVIDE INCENTIVES FOR TEACHERS
36. Reinforce superior performance by teachers in staff meetings, newsletters, and/or memos
37. Compliment teachers privately for their efforts or performance
38. Acknowledge teachers' exceptional performance by writing memos for their personnel files
39. Reward special efforts by teachers with opportunities for professional recognition
40. Create professional growth opportunities for teachers as a reward for special contributions to the school

IX. PROMOTE PROFESSIONAL DEVELOPMENT
41. Ensure that inservice activities attended by staff are consistent with the school's goals
42. Actively support the use in the classroom of skills acquired during inservice training
43. Obtain the participation of the whole staff in important inservice activities
44. Lead or attend teacher inservice activities concerned with instruction
45. Set aside time at faculty meetings for teachers to share ideas or information from inservice activities

X. PROVIDE INCENTIVES FOR LEARNING
46. Recognize students who do superior work with formal rewards such as an honor roll or mention in the principal's newsletter
47. Use assemblies to honor students for academic accomplishments or for behavior or citizenship
48. Recognize superior student achievement or improvement by seeing in the office the students with their work
49. Contact parents to communicate improved or exemplary student performance or contributions
50. Support teachers actively in their recognition and/or reward of student contributions to and accomplishments in class

Appendix C

Survey Questions

The survey below will consist of 5-point Likert-style questions unless stated:

Please answer the following questions with regard to your science teaching:

1. I am continually finding better ways to teach science
2. Even when I try very hard, I don't teach science as well as I do most subjects
3. I know the steps necessary to teach science concepts effectively
4. I am not very effective in monitoring science experiments
5. I generally teach science ineffectively
6. I understand science concepts well enough to be effective in teaching elementary science
7. I find it difficult to explain to students why science experiments work
8. I am typically able to answer students' science questions
9. I wonder if I have the necessary skills to teach science
10. Given a choice, I would not invite the principal to evaluate my science teaching
11. When a student has difficulty understanding a science concept, I am usually at a loss as to how to help the student understand it better
12. When teaching science, I usually welcome student questions
13. I don't know what to do to turn students on to science

To what extent does the elementary school principal:

14. Use data on student performance when developing the school's academic goals
15. Develop goals that are easily understood and used by teachers in the school
16. Discuss the school's academic goals with teachers at faculty meetings

17. Review student work products when evaluating classroom instruction

18. Conduct informal observations of science lessons on a regular basis (informal observations are unscheduled, last at least 5 minutes, and may or may not involve written feedback or a formal conference)

19. Point out specific strengths or weaknesses in teacher's science instructional practices in post-observation feedback (e.g., in conferences or written evaluations)

20. Make clear who is responsible for coordinating the science curriculum across grade levels (e.g., the principal, vice principal, or teacher-leaders)

21. Participate actively in the review of science curricular materials

22. Meet individually with teachers to discuss student progress in science

23. Use tests and other performance measure to assess progress toward school science goals

24. Protect instructional time of faculty

25. Encourage teachers to use instructional time for teaching and practicing new skills and concepts

26. Take time to talk informally with students and teachers during recess and breaks

27. Visit classrooms to discuss school issues with teachers and students

28. Compliment teachers privately for their efforts or performance

29. Reward special efforts by teachers with opportunities for professional recognition or memos in personnel files

30. Lead or attend teacher inservice activities concerned with instruction

31. Support teachers actively in their recognition and/or reward of student contributions to and accomplishments in class

Important Background and Demographic Information:

32. Do you have a science coordinator in the school? (Y/N)

33. Do you have a science coordinator for your grade level? (Y/N)

34. Do you have a science kit including manipulatives (such as FOSS) that is used throughout the school? (Y/N)

35. Science was a prerequisite of my attending my teacher education course (Y/N)

36. What was your major and minor in college?

________ Major ________ Minor

37. Gender M/F

38. Country of origin __________

39. Grade level you teach _________

40. Elementary School Population ____________

41. To what extent have you received in-service training in science education at your school? ______ Days?

42. Years working with current principal at end of current year _____

43. Years experience as a teacher at the end of this school year _____

Appendix D

Interview Schedule

Intro: Tell me a little about yourself….

1. Could you tell me what it is that you like the most about teaching science?

2. Could you share anything you do not like about teaching science?

3. What are your opinions on using prepared kits and schemes in science?

4. Thinking back to when you were a child, how would you describe your own science education?

5. How would you describe your perception of your own scientific knowledge?

6. What can you tell me about your own confidence in teaching science in the classroom?

7. Why do you think some teachers have more confidence teaching elementary school science than other teachers?

8. Could you share your opinions of the guidance you have had from your principal regarding teaching science in school?

9. How do you feel a leader's style relates to increasing student attainment in science?

10. In the survey, there tended to be a low score with regard to aspects of principal leadership that related to science, such as observing science lessons, or discussing science progress. Why do you think that is?

11. What forms of professional development in science have you attended at your current school?

12. Thinking back, how well do you think your training prepared you for teaching elementary school science?

13. What would you say is the most important thing that would make you feel more confident about teaching science in your classroom?

14. Is there anything else you would like to add?

In addition, the interviewees provided the following:

Grade currently teaching

Elementary school size

Years working with current with principal

Years in education

Gender

Country of origin

Appendix E

Original Email to Principals Requesting Participation

Dear (principal's name),

I am a teacher at the American Embassy School, New Delhi, and as part of the dissertation for my doctoral studies at the University of Minnesota, I am studying elementary school teachers' opinions on the teaching of science in the classroom. I am writing to you to request your permission for the elementary school faculty at (school's name) to take part in this survey.

Your faculty's views are very important in helping me to find out how we teach science in elementary schools, how teachers feel about teaching science and the levels of support schools can give to teachers. I hope their comments will enable developments to take place that can lead to better science teaching and better classroom support for elementary school faculty in the international school context.

If you would be willing for your elementary school faculty to participate in the study, please acknowledge your permission by replying to this email. The survey should take 5-10 minutes to complete.

If permission is granted, I will send you an email with an explanation for the teachers and a link to the University of Minnesota authorized survey. I am hoping that you will forward this second email to the elementary school faculty to enable them to participate should they wish.

If you would prefer, you may want to arrange to send me an email list of the faculty which will allow me to contact them directly. The names of schools and participants will be anonymous and confidential. If you would like additional information, please contact me at The American Embassy School, Tel: 91-11-26888854 ext 3402 or my supervisor in Minneapolis, Dr. Deanne Magnusson, Tel: 001-612-6269647, email: magnu002@umn.edu.

Thank you for your time and I hope to hear from you soon.

Yours sincerely,

Ian Clark

Appendix F

Follow-up Survey Letter to Approving Principals for Forwarding to Faculty:

Dear (principal's name),

Thank you so much for your cooperation in this project, your assistance is greatly appreciated. I enclose the cover letter and link for the survey, which focuses on areas of classroom practice, leadership and demographics. This can be forwarded to the faculty.

Regards,

Ian Clark (faculty letter below):

Dear Faculty Member,

I am a teacher at the American Embassy School, New Delhi, and as part of the dissertation for my doctoral studies at the University of Minnesota, I am studying elementary school teachers' opinions on the teaching of science in the classroom. I am writing to request your participation in a short survey.

Your faculty's views at the (school name) will be valuable in helping me find out how we teach science in elementary schools, how teachers feel about teaching science and the levels of support schools can give to teachers.

The survey will take 5-10 minutes to complete. Please try to answer all sections. No teacher, principal or school participating in the study will be identified. Survey responses are strictly confidential.

If you would like to participate, please click on the following secure link.

http://www.surveymonkey.com/s.aspx?sm=4_2fFxW63Yhrqed_2fsC3DesWQ_3d_3d

In completing the survey you give your consent for the data to be used as part of the study.

Thank you for your time and attention.

Yours sincerely,

Ian Clark

University of Minnesota Doctoral Candidate,
The American Embassy School, New Delhi, India,
Tel: 91-11-26888854 ext 3402 email: clark673@umn.edu
Doctoral supervisor: Dr. Deanne Magnusson,
Tel: 001-612-6269647 email: magnu002@umn.edu.

Appendix G

Interview Request for Principals to Forward to Faculty:

Dear (principal name),

I am writing to pass on my gratitude for your forwarding my earlier survey to the faculty at (school name). I have been lucky to have had a good global response to my survey and it will be interesting to analyze the results from such an international sample over the summer. While I realize I have already taken up a good deal of you and your faculty's time, I do have one more request. In order to triangulate my research, I am also looking for some faculty volunteers for telephone interviews. If you feel one or two members of your faculty might be willing, please could you pass on the following email below.

Thanks again for your attention.

Regards,

Ian Clark:

Dear Faculty Member,

Thank you for considering the recent Science Teaching Survey that was sent to (school name) as part of my dissertation research. I have been lucky in that it has helped me collect a great deal of data from over 90 international schools on how we feel about the subject. I do have one further request. If you would be interested in taking part in a short telephone interview on the subject of your science teaching in elementary schools, please could you email me at clark673@umn.edu.

Aside from the interview, if you did not have a chance to participate in the survey and now wish to do so, please click on the link below:

http://www.surveymonkey.com/s.aspx?sm=4_2fFxW63Yhrqed_2fsC3DesWQ_3d_3d

Kind regards,

Ian Clark

University of Minnesota Doctoral Candidate,
The American Embassy School, New Delhi, India,
Tel: 91-11-26888854 ext 3402 email: clark673@umn.edu
Doctoral supervisor: Dr. Deanne Magnusson,
Tel: 001-612-6269647 email: magnu002@umn.edu.

Appendix H

Ranked PSTE Average Scores for Respondents by Major in College

Major in College	PSTE Average	Frequency (N>5)	Valid Percent
Sociology	4.33	6	2%
Environmental Studies	4.13	7	2.3%
Mathematics	4.10	5	1.7%
English	3.89	31	10.3%
Geography	3.82	6	2%
Liberal Studies	3.82	6	2%
Education	3.80	41	13.6%
Elementary Education	3.78	105	34.9%
History	3.66	11	3.7%
Psychology	3.54	16	5.3%
Special Education	3.53	9	3%
Art	3.44	6	2%

Appendix I

Ranked PSTE Average Scores for Respondents by Minor in College

Minor in college	PSTE Average	Frequency (n>5)	Valid Percent
Environmental Studies	4.66	5	1.6%
Science	4.50	10	3.3%
Sociology	4.22	7	2.3%
Music	4.07	5	1.6%
Geography	4.01	8	2.6%
Health Education	3.96	5	1.6%
Education	3.93	18	5.9%
Biology	3.88	6	2%
Mathematics	3.83	12	3.9%
English	3.82	27	8.9%
History	3.78	13	4.3%
PE	3.76	6	2%
None	3.74	76	24.9%
Psychology	3.67	10	3.3%
Business Studies	3.67	5	1.6%
Special Education	3.62	7	2.3%
Art	3.61	7	2.3%
Social Studies	3.61	6	2%
Elementary Education	3.48	18	5.9%
ESL	3.36	5	1.6%
Political Science	3.33	5	1.6%

Appendix J

PSTE Average Scores for Respondents by Years in Education

Years in Education	PSTE Average	Freq.	Valid Percent	Years in Education	PSTE Average	Freq.	Valid Percent
1	3.62	9	2.9%	22	4	4	1.3%
2	3.29	10	3.3%	23	3.86	5	1.6%
3	3.95	13	4.2%	24	3.02	2	.7%
4	3.59	13	4.2%	25	3.09	11	3.6%
5	4.22	10	3.3%	26	3.92	3	1.0%
6	3.68	9	2.9%	27	4.33	3	1.0%
7	3.75	11	3.6%	28	4.08	2	.7%
8	3.88	21	6.9%	29	3.86	5	1.6%
9	3.86	10	3.3%	30	3.45	7	2.3%
10	3.81	22	7.2%	31	3.54	2	.7%
11	3.85	18	5.9%	32	4.38	1	.3%
12	3.79	19	6.2%	33	4.46	2	.7%
13	3.74	8	2.6%	34	3.90	3	1.0%
14	3.72	9	2.9%	35	3.95	5	1.6%
15	3.82	19	6.2%	36	3.79	4	1.3%
16	3.86	6	2.0%	37	3.08	1	.3%
17	3.92	4	1.3%	39	4.08	1	.3%
18	4.28	6	2.0%	40	3.46	1	.3%
19	3.46	3	1.0%	41	4.08	1	.3%
20	3.88	17	5.6%	42	2.38	1	.3%
21	4.03	3	1.0%	43	3.76	2	.7%

Appendix K

Frequency of Respondent Country of Origin

Country of Origin	Frequency
US	194
UK	17
Canada	20
Australia	19
New Zealand	9
Philippines	6
Mexico	6
India	5
None Specified	3
Costa Rica	2
South Africa	2
Germany	2
Colombia	2
Venezuela	2
Netherlands	1
Peru	1
Nicaragua	1
Macedonia	1
Colombia	1
South Korea	1
Croatia	1
Kenya	1
Ireland	1
Portugal	1
Austria	1
Uganda	1
Lebanon	1
Thailand	1
Benin	1
Uruguay	1
Kuwait	1
Pakistan	1

Appendix L

PSTE Average Scores for Respondents by Years with Principal at School

Years with Principal at the school	PSTE Average	Frequency	Valid Percent
0	3.38	1	.3%
1	3.78	128	42.1%
2	3.83	83	27.3%
3	3.82	31	10.2%
4	3.72	21	6.9%
5	4.14	21	6.9%
6	3.69	8	2.6%
7	3.87	3	1.0%
8	3.69	8	2.6%

Outliers removed: 23 yrs, 20 yrs, 17 yrs

Appendix M

PSTE Average Scores for Grade Respondents are Currently Teaching

Grade Currently Teaching	PSTE Average	Frequency	Valid Percent
KG	3.76	44	15.9%
1st Grade	3.72	48	17.4%
2nd Grade	3.89	46	16.7%
3rd Grade	3.92	38	13.8%
4th Grade	3.72	48	17.4%
5th Grade	3.83	52	18.8%

Appendix N

PSTE Average Scores for Respondents by Population of Elementary School

Elementary School Population	PSTE Average	Frequency	Valid Percent
0-100	3.71	51	17.7%
101-200	3.83	56	19.4%
201-300	3.87	38	13.2%
301-400	3.88	28	9.7%
401-500	3.85	25	8.7%
501-600	3.87	38	13.2%
601-700	3.89	22	7.6%
701-800	3.71	16	5.6%
801-900	3.95	5	1.7%
901-1000	3.65	4	1.4%

Appendix O

Instructional Leadership Average Scores for Respondents by Years in Education

Years in Education	Inst. Lead. Average	Freq.	Valid Percent	Years in Education	Inst. Lead. Average	Freq.	Valid Percent
1	2.50	9	2.9%	22	3.01	4	1.3%
2	2.76	10	3.3%	23	3.07	5	1.6%
3	2.91	13	4.2%	24	3.64	2	.7%
4	2.99	13	4.2%	25	3.50	11	3.6%
5	3.18	10	3.3%	26	3.43	3	1.0%
6	3.10	9	2.9%	27	3.46	3	1.0%
7	3.05	11	3.6%	28	3.00	2	.7%
8	2.54	21	6.9%	29	2.82	5	1.6%
9	2.73	10	3.3%	30	2.73	7	2.3%
10	2.84	22	7.2%	31	2.88	2	.7%
11	2.83	18	5.9%	32	4.28	1	.3%
12	2.81	19	6.2%	33	4.00	2	.7%
13	3.23	8	2.6%	34	3.57	3	1.0%
14	3.17	9	2.9%	35	2.98	5	1.6%
15	2.93	19	6.2%	36	3.12	4	1.3%
16	2.69	6	2.0%	37	3.56	1	.3%
17	3.22	4	1.3%	39	3.57	1	.3%
18	3.64	6	2.0%	40	1.33	1	.3%
19	3.71	3	1.0%	41	4.78	1	.3%
20	3.22	17	5.6%	42	2.28	1	.3%
21	3.65	3	1.0%	43	3.33	2	.7%

Appendix P

Instructional Leadership Average Scores for Respondents by Population of Elementary School

Elementary School Population	Instructional Leadership Average	Frequency	Valid Percent
0-100	3.06	51	17.7%
101-200	3.09	56	19.4%
201-300	3.11	38	13.2%
301-400	3.13	28	9.7%
401-500	2.76	25	8.7%
501-600	2.97	38	13.2%
601-700	2.90	22	7.6%
701-800	2.57	16	5.6%
801-900	2.71	5	1.7%
901-1000	3.07	4	1.4%

Appendix Q

Instructional Leadership Average Scores for Grade Respondents are Currently Teaching

Grade Currently Teaching	Instructional Leadership Average	Frequency	Valid Percent
KG	3.14	44	15.9%
1st Grade	2.98	48	17.4%
2nd Grade	2.99	46	16.7%
3rd Grade	2.78	38	13.8%
4th Grade	2.93	48	17.4%
5th Grade	2.95	52	18.8%

Appendix R

Instructional Leadership Average Scores for Respondents by Years with Principal at School

Years with Principal at the school	Instructional Leadership Average	Frequency	Valid Percent
0	2.50	1	.3%
1	3.07	128	42.1%
2	2.89	83	27.3%
3	2.99	31	10.2%
4	3.06	21	6.9%
5	2.81	21	6.9%
6	3.00	8	2.6%
7	2.46	3	1.0%
8	3.31	8	2.6%

Outliers removed: 23 yrs, 20 yrs, 17 yrs

Appendix S

Instructional Leadership Questions Inter-Item Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Uses data for goal setting	1.00	0.62	0.53	0.55	0.37	0.37	0.35	0.40	0.36	0.44	0.39	0.42	0.35	0.41	0.39	0.38	0.36	0.38
2. Develops easily understood goals	**0.62**	1.00	0.68	0.52	0.38	0.43	0.43	0.53	0.37	0.42	0.44	0.46	0.40	0.49	0.51	0.42	0.51	0.51
3. Discusses goals at faculty meetings	0.53	**0.68**	1.00	0.51	0.29	0.37	0.34	0.45	0.37	0.38	0.43	0.48	0.36	0.47	0.48	0.41	0.52	0.56
4. Reviews student work in evaluation	0.55	0.52	0.51	1.00	0.52	0.57	0.36	0.50	0.55	0.51	0.39	0.47	0.43	0.52	0.41	0.42	0.46	0.44
5. Informal observations of science lessons	0.37	0.38	0.29	0.52	1.00	0.70	0.27	0.37	0.60	0.55	0.21	0.31	0.36	0.44	0.34	0.37	0.26	0.34
6. Feedback illuminates strengths/weaknesses in science	0.37	0.43	0.37	0.57	**0.70**	1.00	0.41	0.55	0.66	0.63	0.27	0.34	0.35	0.48	0.40	0.41	0.35	0.36
7. Science coordinator designated for grade	0.35	0.43	0.34	0.36	0.27	0.41	1.00	0.57	0.44	0.45	0.34	0.38	0.35	0.41	0.40	0.38	0.36	0.43
8.Participates in science curriculum material review	0.40	0.53	0.45	0.50	0.37	0.55	0.57	1.00	0.53	0.59	0.39	0.50	0.40	0.54	0.46	0.46	0.47	0.53
9. Meets with teachers to discuss student science progress	0.36	0.37	0.37	0.55	**0.60**	**0.66**	0.44	0.53	1.00	0.75	0.28	0.30	0.34	0.52	0.39	0.43	0.30	0.34
10. Uses assessments to see progress to science goals	0.44	0.42	0.38	0.51	0.55	**0.63**	0.45	0.59	**0.75**	1.00	0.31	0.34	0.31	0.49	0.39	0.40	0.32	0.37
11. Protects instructional time of faculty	0.39	0.44	0.43	0.39	0.21	0.27	0.34	0.39	0.28	0.31	1.00	0.65	0.42	0.45	0.52	0.39	0.44	0.53
12. Encourages new skills and concepts	0.42	0.46	0.48	0.47	0.31	0.34	0.38	0.50	0.30	0.34	**0.65**	1.00	0.47	0.54	0.49	0.44	0.51	0.58
13. Talks informally with faculty and students	0.35	0.40	0.36	0.43	0.36	0.35	0.35	0.40	0.34	0.31	0.42	0.47	1.00	0.70	0.57	0.44	0.50	0.58
14. Classroom discussions of student or faculty issues	0.41	0.49	0.47	0.52	0.44	0.48	0.41	0.54	0.52	0.49	0.45	0.54	**0.70**	1.00	0.65	0.60	0.56	0.64
15. Compliments teachers privately on performance	0.39	0.51	0.48	0.41	0.34	0.40	0.40	0.46	0.39	0.39	0.52	0.49	0.57	**0.65**	1.00	0.67	0.60	0.65
16. Rewards faculty with recognition in files	0.38	0.42	0.41	0.42	0.37	0.41	0.38	0.46	0.43	0.40	0.39	0.44	0.44	**0.60**	**0.67**	1.00	0.49	0.59
17. Leads or attends instructional in-service	0.36	0.51	0.52	0.46	0.26	0.35	0.36	0.47	0.30	0.32	0.44	0.51	0.50	0.56	**0.60**	0.49	1.00	0.65
18. Supports faculty recognition of student progress	0.38	0.51	0.56	0.44	0.34	0.36	0.43	0.53	0.34	0.37	0.53	0.58	0.58	0.64	0.65	0.59	**0.65**	1.00

All above items have significant correlation at .01 level
Bold denotes significance > 0.6

Appendix T

Personal Science Teaching Efficacy Questions Inter-Item Correlation Matrix

	A	B	C	D	E	F	G	H	I	J	K
A. I am continually finding better ways to teach science	1.00	0.35	0.25	0.42	0.21	0.26	0.34	0.34	0.29	0.30	0.29
B. Even when I try very hard, I don't teach science as well as I do most subjects	0.35	1.00	0.50	0.60	0.49	0.31	0.53	0.58	0.47	0.29	0.49
C. I am not very effective in monitoring science experiments	0.25	**0.50**	1.00	0.51	0.49	0.31	0.49	0.47	0.49	0.24	0.44
D. I generally teach science ineffectively	0.42	**0.60**	**0.51**	1.00	0.52	0.26	0.48	0.53	0.51	0.26	0.48
E. I find it difficult to explain to students why science experiments work	0.21	0.49	0.49	**0.51**	1.00	0.35	0.52	0.46	0.54	0.29	0.41
F. I am typically able to answer students' science questions	0.26	0.31	0.31	0.26	0.35	1.00	0.40	0.30	0.40	0.36	0.29
G. I wonder if I have the necessary skills to teach science	0.34	0.53	0.49	0.48	**0.54**	0.40	1.00	0.58	0.62	0.47	0.60
H. Given a choice, I would not invite the principal to evaluate my science teaching	0.34	0.58	0.47	**0.53**	0.46	0.30	0.58	1.00	0.47	0.29	0.53
I. When a student has difficulty understanding a science concept, I am usually at a loss as to how to help the student understand it better	0.29	0.47	0.49	**0.51**	**0.54**	0.40	**0.62**	0.47	1.00	0.43	0.45
J. When teaching science, I usually welcome student questions	0.30	0.29	0.24	0.26	0.29	0.36	0.47	0.29	0.43	1.00	0.39
K. I don't know what to do to turn students on to science	0.29	0.49	0.44	0.48	0.41	0.29	**0.60**	**0.53**	0.45	0.39	1.00

All above items have significant correlation at .01 level
Bold denotes significance > 0.6
Two items removed

Appendix U

Demographic Factors Inter-Item Correlation Matrix

	Coordinator in School	Coordinator in Grade	Science Kit in School	Science Required for College	Science Major or Minor	Gender	Science Inservice Days	Years with Principal	Years in Education
Coordinator in School	1.00	.38**	.16**	-0.03	0.07	-0.03	.24**	.12*	0.04
Coordinator in Grade	.38**	1.00	.38**	0.09	0.01	0.00	0.10	-.15**	0.11
Science Kit in School	.16**	.38**	1.00	0.09	.12*	0.01	0.06	-0.03	0.11
Science Required for College	-0.03	0.09	0.09	1.00	0.00	-0.07	-0.01	-.15**	-0.09
Science Major or Minor	0.07	0.01	.12*	0.00	1.00	0.04	0.03	0.07	0.02
Gender	-0.03	0.00	0.01	-0.07	0.04	1.00	-0.03	-0.01	0.08
Grade Currently Teaching	-0.01	-0.03	-.15*	0.05	0.08	.20**	0.03	-0.03	-0.04
ES Population	0.08	.28**	0.11	-0.04	-0.01	0.01	0.01	.13*	.12*
Science Inservice Days	.24**	0.10	0.06	-0.01	0.03	-0.03	1.00	.14*	-0.02
Years with Principal	.12*	-.15**	-0.03	-.15**	0.07	-0.01	.14*	1.00	.14*
Years in Education	0.04	0.11	0.11	-0.09	0.02	0.08	-0.02	.14*	1.00

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

* Correlation is significant at the 0.05 level (2-tailed)